[1] Solution to the Drill problems of chapter 02
(Engineering Electromagnetics,Hayt,A.Buck 7th ed)
BEE 4A,4B & 4C

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

(c). $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB}/4\pi\epsilon_o \mid \vec{R}_{AB} \mid^3 = (-20\times10^{-6}\times 50\times 10^{-6}(11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z))/(4\pi\times(10^{-9}/36\pi) \mid 14.76 \mid^3)$
$\Rightarrow \vec{F}_{AB} = 30.76\hat{a}_x + 11.184\hat{a}_y - 25.16\hat{a}_z mN$

(d). $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB}/4\pi\epsilon_o \mid \vec{R}_{AB} \mid^3 = (-20\times10^{-6}\times 50\times 10^{-6}(11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z))/(4\pi\times 8.85\times 10^{-12} \mid 14.76 \mid^3)$
$\Rightarrow \vec{F}_{AB} = 30.72\hat{a}_x + 11.169\hat{a}_y - 25.13\hat{a}_z mN$

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)
$\vec{E}_A = Q_A \vec{R}_{OA}/4\pi\epsilon_o \mid \vec{R}_{OA} \mid^3$
$\vec{R}_{OA} = (0-25))\hat{a}_x + (0-(-30))\hat{a}_y + (0-15)\hat{a}_z = (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)cm$
$\mid \vec{R}_{OA} \mid = \sqrt{(-25)^2 + (30)^2 + (-15)^2} = 41.83cm$
$\vec{E}_A = (-0.3\times10^{-6})\times(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)\times 10^{-2}/4\pi\times 8.85\times 10^{-12}\times \mid 41.83\times 10^{-2} \mid^3 = -368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)$
$\vec{E}_B = Q_B \vec{R}_{OB}/4\pi\epsilon_o \mid \vec{R}_{OB} \mid^3$
$\vec{R}_{OB} = (0-(-10)))\hat{a}_x + (0-8)\hat{a}_y + (0-12)\hat{a}_z = (10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z)cm$
$\mid \vec{R}_{OB} \mid = \sqrt{(10)^2 + (-8)^2 + (-12)^2} = 17.55cm$
$\vec{E}_B = (0.5\times10^{-6})\times(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)\times 10^{-2}/4\pi\times 8.85\times 10^{-12}\times \mid 17.55\times 10^{-2} \mid^3 = 8317.36(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)$
$\vec{E}_o = \vec{E}_A + \vec{E}_B = (-368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)) + 8317.36(10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z) = (92.3\hat{a}_x - 77.6\hat{a}_y - 94.2\hat{a}_z)KV/m$

(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).
$\Sigma_0^5((1+(-1)^m)/(m^2+1)) = (1+(-1)^0)/(0^2+1) + (1+(-1)^1)/(1^2+1) + (1+(-1)^2)/(2^2+1) + (1+(-1)^3)/(3^2+1) + (1+(-1)^4)/(4^2+1) + (1+(-1)^5)/(5^2+1) = 2 + 0 + 2/5 + 0 + 2/17 + 0 = 2.52$

(b). Similar to the part(a)

D2.4 (a). $0.1 \leq (\mid x \mid, \mid y \mid, \mid z \mid) \leq 0.2$, 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 $Q = \int_{vol} \rho_v dv$
$\Rightarrow Q = \int_{vol}(\rho^2 z^2 \sin(0.6)\phi)\rho d\rho d\phi dz = \int_0^{0.1}\int_0^{\pi}\int_2^4(\rho^2 z^2 \sin(0.6)\phi)\rho d\rho d\phi dz = \int_0^{0.1}\rho^3 d\rho \int_0^{\pi}(\sin(0.6)\phi)d\phi \int_2^4 dz$
$\Rightarrow Q = \mid \rho^4/4 \mid_0^{0.1} \times \mid (-cos(0.6\phi))/0.6 \mid_0^{\pi} \times \mid z \mid_2^4 = \mid (0.1)^4/4 \mid \times \mid (-cos(108^0) - (-cos(0)))/0.6 \mid \times \mid (64-8)/3 \mid$
$\Rightarrow Q = \mid (0.1)^4/4 \mid \times \mid (1.31)/0.6 \mid \times \mid 56/3 \mid = 1.018mC$

[1] This document is prepared in LaTeX. (Email: ahmadsajjad01@ciit.net.pk)

Engineering Electromagnetics Drill Problems Solutions Chapter

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