EASTERN UNIVERSITY, SRI LANKA

SECOND YEAR/SECOND SEMESTER EXAMINATION

IN SCIENCE (2002/03 & 2002/03(A))

(April./May.'2004)

MT 218 - FIELD THEORY

Answer all questions **Time:Two hours**

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1. State Gauss's theorem.

   (a) A spherical volume with radius a, and charge density distribution given by

$$\rho = \begin{cases} \rho_0 \left(1 - \dfrac{r^2}{a^2}\right) & \text{if } r \leq a \\ 0 & \text{if } r > a \end{cases}$$

   i. Calculate the total charge;

   ii. Find the electric field intensity outside of the charge distribution;

   iii. Find the electric field intensity inside the charge distribution;

   iv. Find the point at which electric field intensity is maximum.

   (b) Find the components of the electric field in the direction of x, y and z axis at the point $(0, 0, z)$ on the axis of the disk with radius a and surface charge density σ over the area $x^2 + y^2 < a^2,\ z = 0$. Find also the potential at the above point.

3. (a) Define the term "electric dipole".

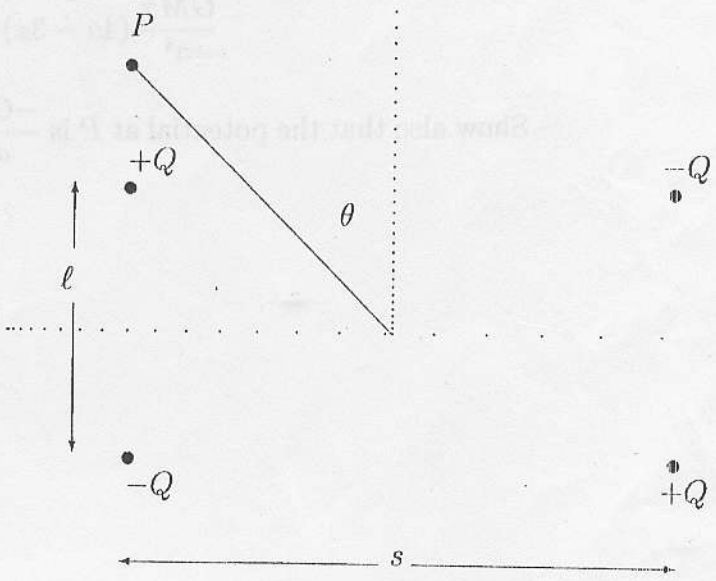
Prove that the electric potential V at a point P at a distance r form the dipole of moment $\underline{P}$ is given by

$$V = -\frac{1}{4\pi\epsilon_0}\left\{\underline{P}\cdot grad\left(\frac{1}{r}\right)\right\}.$$

Hence prove that the force on a dipole in an electric field E is given by,

$$\underline{F} = (\underline{P}\cdot\nabla)\underline{E}$$

(b)



Four equal charge of magnitude Q as shown in figure are located as to form a quadrupole (double-dipole). Prove that if r is very much greater than l and s the potential due to this quadrupole is given by $\frac{Qls\ sin2\theta}{4\pi\epsilon_0 r^2}$.

Where r radial distance, θ angle from the axis to the radial line. Find also a vector expression for the electric field at the distant point due to the above charge configuration.

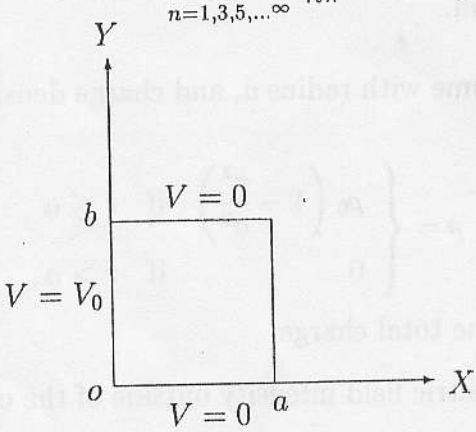
2. Show by using separation of variable or otherwise, that the solution of the equation $\nabla^2 V = 0$, where V is the potential function in two dimensional rectangular co-ordinates is given by;

$$V = (A_1 \sinh \alpha x + A_2 \cosh \alpha x)\,(B_1 \sin \alpha y + B_2 \cos \alpha y)$$

where $A_1, A_2, B1, B_2$ and α are arbitrary constants.

Prove that the potential distribution inside the rectangular region shown in figure,for the boundary conditions noted is given by;

$$V(x,y) = \sum_{n=1,3,5,\ldots\infty} \frac{4V_0}{n\pi} \sin \frac{n\pi y}{b} \frac{\sinh \frac{n\pi}{b}(a-x)}{\sinh\left(\frac{n\pi a}{b}\right)}$$



$c-i$ $\quad V = 0$ at $y = 0, y = b$ $\quad 0 \le x \le a$

$c-ii$ $\quad V = 0$ at $x = a$ $\quad 0 \le y \le b$

$c-iii$ $\quad V = V_0$ at $x = 0$ $\quad 0 \le y \le b$

$$\left(Hint : \int_0^b \sin \frac{n\pi y}{b} \sin \frac{m\pi y}{b} dy = \begin{cases} 0 & \text{if } n \neq m \\ \frac{b}{2} & \text{if } n = m, \ n \neq 0 \end{cases} \right)$$

Eastern University, Sri Lanka
Second Year /Second Semester Examination in Science – 2002/2003 (Proper)
(March/April 2004)

BT 203, Environmental Microbiology

Answer All Questions **Time: 01 hr.**

1) Describe the different stages of sewage (wastewater) treatment.

2) Discuss the following.
   a) The factors that may influence the occurrence and distribution of microorganisms in drinking water.
   b) Control of air microorganisms in confined area.