Quiz 2: Fields & Waves (ECE230), Winter 2021

Duration: 1hr, Total: 20 points (Attempt all questions)

Mar 22, 2021

Only those people attending the lectures are admissible. Any other submission will be ignored.

Q1. Consider a solid sphere of radius $r = 1m$, consisting of a material with conductivity $\sigma = 100s/m$ and $\epsilon = 20C^2N^{-1}m^{-2}$. You created a uniform volume charge density in the sphere using a total charge of 4π C.

(i) How much time τ would it take for the volume charge to decay to 36.8% of its initial value?

(ii) How much would be the surface charge density σ_S at $t = \tau$? [Assume a uniform surface charge distribution]

[$2 + 8 = 10$ marks]

Q2. In lecture 11, we proved that the magnetic vector potential can be transformed as $\vec{A'} = \left(\vec{A} + \vec{\nabla}\lambda\right)$ and this leaves the $\vec{B}$ unchanged. In our last lecture, we saw that this holds true for the $\vec{B}$ in the electrodynamic case as well. However, this transform alone doesn't ensure that $\vec{E}$ is left unchanged in the electrodynamic case since $\vec{E}$ is now relate to both a scalar potential ϕ and a vector potential $\vec{A}$.

Under the transformation $\vec{A'} = \left(\vec{A} + \vec{\nabla}\lambda\right)$, how should ϕ be transformed to ϕ' so as to leave $\vec{E}$unchanged?

[10 marks]