

Monday Reading Assessment: Unit 5, Field Induction and Inductance

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1 Memory Bank

- $\epsilon = -Nd\phi_m/dt$... Faraday's Law
- $\phi_m = \vec{B} \cdot \vec{A} = BA \cos(\theta)$... Definition of magnetic flux
- $\epsilon(t) = V_{max} \sin(\omega t)$... AC voltage signal.
- $\omega = 2\pi f$... Angular frequency vs. frequency.

2 Electric guitar pickup coils

1. Consider a *pickup coil* for an electric guitar that has $N = 1000$ turns of wire around a permanent magnet with $\vec{B} = 0.03\hat{k}$ T. The area of the pickup coil is $\vec{A} = 10^{-4}\hat{k}$ cm². The permanent magnet *magnetizes* the guitar string above it (gives it a magnetic dipole moment). If the string oscillates with a frequency ω , then we can model the B-field of string as

$$\vec{b} = -b_0 \sin(\omega t)\hat{k} \quad (1)$$

(a) If $b_0 = 0.01$ T, and $\omega = 1350$ Hz, what is the total magnetic field function? (b) Graph the magnetic field as a function of time.

2. What is the induced voltage in the pickup coil by the metal string as it vibrates? (Use the given variables from the previous problem).
3. What is the frequency f of the pickup coil voltage?
4. From the pickup coil, the induced voltage is passed to an analog *amplifier*, which grows the signal by a factor of 200. What is the V_{max} of the signal after it has been amplified by a factor of 200?