Workshop #7, diffusion, outline for TF, not students
APM 115: mathematical modeling

2D Diffusion with no-flux boundary conditions.

To the students:

- What is the physical meaning of a no-flux boundary condition?
- Change the program `diffusion_demo_apm115.m` to use zero flux boundary conditions instead of specified temperature on the boundaries.
- Calculate and plot a time series of the spatially averaged temperature.
- Run all three demos and explain the results. In particular, what is the steady state of the cases with non zero sources?

To the TF:

- No flux boundary conditions correspond to insulating boundaries.
- Start by showing the students the solution to the no flux boundary conditions as compared with the fixed temperature boundary conditions using the Matlab scripts workshop07.m and the one used in class. Ask what the difference is…
- Help the students understand that they need to solve the equation at boundary points too now, not just interior points as done in the demo used in class.
- They need to do this by calculating the $Flux_{in}$ and $Flux_{out}$ terms at the boundaries too.
- So for example, the in-x-flux is zero on the left boundary, and the out-y-flux is zero on the top boundary.
- Explain to the students that if we calculate the time derivative of the spatial average of the temperature,
$$\overline{T}^n \equiv \sum_{i,j} T^n_{i,j},$$
then the sum over the $Flux_{in}$ terms (see code) creates a telescopic series which sums to zero with zero flux boundary conditions, and that therefor the spatially averaged temperature is constant in time unless there is a source. If there is a source, the averaged temperature increases linearly in time at a rate equal to the spatial average of the source.