Minor Degree Under Graduate Programme (Computational Techniques)

SYLLABUS

(From the Academic Year 2022-23 Onwards)

BOARD OF STUDY

DEPARTMENT OF MATHEMATICS

SANT LONGOWAL INSTITUTE OF ENGINEERING & TECHNOLOGY

(Deemed to be University under Ministry of Education, Govt. of India)

Longowal – 148106 (Punjab) INDIA

Title of the course : **COMPUTATIONAL LINEAR ALGEBRA**
Subject Code : **MDMA – 521**
Weekly load : 5 Hrs. L T P 3-0-2
Credit : 4 (Lecture 3; Tutorial 0; Practical 2)

UNIT - I

Vector spaces, subspaces, basis, dimensions, linear transformations, Orthogonal vectors, Orthogonal projections, Orthogonal bases, Gram Schmidt orthogonalization. MATLAB basics.

UNIT - II

Triangular factorizations such as LU decomposition, Householder triangulation and QR factorization, conditioning and condition numbers, stability of Householder triangulation.

UNIT - III

Matrix eigenvalue problem: cases of practical applications, reduction to Hessenberg or tridiagonal form, Rayleigh quotient, localization of eigenvalues, computing selected eigenvalues and eigenvectors.

UNIT - IV

Singular value decomposition problems and methods to find SVDs and their applications (Google search engine and image processing).

Software support: MATLAB

RECOMMENDED BOOKS:

1. G. Strang, Linear Algebra and Its Applications, Cengage India Private Limited (2005).
2. B.N. Datta, Numerical Linear Algebra and Applications, 2nd Ed., SIAM (2010).
3. L.N. Trefethen & D. Bau III, Numerical Linear Algebra, SIAM (1997).
4. R. Butt, An Introduction to Applied Numerical Linear Algebra using MATLAB, Narosa (2015).

Course Objectives: After the completion of this course, the student will be able to:

1. Gain a deeper understanding of basic concepts such as vector spaces, basis and dimensions.
2. Utilize factorizations and canonical forms of matrices for different purposes.
3. Find the eigenvalues of a matrix using numerical methods.
4. Implement Linear algebra algorithms using MATLAB.
5. Find the singular values of a matrix and use them in applications.

Title of the course : **INTRODUCTION TO PYTHON**
Subject Code : **MDMA – 611**
Weekly load : 5 Hrs. L T P 3-0-2
Credit : 4 (Lecture 3; Tutorial 0; Practical 2)

UNIT - I

Basics: comments, character set, tokens, core data types, inbuilt functions.
Operators: Arithmetic operators and their properties, Bitwise operators, compound assignment operator. Decision statements: Boolean operators and their uses, if, if-else, nested if statements, conditional expressions.

UNIT - II

Loop control statements: The while, for and nested loops, break and continue statement.
Functions: Syntax and basics, parameters and arguments, The local and global scope of a variable. Strings: The str class, inbuilt string functions, the string operators.

UNIT - III

Lists and List processing: Creating lists and accessing them, slicing, inbuilt list functions, comprehensions, searching techniques, sorting.
Object-Oriented Programming: Defining class, the self-parameter and adding methods, class attributes, overloading, inheritance, overriding. Tuples, sets and dictionaries.

UNIT - IV

Graphic programming: Turtle module and uses, drawing with colors and iterations, Bar charts.
File handling: Need of file handling, text input and output, the seek () function and Binary files.

Software support: Python

RECOMMENDED BOOKS:

1. A.N. Kamthane & A.A. Kamthane, Programming and Problem Solving with Python, McGraw Hill (2020).
2. M. Lutz, Programming Python, O`Reilly Media (2013).
3. M. Lutz, Learning Python - Powerful Object-Oriented Programming, O'Reilly Media (2013).
4. M. Urban & J. Murach, Python Programming - Beginner to Pro, Murach & Associates (2016).
5. R. Gupta, Making Use of Python, Wiley Publishing House (2002).
6. J. Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press (2013).

Course Outcomes: Upon completion of this course, the student will be able to:

1. Explain basic principles of Python programming language.
2. Implement object-oriented concepts.
3. Design and implement a program to solve a real-world problems.
4. Implement conditions and loops for Python programs.
5. Use functions and represent compound data using lists, tuples, and dictionaries.

Title of the course : **ADVANCED NUMERICAL ANALYSIS**
Subject Code : **MDMA-621**
Weekly load : 5 Hrs. L T P 3-0-2
Credit : 4 (Lecture 3; Tutorial 0; Practical 2)

UNIT - I

Jacobi and Givens methods for finding eigenvalues and eigenvectors of a matrix.
Iterative methods for solution of system of linear equations: Relaxation and successive over-relaxation methods. Necessary and sufficient conditions for convergence.

UNIT - II

Newton's method for the system of equations. Stability and convergence analysis.
Iterative method for the system of equations. Sufficient condition for convergence.
Romberg's integration. Gaussian integration. Error analysis.

UNIT - III

Predictor Corrector methods: Milne's and Adam Bashforth methods.
Finite difference method for solving ordinary differential equations.
Classification of PDEs. Solution of 1D parabolic equations by Crank-Nicolson, DuFort methods.
Solution of elliptic equation by diagonal five point and standard 5 point formulae.
Solution of hyperbolic equations by implicit / explicit schemes. Stability, convergence analysis.

UNIT - IV

Solution of boundary value problems by weighted residual methods Galerkin method. Variational formulation of a given boundary value problem. Ritz method and orthogonal collocation method.

Software support: Python

RECOMMENDED BOOKS:

1. E. Isaacson and H.B. Keller, Analysis of Numerical Methods, John Wiley and Sons (1966).
2. M.K. Jain, Numerical Solution of Differential Equations, New Age International (2014).
3. P.K. Kytbe, An Introduction to Boundary Element Methods, CRC Press (2006).
4. B.P. Demidovich and J.A. Maron, Computational Mathematics, Mir Publishers (1981).
5. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical Methods for Scientific & Engg. Computation, New Age International (2012).

Course Outcomes: Upon completion of this course, the student will be able to:

1. Solve the system of equations by relaxation methods and find their eigenvalues.
2. Evaluate the integrals by Romberg's and Gaussian quadrature rule.
3. Solve Heat conduction equation, Laplace equation and Poisson equation by FDM.
4. Solve the boundary value problems by Galerkin, Ritz, and Orthogonal Collocation methods.
5. Perform the convergence and stability analysis of the numerical methods.

Title of the course : **MATHEMATICAL STATISTICS**
Subject Code : **MDMA – 711**
Weekly load : 5 Hrs. L T P 3-0-2
Credit : 4 (Lecture 3; Tutorial 0; Practical 2)

UNIT - I

Random variable, Discrete and continuous random variables, Mathematical expectation, Regression analysis (up to three variables only).

Normal distribution, Exponential distribution and Gamma distribution.

UNIT - II

Moments, Moment generating functions, Characteristic function, Joint distribution function, Marginal and conditional distributions.

Sampling, Types of sampling, confidence interval, testing of hypothesis.

UNIT - III

Tests based on Normal distribution: Student's t, Chi-square and F distributions.

UNIT - IV

Analysis of variance: Completely Randomized Design and Randomized Block Design.

Software support: SPSS / Python / R software

RECOMMENDED BOOKS:

1. P.L. Meyer, Introduction to Probability and Statistical Applications, Oxford & IBH (2007).
2. A.M. Goon, M.K. Gupta and B. Dasgupta, An Outline of Statistical Theory, Vol. I, World Press Pvt. Ltd. (2013).
3. T.W. Anderson, An Introduction to Multivariate Statistical Analysis, John Wiley (2003).
4. S.P. Gupta, Statistical Methods, S. Chand & Co., 43rd Edition, 2017.
5. S.C. Gupta & V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons (2014).

Course Objectives: After the completion of this course, the student will be able to:

1. Evaluate expectation and moments of a random variable.
2. Execute normal, exponential, Gamma distribution as per the requirement.
3. Implement the concepts of sampling distributions.
4. Apply t, Chi-square and F distributions for testing of distributions.
5. Solve one way and two way analysis of variance problems.

Title of the course : **MATHEMATICAL MODELLING**
Subject Code : **MDMA - 721**
Weekly load : 5 Hrs. L T P 3-0-2
Credit : 4 (Lecture 3; Tutorial 0; Practical 2)

UNIT - I

Introduction to mathematical modelling, its scope and role in real life, different types of models, how to develop a model through ODE, PDE, difference equation and solution of these models.

UNIT - II

Continuous population models for single species, insect outbreak model, delay models, linear analysis, models in physiology, harvesting models.

Discrete population models for single species, cobwebbing, chaos, fishery management models.

UNIT - III

Two-species population models: simple predator-prey model, predator-prey models with time delays, models for competition.

Multi-species population models: Lotka-Volterra model.

UNIT - IV

Epidemic models: Deterministic models without removal and with removal.

Diffusion models: Diffusion equation, diffusion in artificial kidney, Longitudinal diffusion in a packed bed.

Software support: Python

RECOMMENDED BOOKS:

1. J.N. Kapur, Mathematical Modelling, New Age International (P) Ltd. New Delhi 2nd Edition (2016).
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd. (2010).
3. R. Aris, Mathematical Modelling Techniques, Dover Publications Inc., New York (1994).
4. J.D. Murray, Mathematical Biology – An Introduction, Springer, New York (2002).

Course Outcomes: Upon completion of this course, the student will be able to

1. Formulate mathematical models based on real life problems.
2. Solve different types of single species continuous / discrete models.
3. Solve different types of two species / multi species models.
4. Solve deterministic epidemic models.
5. Solve different types of diffusion models.