Suggested solutions to exam in Applied Electromagnetism 101023

1

Charging and discharging the capacitors through the resistors has a time constant of RC of magnitude tens of seconds. When the switches are set to on , there is a way to discharge them all coupled i series through the flash lamp. We do not know the resistance of the flash lamp but typical values would be around 1 – 10 ohm giving time constants of milliseconds, so that is the discharge that will take place. The series coupled capacitors have voltage 3 U1.

2

The fields from the circular charge and the corresponding point charge are

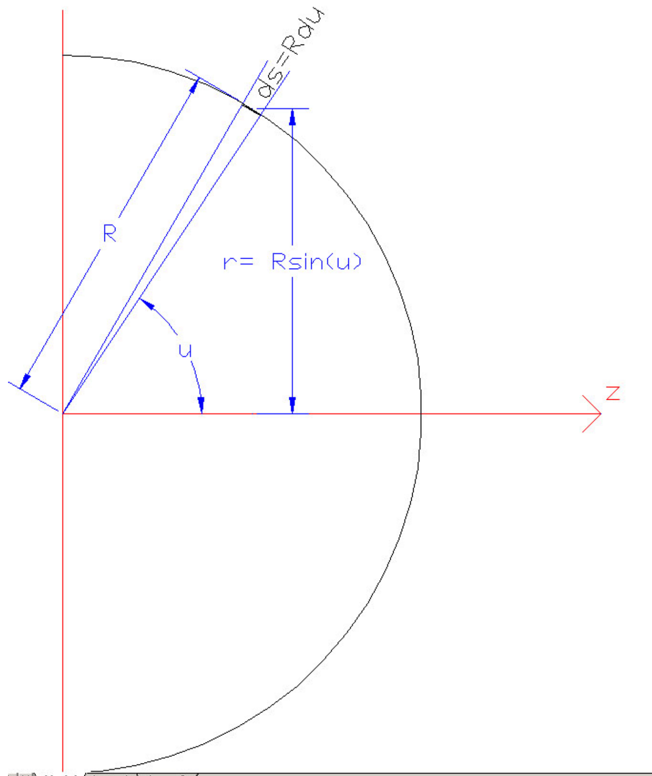
$$E_{circ} = \frac{Qx}{2\pi\varepsilon_0 R^2}\left(\frac{1}{x} - \frac{1}{\sqrt{\left(R^2 + x^2\right)}}\right) \text{and } E_{po\text{int}} = \frac{Q}{4\pi\varepsilon_0 x^2}$$

where R is radius of the ring, x is distance along axis

Condition of deviation 10% gives

$$0.1 = \frac{E_{po\text{int}} - E_{circ}}{E_{po\text{int}}} \Rightarrow x \approx 2.5R$$

Where the last step is done numerically or by plotting.



3

A surface element around the axis has the surface

$$dS = 2\pi r ds = 2\pi R^2 \sin u du$$

Only components parallel with the axis survive, and these are found by multiplyibg with cos u.

$$dE = \frac{\sigma dS}{4\pi\varepsilon_0 R^2}\cos u =$$

$$\frac{\sigma \sin u \cos u}{2\varepsilon_0} du \Rightarrow$$

$$E = \int_0^{\pi/2} \frac{\sigma}{2\varepsilon_0}\sin u \cos u du = \frac{\sigma}{8\varepsilon_0}$$

5

This is two magnetic dipoles beside each other, and the fields are parallel i poi.

$$B = 2\cdot\frac{\mu_0 m}{4\pi d^3} = \frac{\mu_0 I r^2}{2d^3} = 5\,\mu\text{T}$$

6

The resistance, of the two coils is twice the resistance of one : $R_{tot} = 2R$

The self inductance is given by

$$L = \frac{\mu_0\mu_r N^2 S}{l} \Rightarrow L_{tot}\frac{\mu_0\mu_r (2N)^2 S}{2l} = 2L$$

So the time constant remains unaffected (as long as there are no other resistances than the coils themselves))