PEP542 Homework
Spring 2025

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- There could be typos, please let me know if you find any issues.
- Do not copy solutions from Google or other online resources. It is very easy to tell whether the solution is original work or not.
- You are encouraged to discuss the problems with the other students.
- Please scan your solutions (make sure that the solution is recognizable) and upload the PDF file to Canvas.
- Late homework will not be counted in the final grade.
- Each student is granted one late-homework exemption, provided the homework is submitted within five days of the deadline. Please use it wisely.

Homework 4 (Due 2pm, Feb 28)

1. Find the potential inside and outside a uniformly charged **solid sphere** whose radius is R and whose total charge is q using the equation $\phi(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}dV$. Use infinity as your reference point. Compute the gradient of V in each region, and check that it yields the correct field. Sketch $V(r)$.
2. Find the energy stored in a uniformly charged solid sphere of radius R and charge q. Do it three different ways:

- $$W = \frac{1}{2}\int \rho V d\tau$$
- $$W = \frac{\epsilon_0}{2}\int E^2 d\tau \quad \text{(all space)}$$
- $$W = \frac{\epsilon_0}{2}\left(\int_V E^2 d\tau + \oint_S V\mathbf{E}\cdot d\mathbf{a}\right)$$

(Take a spherical volume of radius a). What happens as $a \to \infty$?