MA303 Course Outline FALL 2004

Prepared Fall 2004

Title: Differential Equations for Engineering and the Sciences

Prerequisite: MA 262 or 272

Texts: [1] *Elementary Differential Equations and Boundary Value Problems,* Boyce and Diprima, 8th Edition.

[2] Ordinary Differential Equations using MATLAB, Polking, and Arnold, Prentice Hall, 3rd Edition.

MA303 is a required course for ME students and an elective course for other mathematically oriented students in engineering and science. The students are predominantly juniors in their 5th semester. Some have finished MA 262 two or more semesters in the past though.

MA303 covers the Laplace transform, systems of first order linear equations, numerical methods, series solutions, partial differential equations and Fourier series.

MATLAB is used for plotting, numerical methods and linear algebra.

The prerequisite, MA262, presently covers linear equations, a partial treatment of first order systems, but no longer covers series solutions. Part of the goal of MA303 is to complete these topics with a minimum of overlap. See notes below for added details.

OUTLINE

Chapter and Sections	Hours
5(1)	9
MATLAB(2)	1
6 (3)	5
7.3–7.9 (4)	9
8(5)	2
10.1–10.7(6)	12
Appendices A & B	

The outline leaves 6 hours for tests and review. A list of suggested exercises and computing assignments, MATLAB.1–8, are given below.

Each MATLAB assignment should take 1-1 1/2 weeks to complete. Pass out the first one during the second week of class. MATLAB. 1-3 are introductory. MATLAB. 4 is related to Chapter 6; MATLAB. 5 is related to Chapeter 7; MATLAB. 6 is related to Chapter 8 and MATLAB. 7-8 are related to Chapter 10.

Comments

(1) Section 5.7 – For this section focus on classifying equations using Theorem 5.7.1 rather than computing coefficients.

Section 5.8 – Instead of covering properties of solutions to the Bessel equations, show that these equations arise naturally by demonstrating special solutions to the heat and wave equations.

For example start by seeking special solutions of the heat equation on a disk

$$u_{rr} + u_r/r = u_t \qquad \text{for } 0 < r \le \overline{r},\ t > 0$$
$$u(\overline{r}, t) = 0.$$

Show that $u(r,t) = R(\lambda r)e^{-\lambda^2 t}$ solves the equation for any λ iff $R(r)$ is a solution the Bessel equation of order zero. Graph the bounded solution and point out its zeros $\{r_1, r_2, \dots\}$. Conclude that you can find such solutions satisfying the boundary condition by setting $\lambda = \lambda_i = r_i/\overline{r}$.

(2) Most of the students will have seen MATLAB in their Freshman Engineering Tools Course.

Those who have not seen M-files or plotted with MATLAB should use [2]. You can spend an hour covering chapters 1 & 3 from [2] and have your class try some plotting. (See MATLAB.1.)

(3) See MATLAB.4.

(4) Section 7.8 – See MATLAB.5.

Section 7.9 – Focus on the method of variation of parameters.

(5) Give an overview of the Euler, Improved Euler and Runge–Kutta methods emphasizing their mathematical basis. (See MATLAB.6.)

(6) Have your class compute Fourier coefficients by hand, then use MATLAB to plot partial sums and compare these with the actual function. (See MATLAB.7.) They can do the same for approximate solutions to the heat and wave equations. (See MATLAB.8.)

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Suggested Text Assignments

Section	Problems
5.1	3, 5, 7, 13, 17, 21, 22, 23
2	1, 2, 6, 8, 9
3	1, 4, 6, 10
4	2, 4, 5, 8
5	1–9, 13
6	1–4, 13
7	1–4
8	The wave equation in polar coordinates is $u_{rr} + \frac{u_r}{r} + \frac{u_{\theta\theta}}{r^2} = u_{tt}$. Suppose $u(r, \theta, t) = \cos(t)\cos(n\theta)R(r)$. What is the differential equation that $R(r)$ satisfies? What is it called?
6.1	5b, 7, 11
2	2, 4, 6, 7, 14, 21, 25
3	2, 11, 13, 14, 25
4	1, 2, 5
5	2, 4, 6, 8
6	8, 13
7.3	1, 2, 3, 6, 12, 14, 15, 17, 19, 20, 22
5	1, 3, 5, 13, 24, 26
6	3, 6, 9, 18
7	2
8	2, 6
9	1, 7
8.1	1a
2	1a
3	1a
10.1	1, 4, 14, 15, 16, 17
2	9, 14, 18
3	1, 2, 6,9
4	10, 11, 15, 17, 18
5	1, 4, 5, 7, 8, 9, 12, 17, 18, 19
6	1, 2, 9a, 9c, 9d
7	1a, 1b, 5a, 5b
8	1a, 1b, 5

Statement for Students with Disabilities

Students who have been certified by the Office of the Dean of Students-Adaptive Programs as eligible for **academic adjustments** should go to MATH 909 and request an Information Sheet for **this** semester, that explains how to proceed this semester to get these adjustments made in Mathematics courses. (This is not the same as last semester.) **This should be done during the first week of classes**. Only students who have been certified by the ODOS-Adaptive Programs and who have requested ODOS to send their certification letter to their instructor are eligible for academic adjustments.

Students who are currently undergoing an evaluation process to determine whether they are eligible for academic adjustments, are encouraged to find out **now** what procedures they will have to follow when they are certified, by requesting the above mentioned Information Sheet from MATH 909.

Large print copies of the *Information Sheet* are available from MATH 909 upon request.