Tuesday Reading Assessment: Unit 4, Reactance and Impedance

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1 Memory Bank

- $X_{\rm C} = 1/(2\pi f C)$ ... The reactance of a capacitor with capacitance C, at frequency f.
- $X_{\rm L} = 2\pi f L$ ... The reactance of an inductor with inductance L, at frequency f.
- $Z_{\rm tot} = \sqrt{R^2 + (X_{\rm L} - X_{\rm C})^2}$ ... The total impedance of a series circuit with resistance R, and reactances $X_{\rm C}$ and $X_{\rm L}$.
- $\tau = RC$ ... The time constant of an RC circuit.
- $f_0 = \frac{1}{2\pi\sqrt{LC}}$ ... The resonance frequency of an RLC circuit.

2 Reactance, Impedance, and Waveforms

1. (a) What is the reactance of a capacitor with $C = 0.1$ μF at a frequency $f = 1$ MHz? (b) What will the reactance be at $f = 0.5$ MHz? (c) If this capacitor is installed in an RC circuit with a 50Ω resistor, what is the total impedance? (d) What is the time constant of this circuit?

2. (a) What is the total impedance of an RLC circuit at $f = 10$ kHz, if $R = 100$ Ω, and $C = 10$ pF, and $L = 1$ μH? (b) What is the resonance frequency of this circuit?

3. An amplitude modulated radio wave is generated by a mixer based on an LC resonating circuit (see Fig. 1). The carrier, with frequency $f_{\rm C}$, and the audio, with frequency $f_{\rm A}$, are *mixed*. The modulated result is comprised of two frequencies: $f_{\rm C} - f_{\rm A}$, and $f_{\rm C} + f_{\rm A}$. (a) If we have an audio signal at 4 kHz and a carrier at 1 MHz, what are the final frequencies? (b) Given what you know about *filtering*, how would you construct a circuit that only responds to the signal at $f_{\rm C} + f_{\rm A}$?

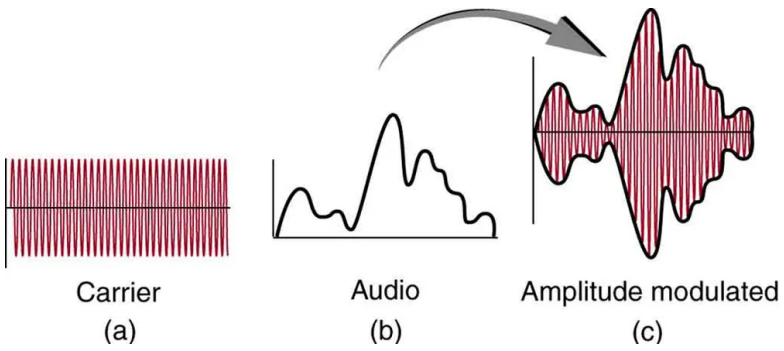

Figure 1: An example of an amplitude modulated (AM) waveform.