BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI-K K BIRLA GOA CAMPUS

INSTRUCTION DIVISION

FIRST SEMESTER

<u>Course Handout (Part II)</u>

Date: 02-08-2017

Course No. **: MATH F422**
Course Title **: Numerical Methodology for Partial Differential Equations**
Instructor-in-charge **: Dr. P. Dhanumjaya**

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. G. D. Smith, Numerical Solution of Partial Differential Equations: Finite Difference Methods (Oxford Applied Mathematics & Computing Science Series) 3rd Edition, Oxford University Press (2010).

T2. C. A. J Fletcher, Computational Techniques for Fluid Dynamics 1, by, Springer-Verlag

3. Reference Books:

1. R. Mitchell and S. D. F. Griffiths, The Finite Difference Methods in Partial Differential Equations by Wiley and Sons, NY, 1980.

2. G. Evans, J. Blackledge and P. Yardley, Numerical methods of partial differential equations by Springer-Verlag, 1999.

Lec. No.	Learner's Objective	Topic to be Covered	Ref. to Text /Ref. Ch./Sec
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	T2: 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	T2: 3.1-3.4
8-19	Systematic methods to find the numerical solution of Parabolic	Explicit and Implicit Method, Derivative boundary condition, Crank-Nicolson Method	T1: P11-40

	equations and their convergence, stability and Consistency. Understand the relative strengths and weakness of each computational method	Reduction of the local truncation error –the Douglas equation , three time level difference equation, Deferred correction method , Richardson Extrapolation	T1: P44-48, T2.4.4
		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	T1: P75-109
20-27	Systematic methods to find the numerical solution of elliptic equations and their convergence, stability and Consistency .	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 T1: Chapter 5
29-32	Systematic methods to find the numerical solution of Hyperbolic equations	Finite difference methods on a rectangular mesh: Lax-Wendroff explicit method, CFL condition, Wendroff Implicit method	T1: P149-155
33-34	How to deal Propagation of Discontinuities	Discontinuous Initial Values, Discontinuous Initial Derivatives, Discontinuities and finite difference approximations	T1: P156-158
35-36		Explicit Methods and Implicit Methods, Simultaneous first order equations.	T1:P173-182
37-40	Introduction to finite volume method	finite volume method for first order PDEs and second order PDEs, and application to Laplace equation	T2: 5.2

Lab Component: Exposure to MATLAB and computational experiments based on the algorithms discussed in the course.

5. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Date, Time	Remarks
1	Mid-Term Test (Lab Exam)	90 Min.	35	11-10-2017, 4:00-5:30 PM	CB
3	Surprise Quiz /Project/Lab Exam/Attendance	***	25	***	
4	Comprehensive Exam (Lab Exam)	3 Hours	40	07-12-2017, 2:00-5:00 PM	CB

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 (Using MATLAB) to get a better understanding of the subject.

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

8. Make-up: Make-up for any component of evaluation will be given only in genuine cases of absence.

9 Notices: All notices related to this course will be put up only on the Moodle course page.

Instructor-In-Charge