

# **Studying for the Prelims**

or

## **Building the Base for a Successful Ph.D.**

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These notes offer my personal guide to the Preliminary Examinations. They are based on almost thirty years of experience, starting with my own journey through the Ph.D. First I'll make some observations about the nature of the Ph.D. and the purpose of the exams and what we the faculty are seeking. I'll then offer some specific advice on preparing for them.

The Doctor of Philosophy Degree (Ph.D.) is the most advanced degree offered by research universities world-wide. It is designed to prepare students for careers in education, research or industry at the highest levels. It is a demanding program that offers the opportunity to excel in a particular technical field, while becoming highly effective in planning, oral and written communication, and other management skills that will have a long lasting impact on your career. Our goal is to assist you in becoming an effective, self-motivated researcher with a broad grasp of you discipline and the ability to relate what you do to the larger world around you.

The purpose of the preliminary examinations is to assess the probability of your success in the program, and, more importantly, it is an opportunity for you build a strong base of integrated disciplinary knowledge that will serve you well for the rest of your career. It is not possible to rush preparation for the exams. To turn in a credible performance, you must be prepared at a very high level. You will be asked to solve and discuss problems from a fairly mature perspective. That means being prepared to cross boundaries between subject areas, and see relationships not necessarily explored deeply in the undergraduate curriculum. Much will be asked in an oral environment, one that most of you are relatively unfamiliar with. And you will be feeling a great deal of pressure.

### ***The Fundamental Knowledge Examination***

There are three major elements to the Fundamental Knowledge exams:

#### **1. Basic Disciplinary Knowledge**

It is important that you have a global picture of the basic disciplinary fields you are to be working in. Thus, you must codify your knowledge in each of the areas being tested. This is best done by systematically developing your own set of notes summarizing the major concepts, important numbers, etc. Keep in mind that each exam really covers several disciplinary areas.

For example, the Thermal Science exam covers thermodynamics and heat transfer. You should prepare notes for each of these areas.

## **2. Basic Problem Solving**

You must be able to rapidly solve a variety of basic problems of the type you worked in your undergraduate courses. You must be able to systematically formulate the problem in a way that leads clearly to a solution method, carry out the solution, and understand the significance of your findings. The best sources for such problems are textbooks of the type recommended for the areas. You must systematically solve large numbers of problems to become truly adept.

## **3. Compound Problem Solving**

In the exams, you will be asked to solve problems that require more than one discipline. For example, you may have to solve a fluid mechanics problem as part of a heat transfer question. The question might involve needing to identify a particular flow regime as being critical to the heat transfer problem, say a boundary layer. You would then need to approximate the boundary conditions, and solve for the temperature profile. You can best prepare for such questions by selecting real world applications and asking yourself how you would attack analyzing the system. For example, what would be required to predict the real efficiency of an automotive turbocharger? Calculating the ideal efficiency is a basic problem solving skill. Dealing with heat transfer and friction losses is a compound problem solving skill.

### ***Research Evaluation Examination***

*The Research Evaluation Examination requires you to become an expert in a single topic, and demonstrate that you have the ability to conceptualize the problem, propose a hypothesis or research scenario, and make progress toward a solution. Your oral presentation should include the following components:*

- 1. A clear statement of your research problem.*
- 2. A discussion of the research history for this problem, citing appropriate literature.*
- 3. A description of the experimental and/or numerical/computational methods needed or used to address the research problem. Include statistical and/or uncertainty analysis where appropriate.*
- 4. A discussion of your findings to date.*
- 5. A summary and statement of your conclusions, including recommendations for future direction the research might take.*

*During and following your presentation, you will be asked a range of questions to assess how well you understand each element and the maturing of your approach.*

## ***Preparing***

*Clearly, being successful will require systematic preparation. The following suggestions have been proven over time, and I strongly urge you to make a study schedule similar to this and plan accordingly. The plan is design to give you ample opportunity to study for the exams, while allowing you to continue taking classes, working on research projects and having some semblance of a normal life.*

*First form a study group with at least one, but preferably two or three, other students who will be taking the same exams. If English is not your native language, avoid forming a group of other non-English speakers. You will be working with this group to develop your oral problem solving skills and to practice your research presentations.*

*Next, determine how many basic disciplinary areas you must prepare for. Most of the exam areas actually cover several basic disciplinary subjects. Set aside a period so that you have two weeks for each area (this might vary depending on the depth and complexity of the area), starting so that it ends three weeks before the exams. For this period set a regular meeting time for the group. The lunch hour is a good time. Your should meet once every week for each student in the group. Thus, two students meet twice a week, three students meet three times a week, etc. Meet in a place with a blackboard. It will be tempting to shortcut this time, but it is critical to developing good oral skills. Assign each two-week period to a disciplinary area. You should order them in a logical way, starting with the most basic and working up. Once your overall schedule is set, set aside two contiguous hours every weekday or evening for individual study. This is the time you will use to outline the area, and do problems on paper.*

*At the beginning of each two-week period, discuss with your group the nature of the area, what you think the scope of the exams might be, and what sources you will use for problems. Assign each group member the task of providing problems to have the other students practice in the oral setting. Each student should spend at least an hour a week answering questions at the board. Start you individual study each two-week period by outlining the area, then filling in your notes. One suggestion is to spend the first hour of each two-hour period working on your notes. Then do problems during the second hour. By the end of the overall period, you should have developed a very strong sense for each area, solved a large number of problems, and begun to feel much more comfortable in the oral setting.*

*You now have three weeks left. During the first of these, prepare your oral research presentation in detail. During the second week, practice your presentation in front of your study group. Your faculty advisor might be willing to listen to your practice. If so, invite him or her. Listen to the constructive criticism and modify your presentation accordingly. List all the questions you think might be asked and make sure you know the answers.*

*Also during the second week prepare short one-page summaries from the area notes you prepared earlier. This serves to consolidate your memory of each area and forces you to prioritize what information you think is most important.*

*During the third week take a break. Go to the movies, get plenty of exercise, and eat well. Splurge on a nice dinner out. Sleep in. You want to enter the exams well rested. Don't worry, your mind will still be thinking about the exams, and you can put some (but not too much) time into checking up on some of those difficult questions you never really understood.*

*You will notice that I am NOT asking you to stay up all night, study weekends, give up your other course work, give up research, or stop exercising and eating properly. I am asking you to plan ahead, be systematic, and spread out studying over a sufficiently long period so that you won't have to do those things mentioned in the previous sentence. In fact, the ability to make and carry out such plans is the hallmark of a successful Ph.D. and a person with a successful career. Learn to do it, and you will be rewarded many times over.*