Syllabus for ME 523

(Formerly ME 540)

Numerical Solutions Applied to Heat Transfer and Fluid Mechanics

Spring Semester, 2008

Lectures: Tuesday and Thursday, 11:15-12:30, 103 Willard Building

3 credits

Instructor: Dr. John Mahaffy , 863-4018, *mahaffy@psu.edu*

Office Hours: By appointment in 231 Reber

Required Texts: None, Course notes will be provided online or as handouts.

COURSE DESCRIPTION: A study of Finite volume and finite difference methods applied to the solution of heat transfer and fluid flow problems. The course has a substantial learn-by-doing component. You will explore various numerical methods by implementing them in computer programs for homework assignments.

Goals:

Computer simulations play an important role in understanding behavior of existing physical systems, and designing new systems to meet a given set of specifications. This course will provide basic information needed to understand the numerical methods used in such simulations, or to write new computer applications.

Topics:

1. Underlying mathematical models
2. Construction of finite volume methods

3. Use of Taylor series to create finite difference methods
4. Use of Taylor series for error analysis
5. Predictor-corrector methods
6. Iterative solution methods for sparse systems of linear equations (convergence properties, preconditioning)
7. Domain Decomposition and Multigrid methods
8. Errors in direct solutions of linear systems
9. Accuracy of Boundary Conditions
10. Stability analysis of transient equations (use of Gerschgorin's Theorem, and Fourier Series analysis)
11. Application of stability analysis to a full advection-diffusion equation
12. Higher order, upwind methods (QUICK, QUICKEST)
13. Numerical Diffusion
14. Solution of the non-linear system resulting from Euler's Flow Equations
15. Construction of difference methods on non-orthogonal grids

Policies:

The lectures will follow notes posted on this web site. You are accountable for all material covered in class, all announcements made, and all handouts provided during class and on the Web site. For best results you should bring a printed copy of the day's notes to class, to let you concentrate more on what is being said.

You may compare results of any programs that you generate for homework with those of other students. However, the programs themselves and any other homework activities must be your own work. Check the College of Engineering's web site for general guidelines on academic integrity

Grading:

1st Examination , 25%
2nd Examination (Finals Period), 20%
Take Home Exercises, 30%
Term Project, 25%

More information is available on the course Web Page

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