Qualifying Exam Advice

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Preparing for the Qualifying Exam can be a stressful and scary time. In talking to my advisor and other graduate students and thinking about my own process I collected a lot of good (in my opinion) advice on how to prepare for quals. This document is a collection of those thoughts in the hopes that they may be useful for future students preparing for their quals. My preparation process is by no means the 'right' one, as everyone's background and topics are different. However in presenting my process I hope it will help others get started or feel more confident in their own quals preparations.

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1 General Advice

1. **Think out loud**
   If you get stuck, your committee members will eventually step in to guide you in the right direction, but if you are silent they won't know what you are thinking or where you are at. Talking through your thoughts will show that you are making an effort and give them something to hint at. This is especially important when you get vague questions like"What does Dirichlet's Unit theorem applied to real quadratic fields say about the integers?" (answer: Pell's Equation). You may not know the result they have in mind immediately, but if you start talking they will likely provide hints to get you to what they are thinking.

2. **Focus on what you know**
   When you are trying to think out loud but feel stuck, what do you say? With all questions, start with what you know. If there are definitions involved, state those to get started (if they are on your syllabus you should know these, if they aren't feel free to ask for a definition). State an example of an object involved to get concrete intuition. If you know a result in a simpler case go ahead and state that. If something reminds you of a condition to a theorem say that and state the theorem. If you have an idea you know won't work go ahead and say what it was and why it won't work! All of these have a good chance of helping you solve the problem (or at least getting a hint to help solve the problem).

3. **Feel free to make simplifying assumptions**
   Maybe you aren't sure how to prove something in general, or only remember the computation for primes, feel free to make that simplification to start. Sometimes your committee will be happy with the simple case, or thinking through the simple case will give intuition for the general case.

   Examples:

- Q: If almost all primes split completely in L/K show that $L = K$.
  If L/K Galois then apply Chebotarev so assume Galois to start.
- Q: Prove the residue theorem.
  First assume only one pole to make the contour simpler. How do you generalize?
- Q: Prove the Weak Law of Large Numbers
  Assume finite variance to simplify the proof even though $E|X_i| < \infty$ is sufficient.

4. **Write everything out and be explicit**
   Writing out everything is dual purposed: 1) makes very clear what you know and establishes notation/definitions where there may be ambiguity and 2) gives you time to think; by writing out the question, writing out defintions, writing out conditions you may realize something useful *or* realize a theorem doesn't apply before you get too far.

5. **You will not know everything during your qualifying exam**
   Your committee's goal is to assess what you know and part of doing that it finding the boundary of what you *don't* know. This means if you know something really well, you will probably move on from it quickly to something you don't know. This means you will get to a point where you don't know the answer or even what the faculty is looking for. Stick to the above advice and know that this is okay and normal.

6. **Not Failing = Passing**
   While studying, I worried a lot about whether I knew 'enough' for a given topic. In many ways, the material you need to know for your quals is vague and undefined (terms on your syllabus are always fair game, but what about a detail of a lemma for a proposition that gets used in a theorem on your syllabus?). But rather than thinking about the threshold for passing and how high it may or may not be, I found it better (ironically) to think about the threshold for failing. Basically, it was easier to convince myself that I knew 'enough' to *not fail* than enough to pass.

2 Types of Questions to Expect

- State and prove major theorems (where proofs are short/understandable enough to present in a small amount of time, possibly with simplifying assumptions)
- Consider a theorem. Where is a particular assumption used in the proof? What happens if we drop a condition (e.g. provide counter example for these cases)?
- State a definition. Give some examples/nonexamples.
- Do a computation (e.g. contour integral, class group computation, etc).
- Here is a set up, what can you say (looking to recognize when conditions for theorems are met and successfully apply them).
- Give a short summary of [topic].
- What is your favorite theorem on this topic? What would you like to talk about within this topic/subject?

3 My Preparation Proccess

Review

1. Review all the material from scratch and make sure everything within the scope of quals (i.e. on or closely related to my syllabus and not too lengthy/detailed) makes sense.
   (a) Write up (typed) notes on exercises, definitions, theorems and proofs as I went to have something to reference back to while studying later. (somewhat includes the next two points, although I stopped keeping up with this and filled in these notes at the end)
   (b) Having a study buddy to work through problems with or practice presenting material is great, especially if you have material you are learning for the first time (which was true for one of my major topics)
   (c) Having a faculty/older student to ask questions when you get stuck is also extremely valuable. If they are willing, have them give mini "mock quals" at the end of each unit to practice what you know
2. Create a list of terms/theorems/examples that should be (mostly) memorized
3. Make lists of potential quals questions. These are both great to practice with and will also help you digest the material. See "questions to expect" for ideas on types of questions.
4. Go back through all the topics and create *handwritten* reviews organized by topic, with a page (at least) for each term appearing on my syllabus.
   (a) Example: a page on characteristic functions included defintions, basic properties, general and specific inversion formulas and a note on their significance
5. Fill in the typed up notes with memorization terms or quals questions, as much from memory as possible.

Practice

1. Get some older students to give you a mock qual for your entire syllabus (about 2 weeks before the date)
   (a) Being prepared to talk about all of the material for 3 hours is significantly more difficult than slices of material for 30 minutes to an hour. It's good to practice that 'math endurance' at least once before exam day.
   (b) Quals are in part a test of thinking on your feet and working through a new problem on the fly with people watching. This is hard to practice on your own, so doing mock quals sessions is a great way to get comfortable not knowing and thinking out loud
2. During the last few weeks before your exam you should be *very* familiar with your syllabus and a good list of practice questions. During this time I would review material while walking to/from work, while in the shower, while waiting for my tea to steep, etc. A friend of mine even recorded voice memos for themselves to listen to while out on walks to review key ideas. This doesn't mean you have to be studying all the time (I'd advise against that) but it can help give you 'mini reviews' and build confidence.
3. It is helpful to practice explaining to people as it's different than thinking internally or even just talking to yourself. That said, they don't (always) need to understand you! Once you have a list of practice questions and/or terms, you can get friends/family to pick something at random and have you explain it (it's totally fine if they don't understand, as long as you do!). I also wrote up a list of questions in python and short script to randomly select questions by topic for practicing on my own or helping people quiz me.

4 Resources

1. **Grad handbook** - The department maintains a graduate student handbook with a section on the qualifying exam, including logistics details regarding scheduling, filing, committee requirements, and syllabus approval.

2. **Quals Syllabus Database** - The department also keeps a Google Drive of previous students Quals syllabi. When creating your syllabus, use this to find examples for your intended topics. Feel free to trim down from previous syllabi! [Note: requires a Berkeley email to access]

3. **MGSA Wiki** - Complementary to the official handbook is the (possibly outdated) MGSA Wiki which has a Qualifying Exam page that contains information about what to expect and prepare as well as links to previous questions listed by topic (again, possibly outdated).

4. **Deparmtent Quals Questions Database** - During 2021 the department launched an official collection of previous quals questions (filling a management gap from the former MGSA collection). In the spreadsheet, there are questions by topic/subtopic, student and faculty names for each questions. There is also a collection of student advice compiled here. [Note: requires a Berkeley email to access]

5. **Your advisor** - Your advisor should be a primary resource for planning and preparing for quals. They can help you get your syllabus together, advise you on study methods, and do practice qual meetings as you review.

6. **Other students (pre-quals)** - Other students who are also pre-quals (e.g. in your cohort) can be great study buddies if they have overlapping topics or interests. You could form a reading group for a topic, or just meet regularly to practice questions and explaining material.

7. **Other students (post-quals)** - Students who have already taken their quals are a great resource for advice and practice. Talk to people in your field(s) about their quals experience and who they would recommend to be on your committee. You can (and should!) also ask some of them to be on a "mock quals" for you as you get close to the date.

8. **Head Grad Advisor(s)** - The logistics of preparing a qual can be tedious, but the grad advisors are super helpful and are always willing to meet with you to go over the details of what needs to be done and the various deadlines.