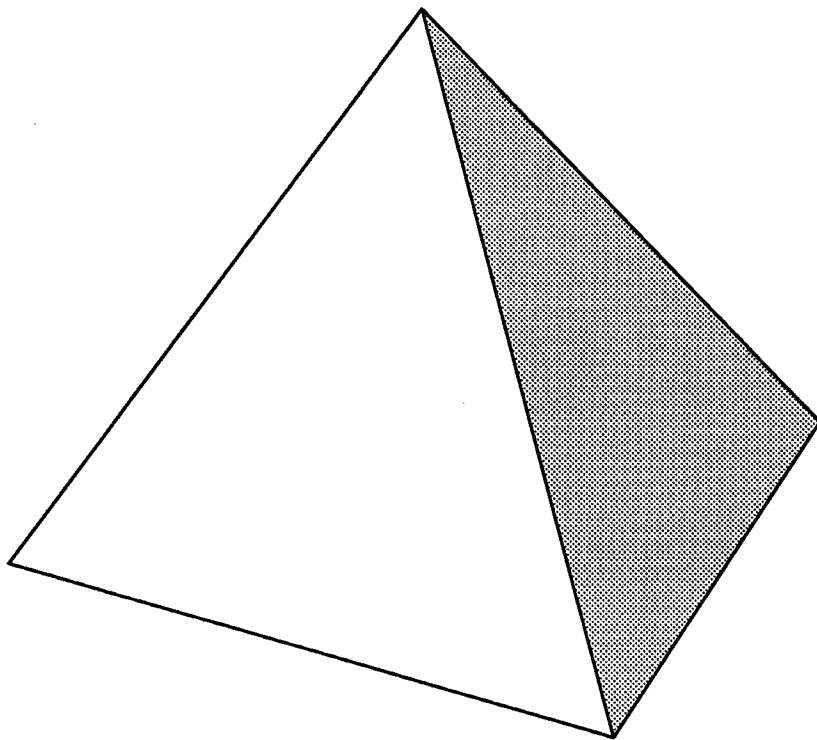


*Mathematics Supplement to*

# Foundations of Engineering



Mark T. Holtzapple  
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Dedicated to our wives and families

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## **To the professor...**

Between the two of us, we have over 20 years of experience teaching freshman engineers. During this time, we have observed many students who have innate engineering ability, but lack fundamental mathematics skills necessary to succeed in their freshman year. Often, they become frustrated without knowing the source of their problem. Some become so discouraged, they drop out of engineering.

Often, the root of their problem is that they do not know high school mathematics, either because they have forgotten it or they never learned it. Because they no longer have access to their high school texts, this knowledge is not readily accessible to them. To overcome this situation, we have prepared *Mathematics Supplement to Foundations of Engineering*.

The modern engineering curriculum is packed, so it is unlikely you will be able to take valuable class time to cover most of the topics in this supplement. Instead, we recommend that you assign these chapters as independent reading and give homework problems to confirm students' command of the subjects. If you have a significant number of students who have never encountered this material in high school, it may be worthwhile to establish evening sessions using upperclassmen as tutors.

This supplement includes a chapter on calculus, even though most students will be taking calculus concurrently with your engineering course. Our purpose is two-fold. First, most calculus courses get so heavily involved with details that students miss the "big picture." Our brief review helps students overcome this problem. Second, the pace of the calculus class may not suit your needs as an engineering professor. For example, you may wish to cover Newton's Laws in the first semester, but might be restricted because the calculus course does not teach the necessary integral calculus until the second semester. Our brief calculus overview overcomes this problem by teaching enough differential and integral calculus that students can do problems related to Newton's Laws.

We hope you find this supplement to be useful and look forward to receiving your suggestions for future editions.

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## To the student...

Mathematics is fundamental to all engineering disciplines. It is such a feared subject and causes so many students difficulty that a few words of advice will help avoid some of the traps. Several factors can hinder your mastery of math skills, so we offer the following suggestions to avoid some of the pitfalls.

1. Mathematics is a sequential subject – each stage builds upon the facts presented previously. In the first years of education, we learn to add; groupings of additions lead to the concept of multiplication; by inverting these operations, we define subtraction and division; abstraction of all the arithmetic operations gives rise to algebra; algebra is used to manipulate and understand all the equations arising in calculus; and so on. Incomplete mastery of previous material causes difficulty in mathematics more often than all other causes combined. If you are fumbling for the algebra, you will miss the concepts in calculus. Weakness in algebra and trigonometry should be remedied before seriously starting calculus. This can be done by spending a few weekends reviewing this supplement, or attending a few sessions with a good tutor. The effort and hours spent laying the groundwork will be richly repaid. Many students (and too many experts) think that mastery only involves understanding the concepts. This is not true. Mastery involves practice until it is second nature. Understanding musical theory does nothing to teach your fingers which notes to play on an instrument. Likewise, you may know algebraic theory, but without practice, you will become bogged down in the algebra and may be unable to concentrate on learning the rules of calculus.

2. Mathematicians and engineers approach the study of mathematics in fundamentally different ways. The engineer uses *applied mathematics* and considers mathematics as the tool or vehicle with which to express her ideas and aid the engineering. In contrast, a mathematician uses *pure mathematics* and views mathematics as an end unto itself and, by and large, is concerned with logical self-consistency and subtlety of the concepts. Mathematics is usually taught by mathematicians and often is presented without regard to the needs or different attitude of the engineering student. In an effort to be rigorous, the presentation is often abstract and without reference to practical problems. Although this approach is not wrong, we believe that people who are interested in engineering are predisposed to think visually and practically.

The purpose of this supplemental mathematics text is to present applied mathematics in a friendly manner to help you learn the essential mathematics necessary to be successful in your engineering studies. This approach is different than traditional mathematics texts which present pure mathematics.

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