-BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

INSTRUCTION DIVISION

FIRST SEMESTER

Course Handout (Part II)

Date:07/01/2016

Course No. **: MATH F422**
Course Title **: Numerical Methods for Partial Differential Equations**
Instructor-in-charge **: Sangita Yadav**
Instructors **: Sangita Yadav**

1.Scope and Objective of the Course:

The study of differential equations is a fundamental subject area of Mathematics which links important strands of Pure Mathematics to Applied and Computational Mathematics. This course enables one to analyze a number of numerical algorithms for approximating the solution of a variety of generic problems which occur in applications. The course will begin with the description of the numerical techniques for PDEs, their Stability and Convergence. Particular emphasis in this course is to interconnect the theoretical results and computer implementation. Students will study not only the solid theoretical backgrounds in developing and understanding the algorithms but also a hands-on experience to implement the methods.

2. Text Book: T1. Computational Techniques for Fluid Dynamics 1, by Fletcher, C.A.J, Springer-Verlag

T2. Numerical Solution of Partial Differential Equations: Finite Difference Methods (Oxford Applied Mathematics & Computing Science Series) by G. D. Smith, Oxford University Press

3.Reference Books:

1. The Finite Difference Methods in Partial Differential Equations by R. Mitchell and S. D. F. Griffiths, Wiley and Sons, NY, 1980.
2. Numerical methods of partial differential equations by Evans, G. Blackledge, J. and Yardley, P, Springer-Verlag, 1999.
3. A friendly introduction to Numerical Analysis by Bradie, 1st Edition, Pearson education, 2007.

4. Course Plan

Lec. No.	Learner's Objective	Topic to be Covered	Ref. to Text /Ref. Ch./Sec	Prob.
1	Review of Numerical Analysis	System of linear algebraic equations, central interpolation, difference methods for derivatives		
2-4	Procedures will be developed for classifying second order PDEs as elliptic, parabolic or hyperbolic	Classification of PDE, nature of well-posed problems, interpretation of PDEs by characteristics and physical basis, appropriate boundary/initial conditions	T1.2.1-2.4, 2.6	
5-7	Overview of computational solution procedures	Discretization: spatial & time derivatives, approximation to derivatives, accuracy of discretization process, finite difference method for partial derivatives	T1.3.1-3.4	
8-11	Introduction to finite volume method	finite volume method for first order PDEs and second order PDEs, and application to Laplace equation	T1.5.2	

12-23	Systematic methods to find the numerical solution of Parabolic equations and their convergence, stability and Cosistency .	Explicit and Implicit Method, Derivative boundary condition, Crank-Nicolson Method	T2: P11-40	All
		Reduction of the local truncation error –the Douglas equation , three time level difference equation, Deffered correction method , Richardson Extrapolation	T2: P44-48, T1.4.4	All
	Understand the relative strengths and weakness of each computational method	Convergence of explicit method, stability by matrix method, Theorems on bounds for Eigen values, Stability for derivative boundary condition, stability von Neumann method , Lax theorem	T2: P75-109	All
24-31	Systematic methods to find the numerical solution of elliptic equations and their convergence, stability and Cosistency .	Improvement of accuracy, Elliptic problems with irregular boundaries, SOR method for iterative methods, rate of convergence, Stone's strongly implicit iterative method	R2:.2.4 T2:Chapter 5	All
32-35	Systematic methods to find the numerical solution of Hyparabolic equations	Finite difference methods on a rectangular mesh: Lax-Wendroff explicit method, CFL condition, Wendroff Implicit method	T2 :P149-155	All
36-37	How to deal Propagation of Discontinuities	Discontinuous Initial Values, Discontinuous Initial Derivatives, Discontinuities and finite difference approximations	T2 :P156-158	All
38-40		Explicit Methods and Implicit Methods, Simultaneous first order equations.	T2:P173-182	All

5. Evaluation Scheme

S. No.	Components	Duration	Marks	Date & Time	Remarks
i	Mid- Sem Test	**90 min**	**35**	**17/3 2:00 -3:30 PM**	**CB**
ii.	**Lab Assignment*** / Quizzes	**IN LAB, KEEP SOME MARKS (SAY 2 OR 3) FOR EACH PROBLEM**	**20**	To be announced / **Surprise**	**CB**
iii.	Comprehensive Exam	**3 hrs**	**45**	**13/5 FN**	**CB +OB**

6. Problems: Students are strongly advised to work out all the relevant problems in the text-book and do similar problems from the reference books. It is also recommended that the students should try out the algorithms on computers by using **MATLAB** to get a better understanding of the subject.

7. Only text book and hand written notes are allowed in open book exam.

8. Chamber Consultation Hours: To be announced in the class.

9. MAKE-UP: Make-up for any component of evaluation will be given only in genuine cases of absence. **No makeup will be given for lab examination and quizzes.**

10. Notices: All notices related to this course will be put **only** on the **Notice Board of Dept. of Maths.**

*** For Lab examination (Assignment): you have to write the numerical code in any one of the computer language.**

Instructor-In-Charge