1. Consider an infinitely long solenoid with $N$ turns per unit length carrying current $I$. The radius of the solenoid is $a$. The current $I$ is a function of time, and changes as

$$I = I_0 \cos \omega t.$$ 

What is the electric field (as a function of time) at a distance $r$ from the axis, considering both the cases $r < a$ and $r > a$. (Hint: Remember problem 1 of the previous problem set.)

2. A current carrying wire and a square loop lies as shown in figure. The current in the wire AB changes in the following manner as a function of time.
Make a sketch of how the current in the loop changes and in which direction (as a function of time), i.e. clockwise or anti-clockwise?

3. Consider two loops of conducting wires. The current in the outer loop is changed in the following way.

Sketch how the current in the inner loop changes.
Here is a particular electromagnetic field in free space:

\[ E_x = 0, \quad E_y = E_0 \sin(kx + wt), \quad E_z = 0 \]
\[ B_x = 0, \quad B_y = 0, \quad B_z = -\frac{E_0}{c} \sin(kx + wt) \]

(a) show that this field can satisfy Maxwell's equations only if \( k \) and \( w \) are related in a certain way.

(b) suppose \( w = 10^9 \text{ sec}^{-1}, E_0 = 0.05 \text{ volt/m} \text{ } \)

what is the wavelength \( \lambda = \frac{2\pi}{k} \) in meter?

The power density in sunlight, at earth, is roughly 1 kilowatt/meter\(^2\). How large is the root-mean-square magnetic field strength?

Note: (1) look up the units of power in SI units. (2) For any quantity \( f(t) = f_0 \sin(wt) \)

root-mean-square value of \( f \) is

\[ \frac{2\pi}{w} \left[ \left( \frac{w}{2\pi} \right) \int_0^\frac{2\pi}{w} f^2(t) \, dt \right] = \sqrt{2} f_0 \]