Course Objectives, Skills, & Attitudes

Learning mathematics is a complex job, but it is not an impossible one. We hope that laying out these course goals and objectives will be helpful to you.

- You will learn some basic terminology.
- You will learn and practice reasoning and mathematical computational skills. We will show you how to get started, and we will show you examples, but most of your learning will come from practice.
- You will adopt some attitudes. You will not be graded on these, but we put them on the list for two reasons.
    - Because having these attitudes will be to your advantage in meeting the other objectives
    - Because having these attitudes will be to your advantage in the rest of your education and professional career.

COURSE OBJECTIVES

Set Theory

Student will be able to construct new sets by performing set operations (complement, union, intersection and Cartesian product) on given sets and determine the cardinality of the new set.

Students will be able to form a partition of a set, draw a Venn diagram to represent the partition, and determine the number of subsets that can be formed.

Students will be able to solve word problems using sets, Venn diagrams, addition principle, and DeMorgan's Laws.

Combinatorics

Student will be able to draw a tree diagram to represent the outcomes of an experiment and determine the number of outcomes by using an appropriate counting formula (Fundamental Counting Principle, factorials, permutation, ordered partition with indistinguishable objects - letter problems, circular permutations, and combinations).

Students will be able to solve word problems involving counting.

Probability

Student will be able to construct an event (collection of equally-likely outcomes), determine the probability of the event (using the properties of probability, the addition rule of probability, and Bayes' formula), determine the odds for and against the event, and determine if two events are disjoint or independent for a given experiment.

Students will know how to construct tree diagrams and Venn diagrams to answer basic and conditional probability questions.

Students will be able to solve word problems involving conditional and binomial probability.

Introduction to Statistics

Students will be able to compute the central tendency (mode, median, and mean), values of a random variable, probability density function, expected value, and standard deviation of a given set of data.

Students will be able to determine the probability a randomly selected score is below, between, or above certain values for an experiment with a normal random variable by performing a Z-score conversion, and using the table of areas under the Standard Normal Curve.

Students will be able to find the mean and standard deviation of a binomial random variable, perform a Z-score conversion, and use the table of areas under the Standard Normal Curve to approximate the probability that a randomly selected score is below, between, or above certain values.

Linear Equations and Matrix Algebra

Student will be able to solve a system of linear equations, using the graphing, substitution, and elimination methods, including systems that are inconsistent or dependent.

Students will know how to represent and solve an application problem using a system of linear equations.

Students will be able to perform matrix operations (addition, subtraction, multiplication, and scalar multiplication), when possible.

Linear Programming

Students will be able to set up a two-dimensional linear program with slack variables and find the solution graphically.

Students will be able to use the Fundamental Theorem of Linear Programming to answer optimization (min/max) problems.

Students will be able to set up and solve a linear programming application problem graphically.

Markov Chains

Student will be able to construct the transition matrix and initial state vector for a Markov process (chain).

Students will be able to use higher powers of the transition matrix to answer conditional probability questions.

Students will be able to find the state vector after n-repetitions of a Markov chain.

SKILLS

Read and understand an English language description of a problem.

You will learn to determine what physical quantities and processes are involved. You will learn to determine which quantities you may presume to be known, which may be neglected, and which you are responsible for determining.

Analyze the problem.

Most problems cannot be solved in a single step. You will learn to break problems down into subproblems that can each be solved independently. You will learn to recognize which laws are relevant, and you will learn to apply the laws to solve the subproblems. You will also learn to reassemble these solutions into a solution to the whole problem.

Describe the problem.

In order to break down the problem and reassemble the solution efficiently, you will learn to describe the problem in several useful ways. You will learn to use appropriate diagrams, graphs, mathematical formulas and terminology to describe problems and solutions in a way that emphasizes the physics and suppresses the complexities and ambiguities of everyday language.

Explain your results.

The last link in this chain is to take your solution, which is usually in a mathematical form, and restate it in English. Taken together, these first four skills are what we call "problem solving."

Organize your knowledge.

Like most college courses, there is a lot of material covered in this class. You will learn to recognize how this knowledge fits together to make a whole subject.

Picturing situations.

In physics, we often deal with complex situations in which several objects interact. You will learn to picture these situations as a step towards analyzing them.

Modeling.

This is a complex skill, which we will only begin to teach you. The idea is to take complicated real-world situations and create models of those situations that are useful. To be useful a model must be simpler than the real thing: enough so that it can be analyzed. But the model cannot be too simple. It must reflect the aspects of the situation that make it worth studying.

Connecting your knowledge.

You will learn how physics is connected to other courses you have taken, to other areas of knowledge, and to knowledge you have gained informally ("common sense").

ATTITUDES

Remember that knowledge is cumulative.

Many technical subjects are structured like a pyramid. Each idea is built on the foundation of the last. Therefore, you cannot forget a formula or idea just because the test is over. That idea may be vital to your understanding of something new next week, next month, or next semester. Learn this subject for life.

Be bold.

We all know this is a difficult subject, and sometimes you will just be clue less. That is ok, it happens to all of us, faculty included. If you do not understand something, ask a question in a big room in a loud voice. The lecture hall is ideal. Remember the saying "the only stupid question is the one not asked." In a similar vein, turn in every homework assignment, even if it is all wrong. Turning in incorrect work looks bold. Not turning it in looks lazy.

Persevere.

At times, you may feel like we are asking too much, or that the material is just too hard. At these times, you need to suck it up and work extra hard. Put in an extra hour working problems, take an extra hour to talk to one of the faculty, whatever it takes. We try to make sure everyone succeeds in this course.

However, we also want you to reach as far as you can. Everyone's ability should be stretched by this course. It isn't supposed to be easy.

Get serious.

When you are doing something difficult, you need to use all your skills, and you need to devote plenty of time. Organize you work so you don't lose things. Do all the assignments. Use every resource available; that includes faculty office time, the MAC, the library, the internet, and other students. Do every assignment as if you were going to frame it. If it is going to be difficult, you want to be able to brag about it later.

Be curious.

Ask yourself why we are studying each idea, concept, formula, etc. Mathematics is one of the most finely tuned subjects in the undergraduate curriculum (This isn't ego, it is age. Mathematics is simply an older subject). Everything in the course is there for a reason. If you can figure the reason out, you will learn something about the way the subject is structured, and that will help you succeed. If you can't figure it out, ask.

Be skeptical.

When you finish a problem, be prepared to back it up. Ask yourself "how can I prove this is correct"? There are ways to do this (checking units, testing limits, etc.); we will demonstrate in class. When you use these methods, you help yourself by looking at the problem in new ways, and by examining how it fits with other ideas. Also, backing up your ideas is an extremely useful skill in the workplace. Practice now.