Oregon State University
Department of Physics

Physics 431: Electrodynamics Capstone
Fall 2020

Assignment Four

Due: Wednesday, October 21, 2020 (11:59 p.m.) **Points Possible:** 50

Written questions and problems are to be neatly written up as described in the syllabus and turned in via Gradescope. Remember that for Gradescope submissions *each problem must be written on a separate page*, with the problem number clearly indicated. I (or the TA) may choose only a subset of problems to grade carefully each assignment – we won't tell you in advance which those might be! – and rely on you to study the solutions to make sure you fully understand the remainder. Problems will be worth 10 points each unless otherwise stated.

As described in detail in the syllabus, any resources you consult (faculty, friends, books, papers, web sites, etc.) must be cited on a problem-by-problem basis. Individual web page urls, book chapter, section and page numbers etc. should be included; simply listing e.g. the site or the name of the book is not enough.

In most all problems, a good sketch or plot will be your friend. Any additional computer files (e.g. *Mathematica* or python code) should be *both* uploaded to *Canvas* **and** appended to your solution and submitted with the rest of your Gradescope submission. (Remember, though, code is not a substitute for a problem solution. You are attaching your code for reference only.)

Reading:

Griffiths §7.1-2

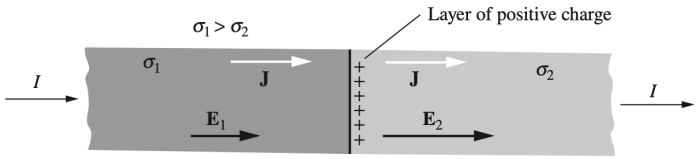
***Griffiths* Problems:**

Chapter 7 Problems: 1, 2, 5, 7

Notes:
7.2: What's the time constant RC if $R = 110$ kΩ and $C = 27$ μF? Plot $Q(t)$ and $I(t)$ for both parts (a) and (c) using these values and taking $V_0 = 120$ V. Indicate the time constant on your plots.

Other Problems:

1. (**10 points total**) Consider the junction between two materials of differing conductivities $\sigma_1 > \sigma_2$ we discussed in class. What is the total surface charge density built up on the interface between the two materials? (*Aside:* Here's a great example of a situation where it's really annoying that the same symbol (σ) is used for both conductivity and surface charge density! Use Σ to stand for the surface charge density in this problem.) Assume a steady current. Express your answer in terms of $J = |\vec{J}|$ and the conductivities σ_i. What's the relationship between J and I?


$\sigma_1 > \sigma_2$
Layer of positive charge
σ_1
J
J
σ_2
I
I
$\mathbf{E}_1$
$\mathbf{E}_2$