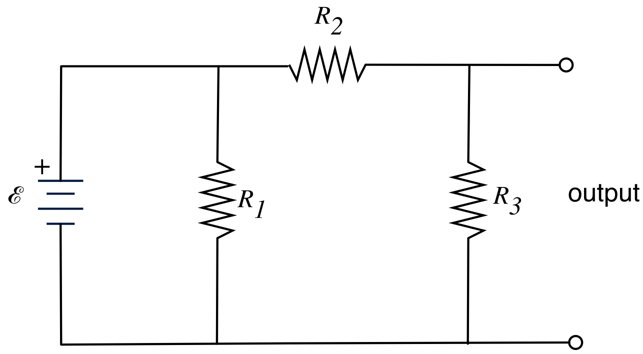
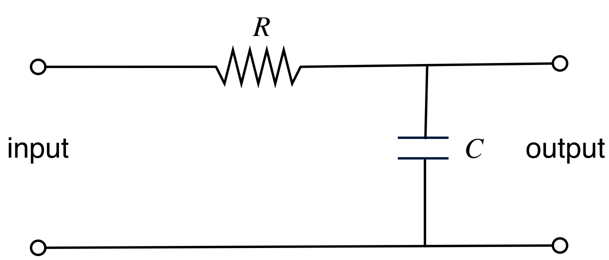
Phys2610 Mid-term Test
1 March 2016, 1:00 – 2:15 pm
Room 519 Allen

1. Find the Thevenin equivalent circuit for the circuit shown below. That is, find an equivalent ideal seat of *emf* with a series resistance that would behave in the same way at the output.

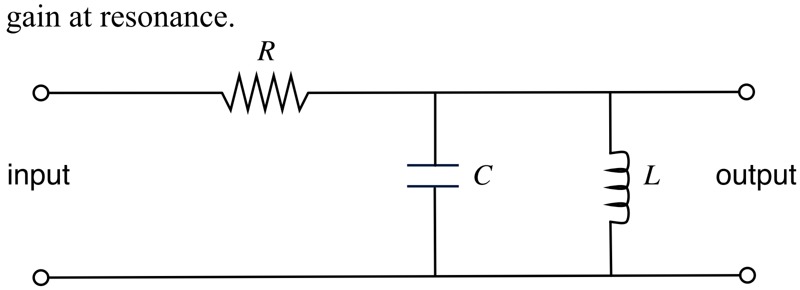


2. (a) For the RC circuit below, if $R = 1$ MΩ, and $C = 100$ μF, and the input is a step function from 0 to 6 V, how long does it take for the capacitor to charge from 3 V to 3.78 V? The capacitor is initially uncharged.

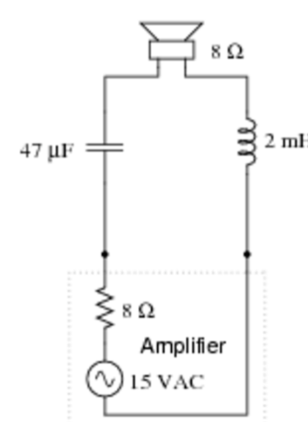
(b) For a 20-kHz ac input, and for $R = 1$ kΩ and $C = 10$ nF, what is the phase shift between the output and input voltages, and what is the gain in dB?



3. If the input in the circuit below is given by $v = V\cos(\omega t)$, express the output as a function of time. What is the gain at resonance.



4. Calculate the peak voltage across the inductor, capacitor, and the 8 Ω speaker in the circuit shown for the resonant frequency and for 200 Hz. Treat the speaker like a simple resistor.



PHYS 2610: Midterm Formula Sheet 2015

Current: $i = \frac{dq}{dt} = \int \mathbf{J} \cdot \overrightarrow{da}$

Steady state: $\frac{di}{dt} = 0; \oint \mathbf{J} \cdot \overrightarrow{da}$

Ohm's law: $\mathbf{J} = \sigma\mathbf{E} = \frac{\mathbf{E}}{\rho} \Rightarrow v = iR$ with $R = \rho\ell/A$

Current density: $\mathbf{J} = ne\vec{v}_d$

Gauss's law: $\oint \mathbf{E} \cdot \overrightarrow{da} = q_{net}/\varepsilon_0$

Electric potential and potential energy: $V = U/q;\ dU = qdV$

Potential difference and emf: $\int_a^b \mathbf{E} \cdot \overrightarrow{dl} = -(V_b - V_a);\ \oint \mathbf{E} \cdot \overrightarrow{dl} = 0$

Power: $P = vi$

Capacitor: $q = CV,\ U = q^2/(2C)$

Solution to $\frac{dy}{dx} + ax = b$ has the form $y = Ae^{-ax} + b/a$

Faraday's law: $\mathcal{E}_{ind} = \int_a^b \mathbf{E} \cdot \overrightarrow{dl} = -\frac{d}{dt}\int \mathbf{B} \cdot \overrightarrow{da} = -L\frac{di}{dt}$

Inductor: $\mathcal{E} = L\frac{di}{dt}$

Magnetic field of ideal solenoid: $B = \mu_0 nI$

Euler's formula: $e^{j\theta} = \cos\theta + j\sin\theta$

Complex impedance: $Z = R + jX = |Z|e^{j\phi}$; $\tilde{v} = Z\tilde{\imath}$; $v = \mathrm{Re}(\tilde{v}) = V cos\omega t$

Capacitive impedance: $Z_C = \frac{1}{j\omega C}$

Inductive impedance: $Z_L = j\omega L$

Series impedance: $Z = \sum Z_i$

Parallel impedance: $\frac{1}{Z} = \sum \frac{1}{Z_i}$

Gain in dB: $G_{dB} = 20\log\left|\frac{v_2}{v_1}\right|$

Q Factor: $Q = \omega_0 L/R$