



# UNIFIED ENGINEERING

Massachusetts Institute of Technology

Department of Aeronautics and Astronautics

Fall 2003

---

## Course Facts

### 1. Introduction

Unified Engineering is the beginning of your education as an Aerospace Engineer. At MIT, aerospace engineering is taught within the context of the CDIO (Conceive-Design-Implement-Operate) framework. Briefly, that means that we want you to graduate as engineers who can contribute to the development of new products in a modern, team-based environment. So in Unified, you will learn skills that will enable you to become an effective aerospace engineer. Of course, you will learn plenty of disciplinary material as well. As you will see, the structure of Unified reflects the dual goals of teaching disciplinary material and the other skills required of an aerospace engineer.

### 2. Course Objectives

The basic objective of Unified is to give a solid understanding of the fundamental disciplines of aerospace engineering, as well as their interrelationships and applications. These disciplines are *Material and Structures (M)*; *Computers and Programming (C)*; *Fluid Mechanics (F)*; *Thermodynamics and Propulsion (T)*; and *Signals and Systems (S)*. In choosing to teach these subjects in a unified manner, we seek to explain the common intellectual threads in these disciplines, as well as their combined application to solve engineering *Systems Problems (SP)*. Throughout the year we will endeavor to point out the connections among the disciplines.

A second objective of Unified is to guide you to an understanding of the fundamental skills, knowledge and sensitivities that are the traits of a successful engineer. These include the skills necessary to work successfully in a group (including technical and graphical communication) and those of self-education (reading, research, and experimentation). Professional engineers have the knowledge and confidence to make estimates of poorly known parameters, create conceptual models of systems, and design new solutions to meet technical challenges. Engineers in positions of leadership are sensitive to the interaction of technical solutions with the economic, political, social and environmental needs, and constraints of society.

The third objective of the faculty and teaching staff is to ensure that you have a positive learning experience. As in most teaching-learning experiences, the effectiveness and efficiency of what we accomplish will depend on the combined efforts of both the faculty and the student. For our part, we will try to make the experience of Unified Engineering stimulating, rewarding, and on occasion, fun.

### 3. Staff

#### 3.1 Lecturers

Prof. Steven Hall, Course Coordinator  
Signals and Systems

Prof. Charles Coleman  
Systems Problems and Laboratories

Prof. Mark Drela  
Fluids

Prof. Ian A. Waitz  
Thermodynamics and Propulsion

Prof. Kristina Lundqvist  
Dynamics

Prof. Mark Spearing  
Materials and Structures

Col. Peter Young  
Flight-CDIO

## 4. Textbooks

The following textbooks are required, and can be purchased at the Quantum Books:

| Professor | Author                              | Title   | Publisher             | Comment     |
|-----------|-------------------------------------|---|-----------------------|-------------|
| Lundqvist | J. Glenn Brookshear                 | Computer Science: An Overview (7 <sup>th</sup> Edition) | Addison-Wesley        | Recommended |
| Lundqvist | Feldman and Koffman                 | Ada95: Problem Solving and Program Design               | Addison-Wesley        | Required    |
| Drela     | John D. Anderson, Jr.               | Fundamentals of Aerodynamics (3 <sup>rd</sup> Edition)  | McGraw-Hill           | Required    |
| Spearing  | Ashby and Jones                     | Engineering Materials 1                                 | Butterworth-Heinemann | Required    |
| Spearing  | S.M. Crandall, N.C. Dahl, & Lardner | An Introduction to the Mechanics of Solids              | McGraw-Hill           | Required    |

The following textbooks are optional, and these are being held on reserve at the library:

1. Introduction to Flight – John Anderson, Jr.
2. Aircraft Performance & Design – John Anderson
3. Understanding Thermodynamics – Hendrick Van Ness
4. Introduction to Engineering: Thermodynamics – Borgnakke Sonntag

## 5. Assignments

### 5.1 Homework

Weekly assigned homework consists of a problem set and a systems problem or laboratory write-up.

**Problem sets.** Problem sets are generally posted to the web site on Monday by the end of class. They are generally due at 5pm on Tuesday of the following week.

A problem set handed out on a Monday will cover material taught in lectures between the previous Friday and the next Thursday, although this may vary slightly from week to week. As a result, you should be able to do some of the problems on the day the problems are handed out, and all the problems by Thursday. You are expected to work on the problems throughout the week. It is up to you to manage your time to ensure that your work is done in a timely manner.

A sample homework solution is provided at the end of this document.

Late problem sets will not be accepted.

**System Problems.** System problems will be available on the web on Wednesdays. The problem should be read and understood in preparation for the Systems lecture the next day. The systems problem is then usually due on Thursday of the following week.

Late system problems will not be accepted.

## 5.2 Quizzes

There will be 5 quizzes during the fall term and 2 quizzes during the final exam period. The quizzes are one hour and usually closed book. Students are allowed to bring to the exam any materials specified by the faculty member in charge. The solution to the quiz will be distributed after the quiz is graded. We will endeavor to grade and return quizzes within one week.

Be aware of the fact that THERE ARE NO MAKE-UP QUIZZES. Missed quizzes will receive a grade of zero unless excused by the Course Coordinator Prof. Steven Hall *prior* to the quiz. As a general guideline, excuses will be granted for a verifiable illness only, and only if notification is received *prior* to the quiz, except of course for emergency situations. Quizzes take precedence over medical appointments, travel plans, athletic events, and personal activities.

## 6. Academic Honesty

The fundamental principle of academic integrity is that you must fairly represent the source of the intellectual content of the work you submit for credit. In the context of Unified Engineering, this means that if you consult other sources (such as fellow students, TA's, faculty, literature) in the process of completing homework, system problems, or MATLAB codes, you must acknowledge the sources in any way that reflects true ownership of the ideas and methods you used.

Discussion among students to understand the homework problems or to prepare for laboratories or quizzes is encouraged. Copies of previous year's problems and quizzes ("bibles") will be made available and are considered useful in the educational process. **COLLABORATION ON HOMEWORK IS ALLOWED UNLESS OTHERWISE DIRECTED AS LONG AS ALL REFERENCES (BOTH LITERATURE AND PEOPLE) USED ARE NAMED CLEARLY AT THE END OF THE ASSIGNMENT.** Word-by-word copies of someone else's solution or parts of a solution handed in for credit will be considered cheating unless there is a reference to the source for any part of the work which was copied verbatim. **FAILURE TO CITE OTHER STUDENT'S CONTRIBUTION TO YOUR HOMEWORK SOLUTION WILL BE CONSIDERED CHEATING.** Official Institute policy regarding academic honesty can be found in the MIT Bulletin Course and Degrees Issue under "Academic Procedures and Institute Regulations."

### 6.1 Unified Study Group Guidelines

Study groups are considered an educationally beneficial activity. However, at the end of each problem on which you collaborated with other students you must cite the students and the interaction. The purpose of this is to acknowledge their contribution to your work. Some examples follow:

1. You discuss concepts, approaches and methods that could be applied to a homework problem before either of you start your written solution. This process is encouraged. You are not required to make a written acknowledgment of this type of interaction.

2. After working on a problem independently, you compare answers with another student, which confirms your solution. You should acknowledge that the other student's solution was used to check your own. No credit will be lost if the solutions are correct and the acknowledgments is made.
3. After working on a problem independently, you compare answers with another student, which alerts you to an error in your own work. You should state at the end of the problem that you corrected your error on the basis of checking answers with the other student. No credit will be lost if the solution is correct and the acknowledgment is made, and no direct copying of the correct solution is involved.
4. You and another student work through a problem together, exchanging ideas as the solution progresses. Each of you should state at the end of the problem that you worked jointly. No credit will be lost if the solutions are correct and the acknowledgment is made.
5. You copy all or part of a solution from a reference such as a textbook or a "bible." You should cite the reference. Partial credit will be given, since there is some educational value in reading and understanding the solution. However, this practice is strongly discouraged, and should be used only when you are unable to solve the problem without assistance.
6. You copy verbatim all or part of a solution from another student. This process is prohibited. You will receive no credit for verbatim copying from another student when you have not made any intellectual contribution to the work you are both submitting for credit.
7. **VERBATIM COPYING OF ANY MATERIAL WHICH YOU SUBMIT FOR CREDIT WITHOUT REFERENCE TO THE SOURCE IS CONSIDERED TO BE ACADEMICALLY DISHONEST.**

## 7. Grades

The rules of the MIT faculty define grades in terms of the degree of the mastery of course material. These definitions are listed in the Bulletin and will be applied in this course using the numerical grade as a guide.

At the end of the term you will receive two final grades since you are enrolled in two courses. Each student's final grade for each Unified Engineering semester will be based on performance in three areas of assessment:

1) The largest proportion of the grade, 60%, will depend on a number of 50-minute, in-class quizzes and two 50-minute quizzes given during the final exam period. These quizzes will not all count equally; they will be weighted by the number of lectures they cover. All quizzes will be considered in calculating a student's total quiz grade.

2) A further 30% of each student's score will reflect performance on Problem Sets, Lab Reports and Systems Problem assignments. These will be weighted by the expected number of hours required to complete them.

3) The remaining 10% of each student's score depends on their performance in various exercises (many of which will occur in class). These may include answering questions in class, either verbally or using the PRS system, submitting assessment surveys, taking concept or reading quizzes, or completing reading assignments before class. Each individual faculty member will specify the way in which this 10% of the grade is determined for the material they teach. There will be no make-up opportunities granted for missing these activities.

[Note: A student's performance on quizzes is the only true assessment of individual performance (versus that of a study group, for example). Therefore, if an individual's performance on the quizzes is significantly lower than on the homework, the average quiz grade may be given proportionally greater weight than described above.]

**JOE B:** Because different faculty members have different grading systems, a mechanism is needed so that you can convert the numerical grade on a quiz to your overall performance in the class. On each quiz, the professor responsible for the quiz will determine and announce the numerical score of a mythical student, "Joe B," who always receives a middle B grade. Performance significantly above this score is an A; performance significantly below is a C or worse. Class average will not be announced, and is not considered in the grading process. Likewise, individual numerical grades will be given on problem sets, systems problems and laboratory write-ups and quizzes. The faculty will announce the Joe B grade, but not the class average. As such, *there should be no competition among students for grades in Unified*. Ideally we would like everyone to learn the material to the standards defined by the MIT faculty for an A.

**Re-grade Requests:** Re-grades on problem set problems, systems problems, and quizzes will be considered when brought to the grader of the problem within 2 weeks of the solutions to that problem being posted. Each re-grade request should be accompanied by the cover sheet for that type of problem (available on the unified web site). The student should fill out the top portion of the cover sheet and submit it to the grader of the problem. The grader will review the problem and explain any changes that will or will not be made in the grade. Once the new grade is logged the problem will be returned to the student. If the student is still dissatisfied with the outcome of the re-grade request, the student may then approach the professor who issued the problem.

## Teaching Methods

The Unified Engineering Team is firmly committed to helping you learn. This firm commitment takes many forms, including a process of continuous improvement in our teaching effectiveness. During this semester, the faculty will be exploiting teaching methods proven to increase students' learning. These methods include presenting information to the student in the context of a compelling challenge or problem, stressing active versus passive learning in the classroom, enhancing feedback to the student, providing multiple opportunities for hands-on learning, implementing policies to improve class preparation, and providing access/exposure to a wider range of learning media. Through these methods we hope to foster a deeper working knowledge of the technical fundamentals. If we are all (the class and the instructors) successful, it will provide a firm foundation for the rest of your studies in the Department and beyond.

## 8. Class Exercises

### 8.1 Exercises at which Student Attendance is Expected

**Lectures.** The lectures are held MWF 9–11 a.m. and TR 10–11 a.m. They are the primary presentation of the subject material by the faculty.

**Systems Problems/Laboratory Lecture.** The weekly systems problem and/or laboratory lecture will generally be on Thursday. It consists of a discussion by the faculty of the systems problem currently being worked on (due the following Friday), or the laboratory for next week.

**Recitations.** Each student is expected to attend two 1-hour recitations (Tuesday and Thursday) per week. There are two groups that students will be assigned to. Group A meets from 9am to 10am and Group B from 11am to noon. The recitations will be taught by the faculty and the TAs. The recitations review the concepts from the previous week, and introduce pertinent examples, which may be related to the assigned homework problems.

Attendance at lectures and recitations is considered mandatory. Although no formal roll call will be taken, participation during in-class exercises will represent part of your grade.

**Quizzes.** Quizzes usually will be on Fridays at 9 a.m. See Section 5.2 for details.

**Laboratories.** The purpose of the Laboratories is to illustrate real phenomena, to contrast them with theoretical models and to teach lab technique. The time available and the level of the students' maturity in Unified are such that it is inappropriate to emphasize laboratory design and construction or detailed lab report writing at this point. Therefore, the lab setup will usually be provided by the Unified staff, and the results will be reported in succinct engineering format.

## 8.4 Tutoring

It is expected that from time to time, some students will have trouble understanding some of the material, or will fall slightly behind in the assigned work. Since Unified has a highly coordinated schedule, falling behind can be disastrous. If you feel yourself falling behind or overwhelmed by the material, communicate the problem as soon as it arises to the faculty or a graduate TA. The Unified staff will work to minimize the impact on your grades and will set up one-on-one tutoring or whatever form of help is deemed necessary. Problems are dealt with on an individual basis.

## 8.5 Name Cards

In Unified, Professors teach at different times throughout the term, it is often difficult for us to learn student names. During the first week of class, the TAs will prepare a name card for each student. This name card is to be placed in front of you at each lecture or recitation throughout the term.

## 8.6 PRS System

Each student will be distributed a remote transmitter to be used with the Personal Response System (PRS). Each one has its own number, assigned to a particular student. Students are responsible for bringing their transmitter to every lecture, in order to participate in exercises that use PRS. Since class participation will be, in part, gauged by each student's responses, operating other students' transmitters in their place will be considered a violation of MIT's academic honesty policy.

The transmitters cost approximately \$50. If a transmitter is lost the student will be responsible for paying for a replacement.