1st year Electricity and Magnetism, Tony Bell

Classwork 3 - 24th February 2005

1. A capacitor consists of two parallel plates, each of area 10^{-3}m, separated by 1mm. What is the capacitance of the capacitor? A charge of 10^{-11} Coulomb is given to the capacitor? What is

a) the electric field between the plates?
b) the energy stored in the capacitor?
c) the magnitude of the force on each plate?
d) the electrical energy density $\varepsilon_0 E^2/2$ between the plates
e) that the multiple of $\varepsilon_0 E^2/2$ and the volume of the capacitor is equal to the energy calculated in b)

2. A small section of wire of vector length $d\mathbf{l}_1=\mathbf{i}+2\mathbf{k}$ (where distances are in nm) is at position $\mathbf{r}_1=4\mathbf{i}+2\mathbf{j}+7\mathbf{k}$ (distances in m). It carries a current of 3 Amp. Calculate the magnetic field due to this small current element at position $\mathbf{r}_2=\mathbf{i}+2\mathbf{j}+3\mathbf{k}$ (distances in m). Give the magnetic field as a vector.

3. (i) A square loop of wire with sides of length b carries a current I.
Derive an expression for the magnetic field at the centre of the square.
You may find it useful to know that $\int \frac{ds}{\left(s^2+a^2\right)^{3/2}} = \frac{1}{a^2}\frac{s}{\left(s^2+a^2\right)^{1/2}}$.
What is the magnitude of the magnetic field if the square loop carries a current of 0.5Amp and length of each side of the square is 200mm. ($\mu_0 = 4\pi x10^{-7}$ Hm^{-1})

(ii) Using the values of I and b given in (i), calculate the magnetic dipole moment of the square current loop. Use the expression given in section E.5 of the lectures to calculate the magnitude of the magnetic field at a distance from the loop of 10m on the axis of the loop (ie equidistant from each side of the loop).