

Following Exercise questions are **IMPORTANT!**

2.4, 2.5, 2.13, 2.14, 2.16 ,2.17, 2.18, 2.19, 2.22, 2.23, 2.27, 2.28,2.29,2.30,2.31

**D2.1 (a).**  $Q_A = -20\mu C$  located at A(-6,4,7) , $Q_B = 50\mu C$  located at B(5,8,-2)  
Find  $\vec{R}_{AB}$

$$\vec{R}_{AB} = (5 - (-6))\hat{a}_x + (8 - 4)\hat{a}_y + (-2 - 7)\hat{a}_z = 11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z$$

(b).  $|\vec{R}_{AB}| = \sqrt{(11^2) + 4^2 + (-9)^2} = 14.76m$

(c).  $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB} / 4\pi\epsilon_0 |\vec{R}_{AB}|^3 = (-20 \times 10^{-6} \times 50 \times 10^{-6} (11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z)) / (4\pi \times (10^{-9} / 36\pi) |14.76|^3)$   
 $\Rightarrow \vec{F}_{AB} = 30.76\hat{a}_x + 11.184\hat{a}_y - 25.16\hat{a}_z m.N$

(d).  $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB} / 4\pi\epsilon_0 |\vec{R}_{AB}|^3 = (-20 \times 10^{-6} \times 50 \times 10^{-6} (11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z)) / (4\pi \times 8.85 \times 10^{-12} |14.76|^3)$   
 $\Rightarrow \vec{F}_{AB} = 30.72\hat{a}_x + 11.169\hat{a}_y - 25.13\hat{a}_z m.N$

**D2.2(a).**  $Q_A = -0.3\mu C$  located at A(25,-30,15) in cm , $Q_B = 0.5\mu C$  located at B(-10,8,12)

Find  $\vec{E}$  at the origin O(0,0,0).

Let  $\vec{E}$  at the origin is denoted by  $\vec{E}_o$  and it will be the sum of  $\vec{E}_A$  ( $\vec{E}$  due to  $Q_A$  located at point A) and  $\vec{E}_B$  ( $\vec{E}$  due to  $Q_B$  located at point B)

$$\vec{E}_A = Q_A \vec{R}_{OA} / 4\pi\epsilon_0 |\vec{R}_{OA}|^3$$

$$\vec{R}_{OA} = (0 - 25)\hat{a}_x + (0 - (-30))\hat{a}_y + (0 - 15)\hat{a}_z = (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)cm$$

$$|\vec{R}_{OA}| = \sqrt{(-25)^2 + (30)^2 + (-15)^2} = 41.83cm$$

$$\vec{E}_A = (-0.3 \times 10^{-6}) \times (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z) \times 10^{-2} / 4\pi \times 8.85 \times 10^{-12} \times |41.83 \times 10^{-2}|^3 = -368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)$$

$$\vec{E}_B = Q_B \vec{R}_{OB} / 4\pi\epsilon_0 |\vec{R}_{OB}|^3$$

$$\vec{R}_{OB} = (0 - (-10))\hat{a}_x + (0 - 8)\hat{a}_y + (0 - 12)\hat{a}_z = (10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z)cm$$

$$|\vec{R}_{OB}| = \sqrt{(10)^2 + (-8)^2 + (-12)^2} = 17.55cm$$

$$\vec{E}_B = (0.5 \times 10^{-6}) \times (10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z) \times 10^{-2} / 4\pi \times 8.85 \times 10^{-12} \times |17.55 \times 10^{-2}|^3 = 8317.36(10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z)$$

$$\vec{E}_o = \vec{E}_A + \vec{E}_B = (-368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)) + 8317.36(10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z) = (92.3\hat{a}_x - 77.6\hat{a}_y - 94.2\hat{a}_z)KV/m$$

(b). Find  $\vec{E}$  at the point P(15,20,50).

It is the same as part(a) but this time we have to calculate  $\vec{R}_{PA}$  and  $\vec{R}_{PB}$  and the rest of the problem is similar to part(a)

**D2.3 (a).**

$$\sum_{m=0}^5 ((1 + (-1)^m) / (m^2 + 1)) = (1 + (-1)^0) / (0^2 + 1) + (1 + (-1)^1) / (1^2 + 1) + (1 + (-1)^2) / (2^2 + 1) + (1 + (-1)^3) / (3^2 + 1) + (1 + (-1)^4) / (4^2 + 1) + (1 + (-1)^5) / (5^2 + 1) = 2 + 0 + 2/5 + 0 + 2/17 + 0 = 2.52$$

(b). Similar to the part(a)

**D2.4 (a).**  $0.1 \leq (|x|, |y|, |z|) \leq 0.2$  . given ranges of x,y and z co-ordinates doesnot constitute a cubical volume so  $dv = 0 \Rightarrow Q = \int_{vol} \rho_v dv = 0$

(b). Differential volume in cylindrical co-ordinates is given by  $dv = \rho d\rho d\phi dz$  . we have  $Q = \int_{vol} \rho_v dv$

$$\Rightarrow Q = \int_{vol} (\rho^2 z^2 \sin(0.6)\phi) \rho d\rho d\phi dz = \int_0^{0.1} \int_0^{2\pi} \int_0^{0.2} (\rho^2 z^2 \sin(0.6)\phi) \rho d\rho d\phi dz = \int_0^{0.1} \rho^2 d\rho \int_0^{2\pi} (\sin(0.6)\phi) d\phi \int_0^{0.2} z^2 dz$$

$$\Rightarrow Q = |\rho^3/4|_0^{0.1} \times |(-\cos(0.6\phi))|_{0.6}^{1.2} \times |z|_0^{0.2} = |(0.1)^4/4| \times |(-\cos(108^\circ) - (-\cos(0)))|_{0.6} \times |(64 - 8)/3|$$

$$\Rightarrow Q = |(0.1)^4/4| \times |(1.31)/0.6| \times |56/3| = 1.018mC$$

<sup>1</sup>This document is prepared in L<sup>A</sup>T<sub>E</sub>X. (Email: ahmadsajjad01@com.net.pk)

# Engineering Electromagnetics Drill Problems Solutions

## Chapter 2

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