Final Review
- 4 questions, 4 hours (with up to 30 minutes of break)
- You may use Griffiths, your notes and graded problem sets, and the solution sets.
- You are responsible for material including Ch 4 in Griffiths and Tues March 10th lecture.
- Due Wednesday, March 18th at 5pm in Sloan Annex.

Topics we covered:
Vector Calculus:
- Div, Grad, and Curl
- Divergence Theorem, Stokes' Theorem

Basic E&M:
- Electric Field ($\vec{E}$), Potential ($V$), point charges and charge distributions, conductors, capacitance ($C$)

Laplace’s Equation:
- Uniqueness Theorem and Method of Images
- Separation of Variables
- Legendre Polynomial expansion given azimuthal symmetry

Multipole Expansion:
- Potential and Electric Field

Polarization:
- Dielectrics and torque
- Bound charges, Electric displacement ($\vec{D}$)
- Linear dielectric (Boundary Value Problems)
- Energy and Forces in dielectric systems

Problem 1: Consider a thin ring of radius $R$ charged uniformly with total charge $Q$. Take the origin at the center of the ring and align the polar axis with the symmetry axis of the ring. Find an expression for the potential $V(r, \theta)$ everywhere, using a Legendre expansion. Give at least the first four coefficients explicitly.

 Hint: $V(r = z, \theta = 0) = \frac{1}{4\pi \varepsilon_0} \frac{Q}{\sqrt{z^2 + R^2}}$, \hspace{1cm} (1 + x)^{-1/2} = \sum_{n=0}^{\infty} (-1)^n \frac{(2n - 1)!!}{(2n)!!} x^{2n}$

Problem 2: Griffiths Problem 4.36 A conducting sphere at potential $V_0$ is half embedded in linear dielectric material of susceptibility $\chi_\varepsilon$, which occupies the region $z < 0$. Claim: the potential everywhere is exactly the same as it would have been in the absence of the dielectric! Check this claim, as follows:

(a) Write down the formula for the proposed potential $V(r)$, in terms of $V_0$, $R$, and $r$. Use it to determine the field, the polarization, the bound charge, and the free charge distribution on the sphere.

(b) Show that the total charge configuration would indeed produce the potential $V(r)$. 