INDIAN INSTITUTE OF SPACE SCIENCE & TECHNOLOGY

B. Tech(I Year) **Physics - II (PH121)** **Quiz 1**

15 Feb' 2017 **Duration:1 Hrs** **Full Marks: 30**

Answer all questions(All questions carry equal marks)

1. If $\mathbf{A} = \frac{1}{2}(\mathbf{B} \times \mathbf{r})$, where $\mathbf{B}$ is a constant vector, find $\nabla \times \mathbf{A}$.

2. Find the curl of the vector function $\mathbf{B}(s, \theta, z) = \frac{1}{s}\hat{\theta}$ (expressed in cylindrical coordinates). Note: The curl must be consistent with the Stokes' theorem (say, around a circular loop centered at the origin).

3. Show that the integral
$$J = \int_V \mathrm{sech}\lambda \mathrm{r}\, (\nabla \cdot \frac{\hat{\mathbf{r}}}{\mathrm{r}^2})\, \mathrm{d}\tau$$
evaluated using (a) Gauss theorem and (b) Dirac's delta function gives the same result. Here, V is a sphere of radius R centered at origin, and λ is a constant.

4. Check the Stokes theorem for the function $\mathbf{V} = y\hat{\mathbf{x}}$, for the path shown in the figure below, and the surface composed of the three flat shaded areas. The curved part is a circle of radius 'a', centered at the origin.

5. A charge distribution with spherical symmetry has density where k is a constant.

   a) Determine the electric field everywhere.
   b) Find the work done in assembling the charge configuration.
   c) Find the energy contained in the electric field outside the sphere due to this configuration.

6. Four charges $-Q$, $2Q$, $-3Q$, and $4Q$, are placed, in that order, on the four corners of a square of size 'a'. Find the approximate potential (upto the dipole term) at a far away point from the square due to this configuration.

$$\nabla \times \mathbf{V}(s,\theta,z) = \left[\frac{1}{s}\frac{\partial V_z}{\partial \theta} - \frac{\partial V_\theta}{\partial z}\right]\hat{\mathbf{s}} + \left[\frac{\partial V_s}{\partial z} - \frac{\partial V_z}{\partial s}\right]\hat{\theta} + \frac{1}{s}\left[\frac{\partial (sV_\theta)}{\partial s} - \frac{\partial V_s}{\partial \theta}\right]\hat{\phi}$$

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