Course Type	Course Code	Name of Course	L	T	P	Credit
DP	**NGPC511**	**Advanced Numerical Methods- Practical**	0	0	3	1.5

Course Objective

The primary objective of the course is to introduce hands on experience and practical programming skills in advanced numerical techniques for geo-physical problems.

Learning Outcomes

Upon successful completion of this course, students will have:

- practical skills on solving equations using numerical approach.
- practical skills on programming and algorithm development.
- Hands on experience on the development of numerical methods.

Unit No.	Details of Lectures	Lectures Hrs.	Outcome
1.	Numerical programming of a polynomial fit to a sequence of data points using least square criterion	**3**	Hands on experience with curve fitting
2.	Programming and numerically integrating Ordinary Differential Equations using explicit schemes. Calculation of the order of accuracy of the various schemes.	**3**	Learning skill of numerical programming
3	Programming and numerical solution of 1-D Boundary Value problems using Matrix inversion method	**3**	Hands on experience with matrix structure
4.	Writing a computer code to evaluate the finite difference stencils in two dimensions for the various partial differential operators on a structured 2D mesh.	**3**	Learning skill of coding mesh based operators
5.	Solving system of linear PDE using Fourier series method.	3	Hands on experience with PDE solver coding
6.	Numerical solution of the 1-D diffusion using semi-implicit finite difference scheme	3	Learning skill of programming ODE solver
7.	Finding the convergence behavior of error in numerical solution of the 1D Poisson equation using various finite difference schemes	3	Hands on experience with finite difference eprogramming
8.	Finite differences for the one-way wave equation using various methods. Computing the von Neumann growth factor.	3	Learning skill of numerical coding
9.	Numerical programming to produce simple finite element stiffness matrices and plot various shape functions	3	Hands on experience with visual representation
10.	Coding the pseudo-spectral differentiation Matrix.	3	Learning skill of numerical coding

11.	Implementing spectral differentiation on a periodic domain.	3	Hands on experience with operator matrices
12.	Set up the sparse operator systems for the 1d, 2d and 3d Poisson equation.	3	Learning skill of programming sparse operators
13.	Solving Poisson equation using the pseudo spectral method.	3	Learning to code spectral solvers
14.	Writing both Serial and MPI-parallel versions of Matrix multiplication and determine the speed up attained through use of multiple cores.	3	Develop parallel computing skills
	Total	42	

Text books

1. Steven C. Chapra, Raymond P. Canale Numerical methods for engineers, Mcgraw-Hill ,2015. ISBN 978–0–07–339792–4
2. Lloyd N. Trefethen. Finite difference and spectral methods for ordinary and partial differential equations. 1996

Reference books

1. Trefethen, Lloyd N. Spectral Methods in MATLAB (Software, Environments, Tools). Philadelphia, PA: Society for Industrial and Applied Mathematics, 2001. ISBN: 9780898714654.
2. Fletcher, C. A. J. Computational Techniques for Fluid Dynamics. Fundamental and General Techniques Volume I. Springer-Verlag, 1996. ISBN: 9783540530589.
3. Bathe, K.-J., Finite Element Procedures, Prentice-Hall, 1996. ISBN 0-13-301458-4.
4. Ferziger, J. H., and Peric, M., Computational Methods for Fluid Dynamics, Springer, Berlin, 356 p., 1996
5. Durran, D.R., Numerical Methods for Wave Equations in Geophysical Fluid Dynamics, Vol. 32 of Texts in Applied Mathematics, Springer, 465 pp., New York, 1999.