Indian Institute of Information Technology Vadodara

Academic Year 2021-22

Mid Sem Question Paper

PH110: Waves and Electromagnetics

(The exam duration is of 80 minutes, and is a closed book exam.)

Q1. Calculate the divergence of the vector fields $\overrightarrow{v} = \frac{\lambda}{r}\hat{r}$ and $\overrightarrow{w} = \frac{\kappa}{r^2}\hat{r}$. Test your results using the divergence theorem. Find out for which one of these vector fields, the divergence admits a delta function at the origin. [5 marks]

Q2. Find the following:

A. If $x\delta(x) = \kappa\delta(x)$, then what is the value of κ ?

B. One is given that $\overrightarrow{\nabla} \cdot (f(\overrightarrow{x})\overrightarrow{A}(\overrightarrow{x})) = \alpha f(\overrightarrow{x})(\overrightarrow{\nabla} \cdot \overrightarrow{A}(\overrightarrow{x})) + \beta\overrightarrow{A}(\overrightarrow{x}) \cdot \overrightarrow{\nabla} f(\overrightarrow{x})$, for some scalar field $f(\overrightarrow{x})$ and some vector field $\overrightarrow{A}(\overrightarrow{x})$. Find the value of α and β.

C. Calculate $\overrightarrow{\nabla} \cdot (\overrightarrow{\nabla} \times \overrightarrow{A}(\vec{r}))$ for some general vector field $\overrightarrow{A}(\vec{r})$.

D. Calculate $\overrightarrow{\nabla} \cdot (\hat{r}r^n)$ using the divergence theorem.

[Each question carries 2 marks.]

Q3. One is given an infinite plane that carries a uniform charge density σ. Find the corresponding electric field.

[3 marks]

Q4. You are given a uniformly charged spherical shell of radius R. Find the corresponding electric potential in the region inside and outside the shell.

[5 marks]

Q5. The electric potential $\phi(\vec{r}) = A\frac{e^{-\lambda r}}{r}$ is of some configuration in an experiment. Here A and λ are some constants. Find the corresponding electric field and charge density in the system.

[4 marks]