Roll No:

National Institute of Technology Delhi

Mid Semester Examinations

Name of Specialization-**Electrical & Electronics Engg,** Year-**2016**, Semester-**3rd**
Course Name – Electric & Magnetic Fields **Maximum Marks – 30**
Course Code - EE-203 **Total Time: 2:00 Hours**

All questions are compulsory.
Symbols have their usual meaning.
Assume any data, if it is missing.

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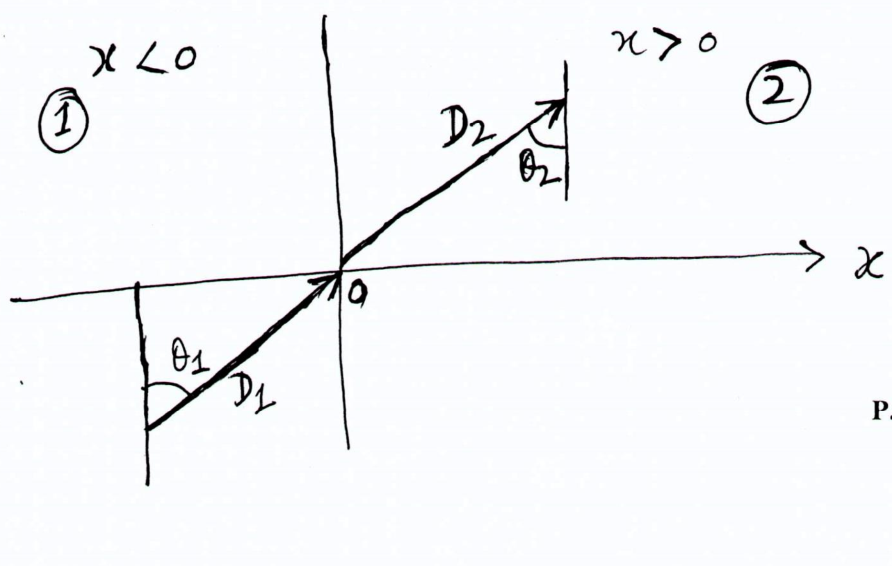
Q.1- Express the vector , $\boldsymbol{V}(r,\theta,\varphi) = \frac{1}{r}\,\boldsymbol{a_r} + r\cos\theta\,\boldsymbol{a_\theta} + \boldsymbol{a_\varphi}$ in Cartesian and cylindrical coordinates. Find the $\boldsymbol{V}\,(1,1,0)$ and $\boldsymbol{V}\left(1, \frac{\pi}{2}, -2\right)$. **(6)**

Q.2-Define energy density of the electrostatic field. A charge distribution with spherical symmetry has density, $\boldsymbol{\rho_V} = \begin{matrix} \boldsymbol{\rho_0}, & \boldsymbol{0 \le r \le R} \\ \boldsymbol{0} & \boldsymbol{r} > R \end{matrix}$. Determine potential (V) everywhere and the energy stored in the region $\boldsymbol{r} < R$. **(6)**

Q.3- How do you define the polarization in dielectric material? Prove that the phenomenon of polarization is accomplished by an equivalent volume charge density throughout the dielectric together with an equivalent surface charge density formed over the surface of dielectric. **(6)**

Q.4- Express the relaxation time of a material of conductivity σ and permittivity ϵ by using continuity of charge equation. The region **1**, defined by $\boldsymbol{x} < 0$ is free space, while region **2**, $\boldsymbol{x} > 0$ is a dielectric material for which $\boldsymbol{\varepsilon_{r2}} = \boldsymbol{2.4}$, see figure below. Given $\boldsymbol{D_1} = \boldsymbol{3a_x} - \boldsymbol{4\,a_y} + \boldsymbol{6a_z}$ C/m^2. Find $\boldsymbol{E_2}$ and angles θ_1 *and* θ_2. **(6)**



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Q.5- Write down the Poisson's equation in cylindrical coordinate for electrostatic homogeneous material. A metal bar of conductivity $\boldsymbol{\sigma}$ is bent to form a flat 90^0 sector of inner radius $\boldsymbol{a}$ and outer radius b and thickness $\boldsymbol{t}$. Show that

(a)- resistance of the bar between the vertical curved surfaces at $\rho = a \; and \; \rho = b$ is

$$\boldsymbol{R} = \frac{2\ln(b/a)}{\sigma \pi t}, \text{ and}$$

(b)- the resistance between the two horizontal surfaces at $z = 0 \; and \; z = t$ is

$$\boldsymbol{R}^* = \frac{4t}{\sigma \pi (b^2 - a^2)}$$

(6)

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