Numerical Methods for Geophysical Partial Differential Equations - SIO 239

http://igpp.ucsd.edu/~fialko/num_pde/

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Prerequisite: calculus and some familiarity with programming.

Yuri Fialko; 321 IGPP; yfialko ucsd.edu; Ph. 822-5028

Lecture course, 4-units, letter grade or S/U grade, homework, class project in lieu of final exam.

Time: Mon Wed , 10:30-11:50 PM, IGPP 303 - Munk Room

class@ucsd.edu

SYLLABUS

Date	Topic	Reading/Homework	Lecturer
04 JAN	Introduction; Canonic PDEs and the associated boundary and initial value problems in geophysical applications	Read: Notes; *Ames Ch. 1*	YF
06 JAN	Integral transformations; solutions to PDEs in spectral domain	Read: Notes	
Finite differences			
11 JAN	Finite difference approximations; consistency, order, and convergence	Read: *Num Rec., Ch. 19.0* Homework 1	YF
13 JAN	No class	Homework 2	
18 JAN	No class: Martin Luther King, Jr. Holiday	Read:	YF
20 JAN	Stability analysis (von Neumann method, matrix method); transport errors	Read: *Num Rec., Ch. 19.1; Hoffman Ch. 10.8*	YF
25 JAN	Explicit and implicit schemes for parabolic equations; upwind and downwind differences; the Crank-Nicholson method; the Richardson (leapfrog) method	Homework 3 Read: *Num Rec., Ch. 19.1*, *Num Rec., Ch. 19.2; Hoffman Ch. 11.1-11.6*	YF
27 JAN	Iterative methods for elliptic equations; successive over-relaxation (SOR); the	Read: : *Hoffman Ch. 9.4-9.8; Num Rec., Ch. 19.0*	YF

	Alternating-Direction Implicit (ADI) method		
01 FEB	Method of characteristics for hyberbolic equations; the Lax-Wendroff scheme; the MacCormack method	Read: *Hoffman Ch. 12.1-12.13*	YF
Finite elements			
03 FEB	Weak form of PDEs; FE equations	Read: Burnett, Ch. 1; FEM intro/summary I; FEM intro/summary II	YF
08 FEB	Weighted residual methods; basis functions	Read: Burnett, Ch. 3, 5.2	YF
10 FEB	Assembly of element equations; 2-D FE	Read: Burnett, Ch. 5.3	YF
15 FEB	No class: President's Day Holiday	Read:	YF
17 FEB	2-D FE cont'd; Multi-dimensional variational principles	Homework 4 Read: Burnett, Ch. 13	YF
22 FEB	Introduction to ABAQUS	See manuals in BarnYard	YF
24 FEB	Mesh generation and assembly; numerical integration; discretization errors	Read: Class notes	YF
Boundary Elements			
29 FEB	BEM formulation, integral equations	Read: Crouch and Starfield, Ch. 1,3; BEM intro/summary; Class notes	YF
02 MAR	Examples of BE; introduction to TWODD and DIS3D codes	Read: Class notes; TWODD DIS3D	YF
Other techniques			
07 MAR	Multigrid and spectral methods; Monte Carlo methods	Read: Notes; Num Rec., Ch. 19.4, Ch. 19.6	YF
09 MAR	Class presentations		YF

SIO 239 SUGGESTED BOOKS:

Textbooks:

Numerical methods for engineers and scientists, J. D. Hoffman, McGraw-Hill, 1992.

Reference Books:

Numerical Recipes/The art of scientific computing 2nd ed., W. H. Press et al., Cambridge, 1992.

Numerical methods for partial differential equations, W. F. Ames, Barnes&Noble, 1969

Finite element analysis: From concepts to applications, D. S. Burnett, Addison-Wesley, 1987.

Boundary element methods in solid mechanics, S. L. Crouch and A. M. Starfield, George Allen and Unwin, 1983.

Computer Homework:

Computer homework can be done most easily by using *MATLAB* which runs on most machines. If you do not have a computer account we will set you up.

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