LINEAR ALGEBRA: BEWARE!

MATH 196, SECTION 57 (VIPUL NAIK)

You might be expecting linear algebra to be a lot like your calculus classes at the University. This is probably true in terms of the course structure and format. But it's not true at the level of subject matter. Some important differences are below.

- Superficially, linear algebra is a lot easier, since it relies mostly on arithmetic rather than algebra. The computational procedures involve the systematic and correct application of processes for adding, subtracting, multiplying, and dividing numbers. But the key word here is *superficially*.
- Even for the apparently straightforward computational exercises, it turns out that people are able to do them a lot better if they understand what's going on. In fact, in past test questions, people have often made fewer errors when doing the problem using full-scale algebraic symbol manipulation rather than the synthetic arithmetic method.
- One important difference between linear algebra and calculus is that with calculus, it's relatively easy to understand ideas *partially*. One can obtain much of the basic intuition of calculus by understanding graphs of functions. In fact, limit, continuity, differentaaition, and integration all have basic descriptions in terms of the graph. Note: these aren't fully rigorous, which is why you had to take a year's worth of calculus class to cement your understanding of the ideas. But it's a *start*. With linear algebra, there is no single compelling visual tool that connects all the ideas, and conscious effort is needed even for a partial understanding.
- While linear algebra lacks any *single* compelling visual tool, it requires *either* considerable visuo-spatial skill *or* considerable abstract symbolic and verbal skill (or a suitable linear combination thereof). Note the gap here: the standard computational procedures require only arithmetic. But getting an understanding requires formidable visuo-spatial and/or symbolic manipulation skill. So one can become a maestro at manipulating matrices without understanding anything about the meaning or purpose thereof.
- Finally, even if you master linear algebra, the connection of linear algebra to its applications is relatively harder to grasp than the connection of calculus to its applications. Applying multivariable calculus is easy: *marginal rates of change equal (partial) derivatives*. Summing up over a continuously variable parameter equals integration. One can get quite far with just these two ideas. With linear algebra, on the other hand, there is no punchline. There's no easy way of spotting when and how a given situation in economics or computer science or any other branch of mathematics requires the use of linear algebra.

Keeping all the above in mind, you can treat this course in either of two ways. You can look at it as a bunch of arithmetic procedures (with the occasional algebraic insight behind a procedure). From that perspective, it's a "grind"-course: relatively low-skilled, but requires a lot of gruntwork and concentration. Or, you can look at it as a bunch of difficult ideas to be mastered, with a few arithmetic procedures to codify the execution of these ideas. From that perspective, it's an intellectually challenging course, and if you succeed, a satisfying one.

In practice, I would recommend seeing the course as a mix. Make sure you master the basic computational procedures. I'll try to keep them to the bare minimum you need to attain familiarity with the structures involved. The homeworks (particularly the routine homeworks) will serve that role. And if I fall short on the explanations in class (I hope I don't), the book will fill the gap.

And give a decent shot to trying to understand the concepts. I can't guarantee success. In fact, as mentioned above, you're much more likely to take away zero conceptual knowledge from a linear algebra course than you are from a calculus course. But at least if you try, you have *some* chance. Give it a shot. The quizzes will help you with that.