Engineering Mathematics

Course Number: 33-99-002-33

Course Content:

1- An Introduction to Mathematics and Engineering Sciences
2- Real Functions: A Review
3- Taylor and Fourier Series
4- Complex Functions; Theory and Applications
5- Ordinary Differential Equations; Selected Topics
6- Partial Differential Equations: Selected Topics
7- Laplace and Fourier Integral Transforms

Course Description:

Engineering students normally take their last course in mathematics when they are at the second year of a 4-year BSc program. At this stage of the program they start to take more applied courses and some would simply try to avoid any serious involvement in physics and mathematics again. Science-based courses, as opposed to applied subjects, need harder work and more patience and most of the students have painful memories from first year science courses. Therefore, the first urgent job for the instructor of a course on Engineering Mathematics is to make sure that the students get interested and realize the immense importance of the subject. If this job is done satisfactorily, the students will say another warm hello to mathematics instead of saying goodbye to it before even the course is kicked off!

Chapter 1 of the course, therefore, brings about reasons for the students to get motivated and being interested in the course. This is really a chapter on mathematical modeling. Various mathematical models, which represent problems in engineering, science, economy, ecology, etc are offered here. If an engineering student goes through the material in this Chapter and is still not motivated, he or she should probably go right to the registration office to quit the program!

Chapter 2 is a review on real functions. While, most of the material in this Chapter is not new, it provides a bird-eye view on such important families like algebraic, transcendental and special functions which are tremendously important in applied physics and engineering. At the end of the Chapter, orthogonal functions are defined and discussed to set the stage for the next Chapter on series.

Chapter 3 explains and compares the most important series used in mathematics, i.e. Taylor and Fourier series. The discussion here goes beyond simple and formal mathematics and opens eyes to some really interesting concepts and methods.

Chapter 4 finishes an unfinished job; it introduces the complex functions for which the real functions are just a subset. The Section titles in this Chapter go nearly parallel to a calculus course on real functions. Again, a complex function is formally defined followed with the

definition of limiting processes, differentiation, integration and decomposition in components. Important families of complex functions are introduced and complex differentiation and integration techniques are discussed. Some applications of complex analysis are also presented in this Chapter.

Chapter 5 offers a short review on the analytic solution methods for the linear Ordinary Differential Equations (ODEs). Initial and Boundary Value Problems (IVPs and BVPs) are discussed separately and in some details and nonlinear differential equations are briefly discussed.

Chapter 6 takes all of the tools and techniques provided in previous Chapters to devise analytic solution methods to linear Partial Differential Equations (PDEs). While different solution techniques are discussed, the focus is on the Separation of Variables Method (SVM). Both BVPs and IBVPs are discussed and the SVM is extended to handle constant or time and space dependent non-homogeneities in either governing equations or auxiliary conditions.

Chapter 7 presents Laplace and Fourier integral transformation methods. These are powerful methods for the solution of linear differential equations. The idea of transforming a complex function or operator to a simpler one surely deserves a separate Chapter! Considering the expected students' backgrounds and the remaining lectures at this stage of the course, sometimes only the Fourier transforms are discussed.

Course Resources:

The following textbook is recommended for this course:

Ali Ashrafizadeh and A. H. Madani, "An Introduction to Applied Mathematics in Engineering", K. N. Toosi University of Technology Press, 2010 (in Persian).

Course Evaluation:

The students are evaluated through a number of assignments, short term projects, mid and final term examinations (each out of 100) as shown below:

Mark = $\frac{1}{5}$ max {M1, M2}

M1 = 0.6 (Final) + 0.3 (Midterm) + 0.1 (Assignments) + 0.1 (Extra work)

M2 = 0.9 (Final) + 0.1 (Assignments) + 0.1 (Extra work)

Term projects (the Extra work) are introduced during the class discussions. Students who would like to do these projects should talk to the instructor during the term (before the final exam) and submit their reports at the day of the final exam. At most, 2 additional marks (out of 20) may be considered for an excellent extra work. Of course somebody may be bright enough to get a mark greater than 20 at the end of the term (this case rarely occurs!). In that case the additional marks will be replaced by an acknowledgement letter from the instructor and a cup of tea (or an ice cream) at a nearby café.