Electromagnetic Theory ELEC 3303
Tutorial Assignment 1/Tutorial 5

10/11 April 2013

To be handed in by 5 p.m. on Monday 8 April 2013.

Please complete a cover sheet and attach it to your work.
Work handed in late will incur a penalty of 10% per day.
Work handed in after noon on 10 April will not be marked.

(1) Three electrons are placed at the vertices of an equilateral triangle whose sides are $1m$ long. Find the nett force (magnitude and direction) on any one of the electrons due to the other two electrons. (**16 marks**)

(2) Find the work done by the electric field $\boldsymbol{E} = E\hat{\boldsymbol{j}}$ on on a charge of qC in moving it along the quarter circle from $(5, 0)$ to $(0, 5)$. (Distances in metres.) (**16 marks**)

(3) Which of the following **cannot** be electric fields? (**18 marks**)

(a) $\boldsymbol{F}(x, y, z) = x^2\hat{\boldsymbol{i}} + y^2\hat{\boldsymbol{j}} + z^2\hat{\boldsymbol{k}}$.

(b) $\boldsymbol{F}(x, y, z) = -y^3\hat{\boldsymbol{i}} + x^3\hat{\boldsymbol{j}}$.

(c) $\boldsymbol{F}(r, \theta, z) = r\hat{\boldsymbol{\theta}}$.

(d) $\boldsymbol{F}(r, \theta, z) = z\hat{\boldsymbol{r}} + r\hat{\boldsymbol{z}}$.

(e) $\boldsymbol{F}(r, \theta, \phi) = r\cos\phi\ \hat{\boldsymbol{\theta}}$.

(f) $\boldsymbol{F}(r, \theta, \phi) = \frac{1}{r^2}\hat{\boldsymbol{r}} + \frac{1}{r}\hat{\boldsymbol{\theta}}$.

(4) A charge of $-qC$ is placed at the centre of a spherical cavity of radius R in a block of material that is a perfect conductor. There is a vacuum in the cavity. What is the charge induced on the surface of the cavity? (**20 marks**)

(5) A narrow channel is drilled in a sphere of radius R which carries a volume charge distribution of $\rho\ Cm^{-3}$. A test charge qC with mass m is released from rest at one end of the channel. Does it return to its starting position? If so, how long does it take to return? If not, where does it end up? (Assume that the channel does not perturb the field of the charged sphere. Ignore all gravitational and frictional effects.) (**30 marks**)

Use:
$\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 Nm^2/C^2$.
Charge on an electron $e = -1.6 \times 10^{-19}C$.
Mass of an electron $m_e = 9.11 \times 10^{-31}kg$.