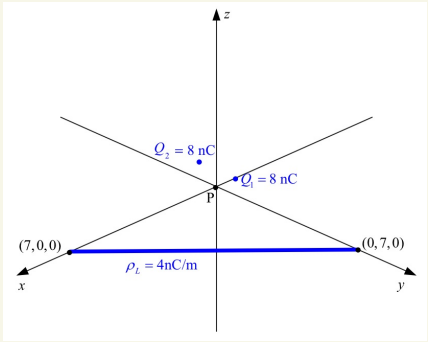
EE 2FH4 - Electromagnetics I - MATLAB - Set 3

Exercise: A finite uniform linear charge $\rho_L = 4n/cm$ lies on the xy plane, while point charges of 8nC each are located at $(0,1,1)$ and $(0,-1,1)$. Find E at $(0,0,0)$.



Electric field due to Q1:

$$E_p = \frac{Q}{4\pi\varepsilon_0 |\vec{R}|^2}\vec{a}_R = \frac{Q}{4\pi\varepsilon_0 |\vec{R}|^3}\vec{R}$$

$$\vec{R}_1 = P - P_{Q_1} = (0,0,0) - (0,1,1) = -\vec{a}_y - \vec{a}_z$$

$$|\vec{R}_1| = \sqrt{0^2+1^2+1^2} = \sqrt{2}$$

$$\vec{E}_1 = \frac{Q}{4\pi\varepsilon_0 |\vec{R}_1|^3}\vec{R}_1 = \frac{8\times10^{-9}}{4\pi \cdot \frac{1}{36\pi}\times10^{-9}\times(\sqrt{2})^3}\cdot(-\vec{a}_y - \vec{a}_z)$$

$$\vec{E}_1 = -25.456\,\vec{a}_y - 25.456\,\vec{a}_z$$

Electric field due to Q_2:

$$\vec{R}_2 = P - P_{Q_2} = (0,0,0) - (0,-1,1) = \vec{a}_y - \vec{a}_z$$

$$|\vec{R}_2| = \sqrt{0^2+1^2+1^2} = \sqrt{2}$$

$$\vec{E}_2 = \frac{Q}{4\pi\varepsilon_0 |\vec{R}_2|^3}\vec{R}_2 = \frac{8\times10^{-9}}{4\pi\cdot\frac{1}{36\pi}\cdot10^{-9}\cdot(\sqrt{2})^3}(\vec{a}_y - \vec{a}_z)$$

$$\vec{E}_2 = 25.456\,a_y - 25.456\,a_z$$

Electric field due to finite line charge:

$$c^2 = a^2 + b^2 = \sqrt{7^2+7^2} = \sqrt{98} \qquad n = \frac{\sqrt{98}}{2}$$

$$|\vec{E}_L| = \frac{\rho_L}{4\pi\varepsilon_0\left(\frac{\sqrt{98}}{2}\right)}$$

$$\vec{E}_L = \frac{4.0\times10^{-9}}{4\pi\left(\frac{1}{36\pi}\times10^{-9}\right)\left(\frac{\sqrt{98}}{2}\right)}\cdot(-\vec{a}_x - \vec{a}_y)$$

$$\vec{E}_L = -7.273\,\vec{a}_x - 7.273\,\vec{a}_y$$

$$\vec{E}_{Total} = \vec{E}_1 + \vec{E}_2 + \vec{E}_L$$

$$= (-25.456\,\vec{a}_y - 25.456\,\vec{a}_z) + (25.456\,a_y - 25.456\,a_z) + (-7.273\,\vec{a}_x - 7.273\,\vec{a}_y)$$

$$\boxed{\vec{E}_T = -7.273\,\vec{a}_x - 7.273\,\vec{a}_y - 50.912\,\vec{a}_z}$$