Mech/Math 358 Engineering Analysis 2012-13 Term 2

Course Organization

Instructor: G. M. "Bud" Homsy 1215 MATHX bud@math.ubc.ca 604-822-3783 (Math office) 604-822-1369 (PIMS office) 604-222-1151 (home)

TAs: Jeff Abeysekera: jeffa@ece.ubc.ca Mohammad Montazer: montazer@math.ubc.ca Ida Karimfazli: ida.karimfazli@gmail.com

Office Hours: Tuesday - Thursday 12:30-1:00 and by appointment

Website: to be announced

Course Description, Prerequisites and Topics

The study of analytical and numerical solutions of ordinary and partial differential equations, with emphasis on those arising in Mechanical Engineering applications. Prerequisites are multivariable calculus including partial differentiation and integration; linear algebra and matrix theory; a first course in ordinary differential equations; and elementary numerical analysis. A list of topics and a schedule are appended to this document.

Text

There is no required textbook for the course, but the following are recommended.

- 1. <u>Elementary Differential Equations and Boundary Value Problems</u> (10th ed.) W.E. Boyce & R. C. DiPrima.
- 2. <u>Applied Partial Differential Equations (with Fourier Series and Boundary</u> <u>Value Problems)</u> (4th ed.) Richard Haberman
- 3. Any of the zillion books with titles like "Differential Equations with Matlab". One such book is *Applied Numerical Methods with Matlab* (2nd ed.) Steven Chapra

Class Meetings, Course Assignments and Computer Labs

Two lectures/week, one computer lab every two weeks, and TA office hours. Assignments will be handed out approximately every two weeks. These will contain problems that you should work and understand before completing the computer labs. Collaboration is allowed on assignments, with the usual warning that you should be sure you understand the material even if you collaborate. *The computer labs should be done independently*. Computer labs are due at 5pm one week from the day of your section. **Note:** You will have difficulty passing the exams and the course if you don't understand the labs.

Tests

There will two midterms and a final. The midterms are scheduled for Thursday, Feb. 14th (Valentine's Day!) and Thursday, March 14th.

Grading

Assignments	10%
Computer labs	21%
Midterms (2)	23% each
Final	23%

MECH/MATH 358 2011-12, Term 2 Syllabus

Topics Covered

1. Review of ODEs: classification; initial value, boundary value and eigenvalue problems; analytical theory

- 2. Review of basic concepts of numerical analysis: numerical solution of initial value problems
- 3. Shooting methods for boundary value problems: root finding techniques
- 4. Finite differences; solution of ODEs by finite differences
- 5. Balance Laws; derivation of the heat equation; scaling and dimensionless variables
- 6. Solution of heat equation by separation of variables; general considerations
- 7. Fourier series; formal development, orthogonality, Convergence Theorem
- 8. Periodic extensions of functions; Fourier sine and Fourier cosine series
- 9. Solving boundary value problems using Fourier series
- 10. Classification of partial differential equations; parabolic, elliptic and hyperbolic equations; the heat equation, Laplace and Poisson equations, the wave equation
- 11. Numerical solution of heat equation by finite differences; explicit methods stability; implicit methods Crank-Nicholson
- 12. Elliptic equations; derivation of Laplace's equation and Poisson equation
- 13. Analytical solution of Laplace's equation by separation of variables
- 14. Finite differences for Laplace's equation; Relaxation methods; finite difference methods for elliptic equations
- 15. Derivation of the wave equation; analytical solution of the wave equation; D'Alembert's solution; right and left-running waves; separation of variables
- 16. Numerical solution of the wave equation; finite differences, stability, the CFL condition
- 17. PDEs in other coordinate systems; cylindrical coordinates; spherical coordinates;
- 18. Bessel's equation; Bessel functions; Fourier-Bessel series
- 19. Eigenfunction expansions (if time allows)
- 20. Sturm-Liouville theory (if time allows)

MECH/MATH 358 Schedule 2012-13, Term 2

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APRIL 1 - Easter 2 - Lecture 24 3 4 - Lecture 25 6
Monday Eigenfunction Last class – O&A
expansions
Sturm-Liouville theory