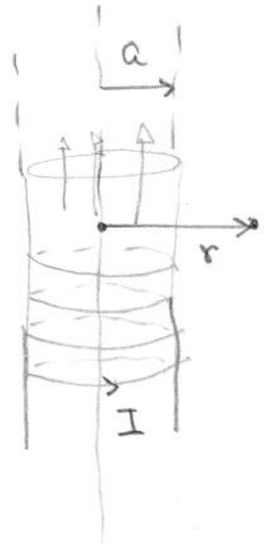
Problem set IV

1.

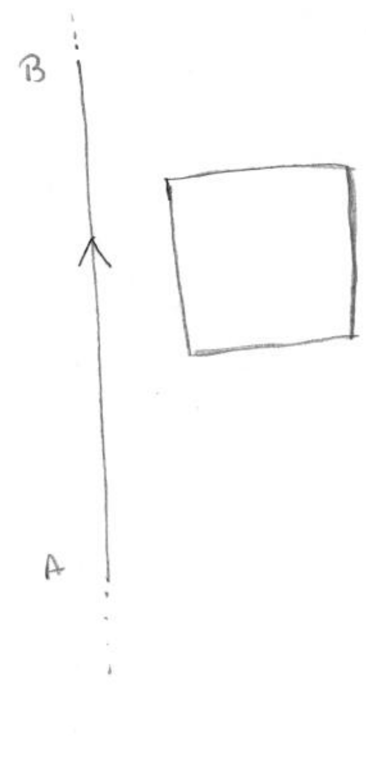



Consider an infinitely long solenoid; with N turs per unit length carrying current I. The radius of the solenoid is "a". The current I is a function of time, and changes as

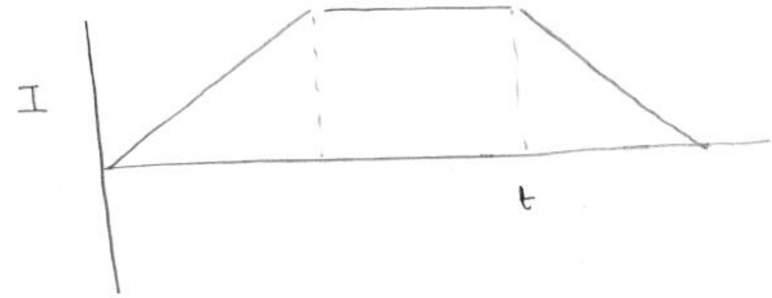
$$I = I_0 \cos \omega t.$$

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

2.

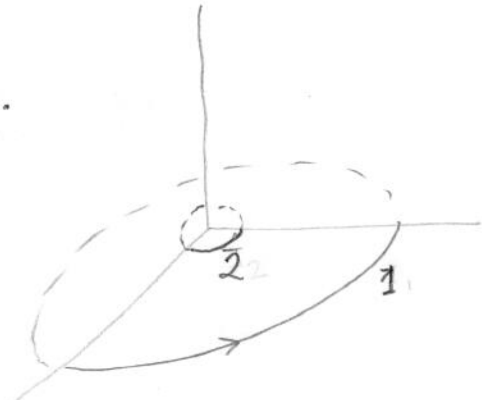



A current carrying wire and a square loop lies as shown in figure. The current in the wire AB changes in the following manner as a function of time

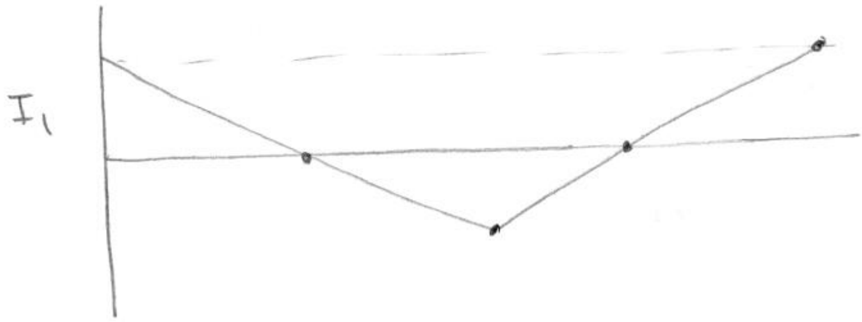



Make a sketch of how the current in the loop changes and in which direction (as a function of time), i.e, clockwise or anti-clockwise ?

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.

(4) Here is a particular electromagnetic field in free space

$E_x = 0 \quad E_y = E_0 \sin(kx + \omega t), \quad E_z = 0$

$B_x = 0 \quad B_y = 0 \quad B_z = -\frac{E_0}{c} \sin(kx + \omega t)$

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

(b) suppose $\omega = 10^{10}\ \text{sec}^{-1}$, $E_0 = 0.05\ \text{Volt}.\text{m}^{-1}$

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

(5) The power density in sunlight, at earth, is roughly 1 kilo watt / 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

$f(t) = f_0 \sin(\omega t)$

root-mean-square value of f is

$$f_{rms} = \left[\left(\frac{\omega}{2\pi}\right) \int_0^{2\pi/\omega} f^2(t)\, dt\right]^{1/2} = \sqrt{2}\, f_0$$