Possible module topics

It seems that we have semi-converged on three possible topics (or a blend of the three) for a module for a dedicated computational physics course. I have listed them below along with what I see as the advantages and disadvantages of each. You may not agree with my list (if so, comment on it) and my list may be incomplete.

1) Solutions of the Laplace and Poisson equations

   Advantages: Does not require much background from the students. Algorithm used is broadly applicable and easy to code.

   Disadvantages: Not very exciting. I don't know how much "new physics" you get from the computation. This statement may reflect my lack of imagination.

2) FDTD solutions of Maxell's equations

   Advantages: Algorithm used is broadly applicable and easy to code. In it's simplest form can even be done in Excel. You can start simply and work-up to the full set of Maxwell's equations. Lot's of rich physics applications, including some (near-field) that are of current interest.

   Disadvantages: Demands somewhat more background from the students. Some cases might be very computationally intensive.

3) Waveguides maybe moving to "can you hear the shape of a waveguide?".

   Advantages: Algorithms used are broadly applicable. Topic is technologically important. Topic is almost infinitely extendable once you look at waveguides that are not square or circular. The question can you hear the shape of a waveguide, leads to some profound mathematics (Gordon, Web and Wolpert, Invent. Math. 10, pages 1-22, (1982) plus the literature on iso-spectral manifolds), a number of beautiful experiments (Sridhar and Kudrolli, PRL 72, pages 2175-2178 (1994)) and a new numerical algorithm (Dirscoll, SIAM Rev. 39, pages 1-17, (1997).

Disadvantages: Demands the most background from the students. I don't know how much "new physics" (over say a square wave guide) you get from the computation. Once again this statement may reflect my lack of imagination. If fact since one rarely does anything but rectangular or circular waveguides I may well be wrong. I think this is a hard problem at the level of "can you hear the shape of a waveguide?".

Comments, suggestions, criticisms?