MATH 448, SECTION 923, MAY-AUG, 2014

Intro: This is a directed studies course. In this section, we will focus upon applied mathematics research and work together on a problem of current interest in the realm of condensed matter experimental physics.

Research experience will include independent and collaborative work on problems where the answers are unknown, practicing oral communication and presentation skills during regular meetings, giving research talks to diverse audiences, writing technical reports, and writing a research paper. Grading will focus heavily upon the experience of doing research and making improvements, although quality of work will obviously play a role.

Application: A basic model of how surface roughness affects magnetic fields within type 2 superconductors has been developed both numerically and asymptotically. In this research, we will endeavor to expand upon this. Using AFM data of superconductor surfaces, we will try to gain a more accurate perspective of the magnetic field profiles that can be measured experimentally.

Work and grading: Work in this course will require programming with Matlab, preparing reports and presentations in LaTeX, and giving talks.

The marks will be divided into:

Oral Progress Reports (30%) – each week, either one-on-one or as part of a small group meeting, you will present your recent work, results, obstacles encountered, and questions. These will be informal presentations and their purpose is really to help you with your research and allow for efficient communication and collaboration. Grading is based on participation and effort (i.e. having something to share – not necessarily a final result!).

Written Progress Reports (20%) – over the summer, you will be asked to prepare 2 or 3 concise reports on the work undertaken. These reports will be formatted in LaTeX. The idea here is to gain experience giving periodic updates to research/industry collaborators. Grading will be based upon completing reports and making requested revisions (if any).

Research Talks (20%) – on two occasions, you will be asked to give a presentation to a wider mathematical audience. Here, you'll develop skills for giving talks to fellow researchers who are not familiar with your research problem. You will get feedback after each talk. The first presentation (10%) will be graded based on giving the talk and then participating in a feedback and reflection session afterwards; the second presentation (10%) will be graded on basic presentation skills and improvements.

Final Report (30%) – this is a report/paper that will summarize all the work you have done on the project. It will be formatted as a research paper, complete with abstract, introduction/background, explanation of the work, results, figures, conclusions, future work, and citations. Two weeks before the end-of-term, you may submit a draft and receive feedback. The final report will be graded based on meeting the standards of an academic paper.

Some preliminary topics we'll look into before beginning research include: Superconductors, Maxwell's Equations, and the London Equation; Finite Differences for Partial Differential Equations; Transformations of Coordinate Systems; Numerical Linear Algebra; and preparing reports, papers, and talks in LaTeX.

Note on workload: Some of the course work will be done during the meeting times (roughly 2-6 contact hours per week). While you are expected to work more on your own, you should limit yourself to a total of ≈10 hours of work per week, including meeting times (roughly what a "regular" 3 credit course amounts to). If the workload gets to be too much, be sure to speak up ☺