BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
INSTRUCTION DIVISION

FIRST SEMESTER 2015-2016

Course Handout (Part II)

Date 03/08/2015

In addition to Part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No   : **CE F324**

Course Title   : Numerical Analysis

Instructor-in-charge   : **SHIBANI KHANRA JHA**

Course Description and Scope & Objective

It is needless to say that the present digital world has made students to use commercial software that involve numerical methods, quite often. The proper and justified use of these programs is only possible if knowledge of the basic theory underlying the methods have been sufficiently developed among the students. This course is framed to provide a sufficient background to numerical methods required to solve engineering problems, especially various civil engineering and natural problems. We know that various scientific phenomena whether natural or man-made, can be modeled using mathematical expressions. To represent these phenomena, one need to solve these mathematical models by analytical, graphical, or approximate methods. Numerical Analysis is the approach that deals with the approximate solution methodologies of various mathematical models. This course introduces the core concepts of error estimation and accuracy of numerical solutions. It then discuss the methods of solution of linear and non-linear equations. Both direct and iterative solution methods are discussed. Then ordinary differential equations frequently used in engineering applications are introduced and its various solution methodologies are discussed. Next the numerical solutions of partial differential equations which are again quite common forms of mathematical models for many natural problems, are discussed, along with a brief review of different category of partial differential equations and well known analytical techniques for the solutions of some of the simple models and finally discussing the necessity of numerical methods. Finite difference operators are introduced and used to solve typical initial and boundary value problems of engineering interests.

Text Book:

TB1. Numerical Methods for Engineers by Steven C. Chapra , Raymond P. Canale, Tata McGraw-Hill Edition, 6th Edition, 2012.

Reference Books:

RB1. Applied Numerical Analysis by Curtis F. Gerald, Patrick O. Wheatley, Pearson Education, 7th Edition, 2003.

RB2. Numerical Methods for Engineers and scientists by J. D. Hoffman, 2nd Edition. CRC 2010.

RB3. Introduction to Numerical Analysis 3rd Edition, Devi Prasad, Narosa 2006.

Course Plan:

Lec. No.	Learning Objectives	Topics to be covered	Reference
1- 2	To understand the significance of numerical methods in context of solving engineering problems	Introduction, Kinds of errors in numerical procedures, measurement of efficiency of numerical procedures, order of accuracy	CHAP 1, 3, 4 TB1
3-7	To study the solution methodologies of non-linear equations and system of non-linear equations	Bisection, secant, method of false –position, Newton's method, Fixed point iteration method, Order of convergence, multiple roots.	CHAP 5, 6, 8 TB1
8-15	To solve a linear system using matrix and iterative methods to solve a set of algebraic equation	The Elimination method, Gaussian Elimination, Other direct methods, Pathology in linear systems-singular matrices, Determinants and matrix inversions, Tri-diagonal systems, Thomas algorithm, Norms, condition numbers and errors in computed solutions, Jacobi's method, Gauss Seidel method, Newton's methods, fixed-point methods for non-linear systems	CHAP 9, 10, 11, 12 TB1
16-21	To understand regression and an interpolating polynomial and its efficient evaluation?	Least square regression, Existence and Uniqueness of interpolating polynomial, Lagrange polynomials, divided differences, evenly space points, error of interpolation	CHAP 17, 18 TB1
22-26	To compute numerical derivatives and integration using discrete data points and to know how to integrate functions	Derivatives from difference table, Higher order derivatives, Newton-Cotes Integration formulas, The Trapezoidal rule - a composite formula, Simpsons rule, Gaussian Quadrature, Richardson Extrapolation	CHAP 21, 22, 23, 24 TB1

27- 32	Ordinary Differential Equation: To understand initial value problems and computation of numerical solutions of initial value problems	Taylor series method, Euler and Modified Euler's method, Runge-Kutta (RK) Methods, Multistep methods: Milne's method, Adams-Moulton method, Predictor – corrector formulas, System of equations and higher order equations, stiffness.	CHAP 25, 26 TB1
33- 36	Ordinary Differential Equation: To study boundary value problems (BVP) and its solution methodologies, Eigenvalue problems	General method for BVP, Eigenvalue problems, Finite difference method, solution of a set of equations, Derivatives, boundary conditions.	CHAP 27, 28 TB1
37-42	To understand different types of PDEs as well its significance in engineering and scientific problems, Development of Finite Difference Equations for these PDEs	Types of PDEs: Elliptic, Parabolic, Hyperbolic, physical significance of PDEs, Types of boundary conditions and its physical significance, Finite Difference formulation: Laplace equation, Poisson's equation, Diffusion equation, Advection-Diffusion equation, Explicit methods, A Simple Implicit Method, The Crank-Nicolson Method, Two dimension problems frequently used in engineering applications	CHAP 29, 30, 32 TB1

NOTE TO STUDENTS:
Students can follow the text and reference books cited in the handout as well as the notes provided by IC. Students are advised to write their own programs by using **MATLAB** to get a better understanding and control of the subject.

Evaluation Scheme

No.	Evaluation component	Duration	Weightage (%)	Date & Time	Nature of component
1	Mid-Semester examination	90 min	25	10/10 2:00 - 3:30 PM	CB
2	Comprehensive examination	180 min	45	14/12 FN	CB+ OB
3	Tutorial/Assignment/Projects	-	30	Will be announced in class	

Chamber Consultation Hour: To be announced in class (**Dr. Shibani Khanra Jha: 6021 I NAB**)

Make-up Policy:

1. No makeup for tutorials/assignments/projects/Mid-semester will be granted. Make-up will be granted only for reasonable cases. However, prior permission through IC as well as ID is must.
2. For medical cases, a certificate from the concerned physician of the Institute Medical Centre as well as statement of inability to attend the examination from hostel warden must be produced to IC as well to ID.

Notices: All notices concerning the course will be displayed on Nalanda webpage as well as will be announced in class on regular basis.

Instructor-in-charge

CE F324