PREFACE OF THE COURSE FILE
DEPARTMENT OF MECHANICAL ENGINEERING
TEZPUR UNIVERSITY

Academic Year	:	**2019–2020**
Session	:	**Spring Semester 2020**
Department for which the Course is offered	:	**Mechanical Engineering**
Name of the Programme	:	**M.Tech. in Mechanical Engineering (Specialization: Thermo-Fluids Engineering)**
Students' Batch	:	**2019–2021**
Semester	:	**Second**
Title of the Course	:	**Numerical Methods**
Course Code	:	**ME 530**
L-T-P Structure of the Course	:	**3-0-1**
Category of the Course	:	**Core**
Class Timetable of the Course	:	$\frac{\textbf{Mon}}{\textbf{11.30am–12.30pm}}$, $\frac{\textbf{Wed}}{\textbf{11.30am–12.30pm}}$, $\frac{\textbf{Thurs (P)}}{\textbf{2.30–4.30pm}}$, $\frac{\textbf{Fri}}{\textbf{3.30–4.30pm}}$
Course Coordinator/Instructor	:	**Prof. Dilip Datta**
Other Table of the Course Instructor	:	**ME 540 ::** $\frac{\textbf{Mon}}{\textbf{3.30–4.30 pm}}$, $\frac{\textbf{Tue}}{\textbf{12.30–1.30 pm}}$, $\frac{\textbf{Thurs}}{\textbf{10.30–11.30 am}}$

Instructor **HOD**

1 Objectives

(1) The main objective of the course is to impart knowledge to students on how to solve a mathematical model numerically using the computing power of a computer, which is very tough or even impossible to solve by an exact method.

(2) To teach students both theory and programming of important numerical methods often required in practical computations.

2 Lesson Plan

SN	Unit	Indented Learning Outcomes (ILOs)	L+P	Completion Date		Remarks
				Proposed	Actual	
1	Introduction*	Approximations and error analysis	2+1			
2	Roots of transcendental equations	1. Bracketing methods (bisection and false position methods). 2. Open methods (Newton-Raphson, secant, and fixed-point methods).	3+1			
3	Roots of polynomial equations	Polynomial deflation, Müller method and Bairstow's method.	3+1			
4	System of linear algebraic equations	1. Direct methods (Gauss elimination, Gauss-Jordan elimination, LU decomposition, and matrix inversion methods). 2. Iterative methods (Jacobian, Gauss-Seidel, and successive relaxation methods).	6+2			
5	System of nonlinear algebraic equations	Fixed point iteration and Newton's methods.	3+1			
6	Eigenvalues and eigenvectors	Direct power, inverse power, and shifted power methods.	2+1			
7	Numerical differentiation	Finite difference methods (for first and second order derivatives).	3+1			
8	Numerical integration	1. Newton-Cotes methods (Trapezoidal rule, Simpson's rules, Romberg integration). 2. Gauss quadrature.	3+1			
9	Ordinary differential equations (ODEs)	1. Initial value problems (Euler, Runge-Kutta, and predictor-corrector methods). 2. Boundary value problems (Shooting and finite difference methods). 3. Eigenvalue problems.	6+2			
10	Partial differential equations (PDEs)	1. Classification and characteristics of PDEs. 2. Elliptical, parabolic and hyperbolic equations.	3+2			
11	Similarity transformation	QR decomposition with Householder transformation	2+1			
		Total contact hours	**36+14**			

Instructor **HOD**

3 Course Outcome

SN	Course Outcome (CO)	Units
1	Find roots of single-variable transcendental and polynomial equations	2, 3
3	Solve both linear and nonlinear systems of algebraic equations	4, 5, 6
2	Perform numerical differentiation and integration	7, 8
4	Solve both ordinary and partial differential equations	9, 10
5	Programming various numerical methods and apply them to different relevant real-life problems	1–11

4 Textbooks

1. Gerald, C.F. and Wheatley, P.O. *Applied Numerical Analysis.* 5/e, Addison-Wesley, 1994.
2. Conte, S.D. and de Boor, C. *Elementary Numerical Analysis.* 3/e, Tata McGraw-Hill Education, 2005.
3. Hildebrand, F.B. *Introduction to Numerical Analysis.* 2/e (revised), Courier Dover Publications, 1987.

5 References

1. Kreyszig, E. *Advanced Engineering Mathematics.* 10/e, John Wiley and Sons, 2010.
2. Burden, R.L. and Faires, J. D. *Numerical Analysis.* 9/e, Brooks/Cole, 2011.
3. Chapra, S.C. and Canade, R.P. *Numerical Methods for Engineers.* Tata McGraw-Hill, 2006.
4. Mathews, J.H. *Numerical Methods for Mathematics, Science and Engineering.* Prentice-Hall of India, 2000.

Instructor **HOD**