PHYS 4392 Exam 2

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Printed Name _____

DIRECTIONS:

1. If I can't read it, I can't grade it.

2. **Show** your work to receive credit.

3. **BOX YOUR FINAL ANSWERS**

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5. Paginate all pages. Label the problem number clearly.

6. Staple your pages together, in order.

7. Good luck.

Q1 10 pts. A parallel plate capacitor with plate area A and plate separation d has a potential difference V applied to its plates by connecting them to a battery. A dielectric of thickness t $(t < d)$ and of the same area as the plates is inserted between them such that there is an air gap between the dielectric and both of the plates. What is the capacitance C of this structure? Ignore edge effects.

Q2 10 pts. A sphere of homogeneous linear dielectric material with relative dielectric constant $\epsilon_r = \epsilon/\epsilon_0$ is placed in a uniform electric field $\boldsymbol{E}_0$. Show that the induced surface charge density σ_P is

$$\sigma_P = \frac{3\epsilon_0(\epsilon_r - 1)}{\epsilon_r + 2} E_0 \cos\theta\,,$$

where θ is measured from the direction of $\boldsymbol{E}_0$. Recall from example 4.8 in Griffiths that the electric field $\boldsymbol{E}$ inside the sphere in this case is $\boldsymbol{E} = \frac{3}{\epsilon_r+2}\boldsymbol{E}_0$.

Q3   10 pts. An infinite sheet of electric dipoles has a dipole moment per unit area $\boldsymbol{p}$ directed along the normal to the plane. Find the potential V and the the electric field $\boldsymbol{E}$ everywhere in space. **Hint:** Consider a point a perpendicular distance z above the plane. Take it from there. The final answer is not complicated.

Q4   15 pts. Consider two concentric metal spherical shells. One has a radius a and the other has a radius b. The gap between them is filled with a linear isotropic dielectric material such that exactly half of the gap volume is filled with material of permittivity ϵ_1 and the other half is filled with material of permittivity ϵ_2. See the figure below. The inner shell has a charge Q while the outer shell carries a charge $-Q$. You can assume the electric field between the two shells is spherically symmetric.
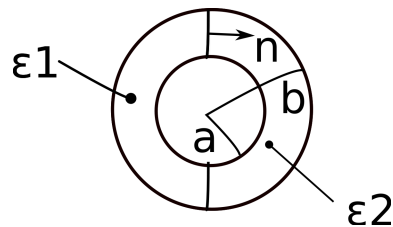
a) 10 pts   Find the electric displacement $\mathbf{D}_1$ and $\mathbf{D}_2$ in the region ϵ_1 and ϵ_2.

b) 5 pts   Find the electric field in the regions of ϵ_1 and ϵ_2.

Q5 1 pt. Extra credit. Below is a passenger bus, similar to a PONY bus or a DART bus. Is the bus travelling to the left or to the right? Explain your answer. Guesses will receive no credit.

SMU   SMU