

# How to Study for Qualifying Exams

## SIAM Student Chapter

### Professional Development Session\*

November 9, 2010

#### **Why do we have Qualifying Exams?**

By the time most students take the Final Exam in a course they know the material just well enough to pass it. However, they typically haven't wrestled with it enough for the brain to retain it over the long term, understand it at a deeper level, or know how to apply it to solve real problems. To achieve these goals—which are so important for research—requires a prolonged and intensive effort.

You take qualifying exams:

1. So that fundamental ideas remain at your fingertips for life.
2. To digest an entire subject and understand it at several levels of detail, i.e., to distill out the central themes and ideas.
3. To master fundamental material that every professional should know. Even if you don't use it all as a graduate student, it will eventually be useful in ways you do not anticipate.
4. To force you to master basic theory and learn how to apply it by solving lots and lots of problems.
5. To make connections between different aspects of the subject (by solving problems).
6. To synthesize material at a higher level.
7. To learn to think on your feet, fairly quickly.
8. To use problem solving to prepare you for research by encouraging you to think more like a researcher and less like an undergraduate or beginning graduate student.
9. To experience what it feels like to be an expert at a subject and learn how to attain such expertise.

---

\*Compiled by J. Zweck from discussions with Drs. Gowda and Roy and former graduate student Noemi Petra.

All of these points are essential preparation for future research (or development) work in fields that rely on the material covered on the exam.

## **Some Strategies for Preparing for Qualifying Exams**

### **Three essentials for creative work:**

1. The theory must all be in your mind and be readily accessible.
2. You must have gained experience solving **lots** of problems of varying degrees of difficulty.
3. You should have distilled the subject to its essence and cemented a dense web of connections within it.

For each exam you will probably need to adopt somewhat different strategies.

Start early, plan, pace yourself. Take the time to fill in gaps in your knowledge/experience from "prerequisite" courses.

### **Ways to get the theory in your mind:**

1. Identify helpful source material: lecture notes, course textbooks, classic references in the field (often challenging), and more elementary texts that you can relate to.
2. You need to master definitions, theorems (and know the difference between the two), examples, counter-examples, main proof techniques, major applications.
3. Don't dive in at the deep end: Make sure you master the more elementary material before tackling esoteric/specialized results. Students who cannot demonstrate knowledge of the basics are very unlikely to pass.
4. Go through your sources and write down a detailed list of things you need to know. This should be a list of questions (eg., what does the Fundamental Theorem of Calculus say?) rather than answers.
5. Then with your sources closed *write* down what you know about each item on the list, as precisely and succinctly as you can. Look at your sources *only* when you get stuck.
6. Grade yourself! Repeat until mastery is attained.
7. Use "flash cards" to practice more random access to the material.
8. Explain concepts in your own words to solidify understanding, but make sure you can use technical language like a professional too.
9. Writing is much more effective than talking/reading: You feel and see the pen on the page as you write, you can look back over what you have written and fine tune it, you can be a much more exacting grader, and, after all, in the end you have to write the exam!

### **Preparation through Problem Solving:**

1. Identify several sources of problems: homework sets from the course you took and from other professors' classes, past course and qualifying exams, problems from course textbooks, classic references, and more elementary texts.
2. Work as many problems as you can, with a variety of levels of difficulty.
3. Figure things out both by yourself and in a small group.
4. Think like a professor: Why were these questions on the exam? Devise questions for other group members (variants of standard problems and/or problems that rely on a novel synthesis of material).
5. Work intensively for two-three hours and then take a break.
6. Take breaks that allow you mind to wander freely (vigorous exercise, walks in the park, cooking...).
7. Grade/critique your work and that of your group members.
8. Keep a note-book of solved problems and annotate it to reveal common themes and to gain a higher level of understanding.
9. Identify the essential reasons that your solution worked. What other problems rely on similar ideas?
10. Talk to your professors to clarify your understanding and get ideas for harder problems.

**If you have prepared adequately the exam should be fairly straightforward.**