# Problem Set 10
# Physics 104A

Due Wednesday December 1, 11:59 PM
No late HW will be accepted.

Primary topic: PDE

**1.** (Does not need to be turned in) Derive the Laplacian operator in cylindrical coordinates.

**2.** **a)** Find the electrostatic potential everywhere inside a hollow sphere of radius 1 with surface potential $35(\cos\theta)^2$.

**b)** Find the electrostatic potential everywhere outside the sphere of part a) (assuming there are no charges elsewhere in the universe).

For problems 3 and 4 below, you can leave your answer in terms of a suitable series as long as you give an integral formula for how the series coefficients will be obtained.

**3.** A rectangular plate has its edges lying on the lines $x = 0$, $x = 30$, $y = 0$, and $y = 40$. Find the steady-state temperature distribution in the plate, given that the temperature is $0^\circ$ along the two long sides and along the short side at $y = 0$, while at $y = 40$ the temperature is $100^\circ$ for $0 < x < 10$ and $0^\circ$ for $10 < x < 30$.

**4.** Find the steady-state temperature distribution in a spherical shell of inner radius 1 and outer radius 2 if the inner surface is held at $0^\circ$ and the outer surface has its upper half at $100^\circ$ and its lower half at $0^\circ$. ( Note that with neither 0 nor infinity in the region you are solving for, you need to keep *both* $r^n$ and $\frac{1}{r^{n+1}}$ radial solutions, and solve paired equations for their coefficients.)