$5^{\text {th }}$ HOMEWORK-Solutions
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Hand in: Friday $\mathbf{1 0}^{\text {th }}$ of April 2020, time: 23:59

1. Consider a dielectric sphere of radius $R$ and permitivity $\varepsilon$, with a point charge $Q$ embedded at the center of the sphere.
(i) Find the electric displacement $\mathbf{D}$ inside the sphere
(ii) Find the electric field inside the sphere.
(iii)Find the polarization inside the sphere.
(iv) Find the surface charge density (due to the polarization of the dielectric) on the surface of the sphere.
(v) Find the total amount of the bound charge on the surface of the sphere.
(vi) What is the volume charge density of the bound charge?
(12 marks)
2. The force per unit volume on a dielectric (permitivity $\varepsilon$ ) inside an electric field $\mathbf{E}$ is given by the relation $\mathbf{F}_{\text {vol }}=(\mathbf{P} \cdot \vec{\nabla}) \mathbf{E}$. Start from this expression and show that this force is equal to

$$
\mathbf{F}_{v o l}=\frac{1}{2}\left(\varepsilon-\varepsilon_{0}\right) \vec{\nabla} E^{2}
$$

Hint: You will need the relations $\mathbf{D}=\varepsilon_{0} \mathbf{E}+\mathbf{P}, \mathbf{D}=\varepsilon \mathbf{E}, \vec{\nabla} \times \mathbf{E}=0$.

