BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

HYDERABAD CAMPUS

Second Semester 2015-16

Course Handout (Part II)

Date:03-08-2015

Course No.	**: MATH F444**
Course Title	**: Numerical Solutions to Ordinary Differential Equations**
Instructor-in-charge	**: Dilip Kumar Maiti**
Instructors	**: Dilip Kumar Maiti**

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 interpolation and introduction of difference equations followed by the numerical techniques for IVPs and BVPs, 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. Computer Methods for Ordinary Differential Equations and Differential Algebraic Equations by UM Ascher and LR Petzold, SIAM, 1998

3.Reference Books:

1.An Introduction to the Finite Element Method by Reddy, 2nd edition, TMH, 2003.

2. Computational Methods in Ordinary Differential Equations (Introductory mathematics for scientists & engineers) by Lambert, John Wiley & sons Inc. 1991

3. A friendly introduction to Numerical Analysis by Bradie, 1st Edition, Pearson education, 2007.

4. Numerical Solutions of Ordinary Differential Equations by K Atkinson, W Han, D Stewart, Wiley Inter science, 2009.

Lec. No.	Topic(s)	Ref. to Text /Ref. Ch./Sec
1-2	Review of, Interpolation and related topics to Numerical Analysis. IVPs, BVPs and DAEs for Ordinary Differential Equations.	
3-5	General properties of Numerical Methods: order/convergence/stability, local/Stiffness	T1: 3.1-3.7
6-8	**Initial Value Problems (IVP):** One Step Methods; Euler's method, Convergence of Euler's Method, Runge-Kutta Methods, Absolute Stability of Runge-Kutta Methods,	T1: 4.1-4.7
9	Lab Component for One Step Methods	
10-14	Linear Multi-step methods; Construction of linear multi-step methods, Adams methods, zero stability, consistency, convergence, Predictor-corrector methods; Absolute stability of predictor-corrector methods. Nature of stiff ODEs and their numerical methods	T1: 5.1-5.5

15	Lab Component for Multi-step methods	
16-19	BVP Theory and Applications: Linear BVP and Green's function, Stability of BVP, BVP Siffness	T1: 6.1-6.4
20-22	**Boundary Value Problems (BVP)**: Shooting Methods; the method of bisection, the Newton-Raphson method,	T1: 7.1-7.2
23	Lab Component for Shooting Methods	
24-28	Matrix Methods: Finite Difference Methods to Linear boundary value problems and Non-linear boundary value problems, consistency, stability, and convergence analysis	T1: 8.1-8.7
29	Lab Component for Matrix Methods	
30-32	Differential Algebraic Equations (DAE): Index and mathematical structures, Index reduction and Stabilization, Modeling with DAE's Numerical Methods for Differential Algebraic Equations (DAE)	T1: 9.1-9.3, 10.1
33	Lab Component for DAEs	
34-39	**FEM for ODEs** Introduction to FEM: Weak formulation of BVP, Variational Methods of Approximation, Basic steps of Finite Element Analysis, Finite Element Error Analysis, Approximation Errors, Convergence of Solution, Accuracy of Solution.	R1: 2.1-2.4, 3.1-3.2, 5.1-5.4
40-41	Lab Component for Two Point BVP using FEM	

5. Evaluation Scheme

S. No.	Components	Duration	Marks	Date & Time	Remarks
i	Mid- Sem Test	**90 min**	**35**	10/10 2:00 - 3:30 PM	**CB**
ii.	**Lab Assignment**		**20**	To be announced	**CB**
iii.	Comprehensive Exam	**3 hrs**	**45**	14/12 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 (Using MATLAB/C++, Mathematica) 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 only on the Notice Board of Mathematics.

Instructor-In-Charge