I wrote this little essay for first semester calculus students, having found that a remarkable number of these students didn’t have any idea what it actually takes to do well in a calculus course. The students in this 3rd semester engineering calculus course probably have a much better idea how to study mathematics, but I will show you this essay for whatever use it may be to you.

For my first semester course, I recommended a “how-to-study” book, *What Smart Students Know*, by Adam Robinson. This book is somewhat frothy and evidently written by someone in sales/promotions, but it is nonetheless useful. I refer to this book occasionally in my essay, and I haven’t edited out these references. Perhaps it could also be of some use to you to take a look at *What Smart Students Know*.

1. **You need a good working knowledge of your previous mathematics courses.** This does not mean that you have to remember every detail today. It does mean, however, that you need to be comfortably familiar with the ideas, and reliable in doing computations by hand.

   Moreover, you need to take responsibility to identify weak spots and to review previous work as needed. When you make a mistake in your work, you need to treat that not as a randomly occurring natural misfortune, to be borne passively, but rather as a clue to something you don’t understand, to be tracked down, uncovered and corrected; your mistakes are opportunities to learn.

2. **You need to spend a minimum of ten hours per week outside of class in thoughtful concentrated effort studying calculus.** The best students will need to spend this time to achieve the thorough knowledge of calculus which will be useful in future work. The weakest students will need this time and more merely to survive.

   You can’t master calculus without spending time and effort, but it is also possible to spend a lot of time and effort ineffectively! The book *What Smart Students Know*, by Adam Robinson, has some recommendations about about active, effective learning.

3. **You need to read your text.** You need to know what is in the text. The lectures and recitation sections will not precisely repeat the material in the text, but complement it, provide insights into the material and practice with using it. Reading the text does not mean briefly skimming through it, but actively studying it.

   You must not skip the examples in the text, which are essential both for understanding the material and for completing the homework; you will have adequately understood an example when you can close the text and reproduce the example on paper!

4. **You need to attend the lectures.** Something important will be done in every class, and you will be expected to know about it. You should be prepared to take an active part in class, to ask questions as necessary, and to do practice exercises given to you in class. You will need to take notes on the lectures and to review your notes actively; sometimes the structure and purpose of the lecture will become clear to you only when you study your notes after class.

5. **You need to do the homework completely and thoughtfully.** I haven’t yet met someone who could learn calculus without doing plenty of homework. Bearing in mind that the homework is for you, not for me, you should carry on a dialogue with yourself about it: What did I learn in this problem? What did I practice? What techniques did I use? Can I outline the steps which I needed to do this? Where there any unexpected turns in the problem? Did I make any mistakes which reveal a need for some more practice? etc. etc.
I will assign what seems to me a reasonable amount of homework. Perhaps you will need to do more in order to instruct yourself adequately. Take responsibility to do what you need to do.

6. You need to do some memorization. There are certain concepts, definitions, and theorems which are so fundamental that you should know the precise formulation. Often memorization is the first step towards real understanding of the concepts (which is of course the ideal goal). I will point out material which you need to memorize, and will give you some hints about how to go about it.

7. You need to allow adequate time to review for quizzes and exams and you need to review actively and intelligently. It is unlikely that a couple of hours at the last minute will suffice. There is an extended discussion of rehearsing for exams in the book *What Smart Students Know*. Exam preparation is a time for you to construct an intellectual synthesis of the course, to put your knowledge in order.

8. You need to have, or to develop, patience, persistence, and intellectual courage. Mathematics has certain virtues to teach, and the acquisition of these virtues is more important for learning mathematics (and for living) than any particular technique which you might learn. The most important thing to be learned in this course is to face a problem for which it is not all apparent at first what method or technique might be useful, and to discover, by patient involvement with the problem, what is to be done.

This sounds fine, but possibly it could entail a conflict of expectations between you and me. You may be frustrated by a problem, and may ask about it, expecting step by step instruction in the method of solution. But I may reply instead with another question and the instruction to go home and think. You may think mathematics is about following rules, and that my answering a question with a question is arrogant and unhelpful. I think mathematics is about developing the perception and power to solve problems, and solving problems is the only way to learn to solve problems.

We have already discussed in class the nature of engineering work, and concluded that it is not at all a matter of following set procedures. The most helpful education in mathematics for you is one which helps you develop a flexible and persistent approach to solving problems.

Many students are inclined to skip any exercise which they cannot solve immediately by following the pattern of an example. I am afraid that the style of instruction in elementary mathematics tends to reinforce the inclination to give up in the face of frustration. This is too bad, since passive, dependent students do not become mature learners and thinkers, just as sedentary people do not become athletes. To become a mature learner, one needs to develop the strength to persist in the face of frustration.

10. Above all, you need to take responsibility for your learning. All that I can do is explain, assign reading and practice exercises, answer questions, offer encouragement, and guide you to helpful resources. But you have to do the learning.