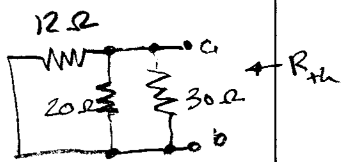
Solutions | Physics 116A Exam I | 11/3/04

23 1. (a) $20\,\Omega \parallel 30\,\Omega = \frac{20\times 30}{20+30}\,\Omega = \frac{600\,\Omega}{50} = 12\,\Omega$

$V_{ab} = 6V\left(\frac{12\,\Omega}{12\,\Omega + 12\,\Omega}\right) = \underline{\underline{3V}}$.

(b) $i_3 = V_{ab}/30\,\Omega = 3V/30\,\Omega = 0.1\,A$

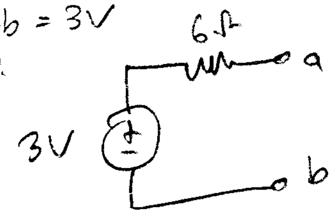
(c) set independent sources to 0 to find R_{th}



This gives $12\,\Omega \parallel 12\,\Omega = 6\,\Omega$

$V_{o.c.} = V_{ab} = 3V$

Equiv. Circuit:



24 2. (a) $\underset{\sim}{Z}_2 = R_2 + \frac{1}{j\omega C} = 2\,\Omega + \frac{1}{\frac{1}{6}\times 3j} = \underline{2(1-j)\,\Omega}$

(b) $\underset{\sim}{i}_2 = \underset{\sim}{i}_s \frac{R_1}{R_1 + Z_2} = \frac{\cancel{2}\,\Omega \times 5\,A}{\cancel{2}_1\,\Omega + \cancel{2}(1-j)\,\Omega} = \frac{5}{2-j}\,A$

$= \frac{5\,A}{2.24\angle -26.6^\circ} = \underline{\underline{2.24\angle 26.6^\circ}}$

(c) $\underset{\sim}{V}_o = i_2 R_2 = 2.24\angle 26.6^\circ \times 2\,\Omega = 4.47\angle 26.6^\circ\ V$

$V_o = 4.47\cos(3t + 26.6^\circ)$

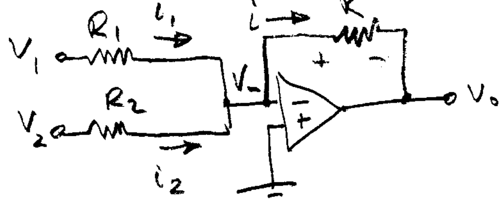
See note} ⇒ (d) $P_{av} = \frac{1}{2}\frac{|V_o|^2}{R_2} = \frac{1}{2}\times(4.47)^2/2\,\Omega = \underline{\underline{5\,W}}$. {For R_1 $\cos(\phi_1 - \phi_2) = 1$

15 3. (a) − input of Op-Amp is virtual ground ($V_- = 0V$).

(b) $\frac{V_1}{R_1} + \frac{V_2}{R_2} = i$

(c) $V_o = -iR = -\left[\frac{V_1}{R_1} + \frac{V_2}{R_2}\right]R$

Careful with sign of V_o: }



Note $V_- - V_o = iR$

$V_- = 0$

$\underline{\underline{V_o = -iR}}$.

Note on 2(d): In general, $P_{av} = \frac{1}{2} V_m I_m \cos(\phi_1 - \phi_2)$

where $V_m \equiv |\underset{\sim}{V}|$, $I_m \equiv |\underset{\sim}{I}|$, $\phi_1 = \arg(\underset{\sim}{V})$, $\phi_2 = \arg(\underset{\sim}{I})$.

(assuming sinusoidal voltages and currents, $\underset{\sim}{V}$ and $\underset{\sim}{I}$ are phasors.)

38 4. (a) $\underset{\sim}{V_o} = \frac{R}{R + j\omega L}\underset{\sim}{V_s} \Rightarrow \underset{\sim}{H}(j\omega) = \frac{R}{R + j\omega L} = \frac{1}{1 + j\omega L/R}$

see note below (b) $A_v = \sqrt{\underset{\sim}{H}^* \underset{\sim}{H}} = \sqrt{\frac{1}{(1 - j\omega L/R)(1 + j\omega L/R)}} = \sqrt{\frac{1}{1 + \omega^2 L^2/R^2}}$

(c) As $\omega \to 0$ $A_v \Rightarrow 1$. (Just substitute $\omega = 0$)

(d) $\frac{1}{\sqrt{2}} = \frac{1}{\sqrt{1 + \omega_c^2 L^2/R^2}} \Rightarrow 2 = 1 + \omega_c^2 L^2/R^2 \Rightarrow \underline{\underline{\omega_c = R/L}}$

(e) $\arg(H(j\omega_c)) = \arg\left(\frac{1}{1+j}\right) = \arg\left(\frac{1}{\sqrt{2}\angle 45^\circ}\right) = \underline{-45^\circ}$

(f) $H(\underset{\sim}{s}) = \frac{1}{1 + \underset{\sim}{s}L/R}$ (Note: just substitute **s** for jω)

(g) Pole where $1 + sL/R = 0 \rightarrow \underline{\underline{s = -R/L}} \ (= -\omega_c)$.

(h) low pass filter ($A_v = 1$ at $\omega = 0$ and falls like $1/\omega$ for $\omega \gg \omega_c$)

Note on Part (b): $\underset{\sim}{H}^*$ is the complex conjugate of $\underset{\sim}{H}$ (replace j with -j wherever it appears)