1) A point charge, $q$, moving with velocity, $v$, enters a region with uniform magnetic field, $B$. The charge is moving in the positive $y$-direction. The magnetic field is in the $x$-direction. What is the force acting on the charge? (Boyer points)

$F = qvB$

2) An infinitely long cylindrical conductor has a hollow core. The outer radius is $5a$, while the hollow core radius is $a$. A current of $2A$ flows through the conductor. What is the magnitude of the magnetic field at a distance of $6a$ from the center? (Boyce points)

$B = \frac{2I}{2\pi r}$
3. A wire carrying a current of 1 A is bent into the shape shown in the figure. The wire is in a uniform magnetic field of magnitude B = 0.5 T, directed into the page. The wire makes an angle of 30° with the horizontal. Calculate the magnetic force on the wire. (10 points)

\[ F = BIL \cos \theta \]

\[ F = (0.5 \text{ T})(1 \text{ A})(0.5 \text{ m}) \cos 30° \]

\[ F = 0.43 \text{ N} \]

4. A rectangular coil is moving in a uniform magnetic field. The coil is made of three straight segments, each of length \( l \). The coil is moved at a constant velocity \( v \) in the direction perpendicular to the magnetic field. Calculate the induced voltage in the coil. (10 points)

\[ E = BLv \]

\[ E = B(l)(v) \]

5. A wire of length \( L \) is moving with a constant velocity \( v \) in a magnetic field of magnitude \( B \). Calculate the induced voltage in the wire, and determine the direction of the induced current. (10 points)

\[ E = BLv \]

\[ E = (0.5 \text{ T})(0.2 \text{ m})(5 \text{ m/s}) = 0.5 \text{ V} \]

\[ i = \frac{E}{R} \]

\[ i = \frac{0.5 \text{ V}}{0.1 \Omega} = 5 \text{ A} \]

6. A solenoid with a length \( L \) and a radius \( r \) is wound with \( n \) turns per meter. Calculate the self-inductance of the solenoid. (10 points)

\[ L = \frac{\mu_0 n^2 A}{2} \]

\[ L = \frac{\mu_0 n^2 \pi r^2}{2} \]

7. A rectangle with sides of length \( a \) and \( b \) is placed in a uniform magnetic field of magnitude \( B \). Calculate the magnetic flux through the rectangle. (10 points)

\[ \Phi = B A \]

\[ \Phi = B(ab) \]

8. A solenoid with a length \( L \) and a radius \( r \) is wound with \( n \) turns per meter. Calculate the capacitance of the solenoid. (10 points)

\[ C = \frac{\kappa \varepsilon_0 n^2 A^2}{2L} \]

\[ C = \frac{\kappa \varepsilon_0 n^2 \pi r^2 A^2}{2L} \]

9. A capacitor with a capacitance \( C \) is charged to a potential difference \( V \). Calculate the energy stored in the capacitor. (10 points)

\[ U = \frac{1}{2} CV^2 \]

\[ U = \frac{1}{2} \varepsilon_0 \frac{Q^2}{2C} \]

10. A parallel plate capacitor with a plate area \( A \) and a plate separation \( d \) is charged to a potential difference \( V \). Calculate the energy stored in the capacitor. (10 points)

\[ U = \frac{1}{2} CV^2 \]

\[ U = \frac{1}{2} \varepsilon_0 \frac{Q^2}{2C} \]

11. A cylindrical capacitor with inner radius \( r_i \) and outer radius \( r_o \) is charged to a potential difference \( V \). Calculate the energy stored in the capacitor. (10 points)

\[ U = \frac{1}{2} CV^2 \]

\[ U = \frac{1}{2} \varepsilon_0 \frac{Q^2}{2C} \]
13) For the circuit of series RLC, as in Problem 12, which of the following statements is correct when the driving angular frequency \( \omega_0 \), is varied from below the resonance frequency \( \omega_r \), to above? Note: classification is based on the phase shift of the current relative to the driving voltage. Please circle to select the correct statement. [10 points]

(a) __________

(b) __________

(c) __________

(d) __________

The circuit is:
(1) more inductive for \( \omega < \omega_r \), more capacitive for \( \omega > \omega_r \), and is resistive at \( \omega = \omega_r \).
(2) more inductive for \( \omega < \omega_r \), more capacitive for \( \omega > \omega_r \), and is purely resistive at \( \omega = \omega_r \).
(3) more inductive for \( \omega < \omega_r \), more capacitive for \( \omega > \omega_r \), and is purely resistive at \( \omega = \omega_r \).
(4) more inductive for \( \omega < \omega_r \), more capacitive for \( \omega > \omega_r \), and is purely resistive at \( \omega = \omega_r \).

14) At t=0, after the switch is closed in the RL circuit below, how much energy is stored in the inductor? [t = inductance, \( I = current \)] [10 points]

\[ E = 120 \text{ J} \]

\[ E = 150 \text{ J} \]

\[ E = 100 \text{ J} \]

\[ E = 50 \text{ J} \]

Rise of current \( = 120 \text{ J} \)

\( E_{\text{cr}} = \frac{1}{2} L I^2 = \frac{1}{2} \times 150 \times 10^3 \times 0.05 \) = 6000 \text{ ft-lb}.

Energy stored in inductor at time \( t \) is

\[ E(t) = \frac{1}{2} L I^2 = \frac{1}{2} \times 150 \times 10^3 \times (10 \cos 50\pi t)^2 \]

\[ E(t) = 120 \text{ J} \]

\[ E(t) = 150 \text{ J} \]

\[ E(t) = 100 \text{ J} \]

\[ E(t) = 50 \text{ J} \]

\[ E(t) = 0 \text{ J} \]