ALL SYLLABUS

DEPARTMENT OF MATHEMATICS

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY WAKNAGHAT, SOLAN (H.P.) INDIA

Department of Mathematics Jaypee University of Information Technology, Waknaghat, Solan, HP.								
Mathematics Courses Catalogue (B.Tech/B.Sc/M.Tech/M.Sc/Ph.D Programmes)								
SR. NO.	SUBJECT CODE	NAME OF THE SUBJECTS	PROGRAM	SEM	COURSE CREDITS			TOTAL CREDIT
1	18B11MA111	Engineering Mathematics-I	B.Tech	I	3	1	0	4
2	18B11MA112	Basic Mathematics-I	B.Tech	I	3	1	0	4
3	18B11MA211	Engineering Mathematics-II	B.Tech	II	3	1	0	4
4	18B11MA212	Basic Mathematics-II	B.Tech	II	3	1	0	4
5	18B11MA311	Numerical Methods	B.Tech	III	3	0	0	3
6	18B11MA312	Probability and Statistical Techniques	B.Tech	III	3	1	0	4
7	18B11MA313	Probability and Statistics	B.Tech	III	3	0	0	3
8	18B11MA314	Probability Theory and Random Processes	B.Tech	III	3	1	0	4
9	18B11MA413	Discrete Mathematics	B.Tech	IV	3	0	0	3
10	18B11CI414	Discrete Computational Mathematics	B.Tech	IV	3	0	0	3
11	18B11MA411	Biostatistics	B.Tech	IV	3	0	0	3
12	18B11MA412	Biostatistics Lab	B.Tech	IV	0	0	2	1
13	21B1WMA831	Soft Computing & Optimization Algorithms	B.Tech	VIII	3	0	0	3
14	22B1WMA731	Linear Algebra for Data Science and Machine Learning	B.Tech	VII	3	0	0	3
15	22BS1MA112	Linear Algebra	B.Sc	I	3	1	0	4
16	22BS1MA111	Calculus	B.Sc	I	3	1	0	4
17	20MS1MA111	Basics of Mathematics and Statistics	M.Sc	I	2	0	0	2
18	17P1WMA112	Intuitionistic Fuzzy Set Theory and Similarity Measure	Ph.D	II	3	0	0	3
19	17P1WMA113	Advanced Numerical Analysis	Ph.D	II	3	0	0	3
20	17P1WMA231	Advanced Linear Algebra	Ph.D	I	3	0	0	3
21	13P1WMA232	Mathematical Analysis	Ph.D	II	3	0	0	3
22	22M11MA111	Mathematical Foundations of Data Science	M.Tech	I	3	0	0	3
23	22M17MA171	Mathematical Foundations of Data Science - Lab	M.Tech	I	0	0	2	1
24	22P1WMA231	Applied Soft Computing Techniques	Ph.D.	II	3	0	0	3
25	19B1WEC733	Optimization Techniques	B.Tech.	VII	3	0	0	3
26	21B11GE101	Bridge Course I	B.Tech.	I	0	0	0	0
27	21B11GE103	Bridge Course III	B.Tech.	I	0	0	0	0

Engineering Mathematics I

COURSE CODE: 18B11MA111

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Basic concepts of calculus and algebra

Course Objectives:

1. Various techniques of Multivariate Calculus and Integral Calculus.
2. The fundamental concepts of Vector Calculus.
3. The fundamentals of Laplace transforms and their applications.
4. To develop the essential tool of Matrices and Linear Algebra in a comprehensive manner.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Evaluate partial derivatives with its physical significance and expand functions of several variables.	Familiarity & Usage
CO-2	Find maxima and minima of functions of several variables with / without constraints.	Assessment
CO-3	Find areas and volumes of solids using multiple integration	Assessment
CO-4	Understand the calculus of vectors and vector valued functions with their physical significance	Familiarity & Usage
CO-5	Use Laplace transforms and inverse Laplace transforms to solve IVP	Usage
CO-6	Solve linear systems of equations and perform diagonalization of matrices	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Differential Calculus:** Limits and continuity of function, Partial Differentiation, Chain rule, Total Derivative; Maxima, Minima and Saddle points; Method of Lagrange's multipliers, Taylor's series for two or more variables	10

2	**Integral Calculus:** Improper integrals; Beta and Gamma functions and their properties; Double integrals, Change of order and Change of variables, Applications to areas and volumes.	**10**
3	**Vector Calculus:** Equations to a line and a plane, Tangent plane and Normal line, Gradient, Curl and divergence and their physical significance, Directional derivatives, Line and surface integrals.	**6**
4	**Laplace Transform:** Laplace Transform, Inverse Laplace transform, Convolution, Dirac delta and Unit Step function, Solution of initial value problems.	**6**
5	**Matrices:** Algebra of matrices, Row Echelon form, Inverse and Rank of a matrix, Symmetric, Skew- symmetric and Orthogonal matrices; Determinants; Solution of systems of linear equations (Gauss's elimination, Rank method), Linear Independence and Dependence of vectors. Eigen values and Eigenvectors; Cayley-Hamilton Theorem, Diagonalization of matrices and Orthogonal transformation.	**10**
Total lectures		**42**

Suggested Text Book(s):

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, 2002.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.

Suggested Reference Book(s):

1. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.
2. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_ma05/preview
2. Link to topics related to course:
   i. https://www.whitman.edu/mathematics/calculus_online/chapter14.html
   ii. https://nptel.ac.in/courses/103103037/5
   iii. https://nptel.ac.in/courses/111106051
   iv. https://nptel.ac.in/courses/111107108/25
   v. https://nptel.ac.in/courses/117101056/16

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Mathematics I)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	0	1	2	1	0	0	0	2	1	1	1
CO-2	3	2	3	1	2	1	0	0	0	1	2	2	1.5
CO-3	2	1	1	0	1	1	0	0	0	2	1	2	1
CO-4	3	1	1	1	2	2	0	0	0	2	1	2	1.5
CO-5	2	2	1	2	1	2	0	0	0	1	2	3	1.5
CO-6	3	2	1	1	1	2	0	0	0	2	2	3	1.5
Average	2.67	1.5	1.17	1	1.5	1.5	0	0	0	1.67	1.5	2.17	

Basic Mathematics-I

COURSE CODE: 18B11MA112

COURSE CREDITS: 04

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Basic knowledge of Arithmetic and Algebra.

Course Objectives:

1. To learn the basic concepts of Matrices and Determinant used in solving the system of linear equations.
2. To learn the fundamentals of vector, coordinate geometry and Complex number.
3. To learn and use the basic concepts of Differential and Integral Calculus

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic properties of Matrices and Determinant, Solution of system of linear equations	Familiarity& Usages
CO-2	Understand the various concept of vectors and coordinate geometry	Familiarity
CO-3	Understand complex numbers and their properties; geometrical representation, Polar form. DeMoivre's theorem. Roots of complex numbers	Familiarity
CO-4	Work with sets, relations and functions	Usages
CO-5	Understand the basic concept of Differential Calculus; limit and continuity. Derivative. Rules of differentiation. Tangent to a curve. Taylor's series. Maxima and minima.	Familiarity& Assessment
CO-6	Understand the basic concept of Integral Calculus; Integrals of elementary functions. Substitution and partial fractions. Definite integral as a limit of sum. Properties of definite integrals. Application to areas and lengths.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Matrices and Determinants** Algebra of matrices. Determinant of a square matrix. Properties of determinants. Some simple type of matrices. Inverse of a matrix. Solution of equations	8

2	**Vectors and Coordinate Geometry** Vectors and their algebra. Unit vectors. Components of a vector. Position vector. Direction cosines and direction ratios. Dot and cross products. Projection of a vector on another. Distance between two points. Equations of a line, plane and sphere. Intersections. Shortest distance between lines and planes.	**9**
3	**Complex Numbers** Definition and geometrical representation. Algebra. Complex conjugate. Modulus and amplitude. Polar form. DeMoivre's theorem. Roots of complex numbers. Simple functions.	**6**
4	**Sets, Relations and function** Sets and their representation. Union, intersection and compliment. Mapping or function. One-one, onto mappings. Inverse and composite mappings.	**6**
5	**Differential Calculus** Basic concept of limit and continuity. Derivative. Rules of differentiation. Tangent to a curve. Taylor's series. Maxima and minima.	**6**
6	**Integral Calculus** Fundamental theorem of calculus (statement only). Integrals of elementary functions. Substitution and partial fractions. Definite integral as a limit of sum. Properties of definite integrals. Application to areas and lengths.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. NCERT. Mathematics Textbook for class XI and XII.
2. R.D. Sharma, Mathematics, Dhanpat Rai Publications, New Delhi.

Suggested Reference Book(s):

1. G. B Thomas, R. L. Finney Calculus and analytical geometry, 9th Ed., Pearson Education Asia (Adisson Wesley), New Delhi, 2000.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/122104018/
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111106086/2
   ii. https://nptel.ac.in/courses/112104035/14
   iii. https://nptel.ac.in/courses/111103070/
   iv. https://nptel.ac.in/courses/111104085/8
   v. https://nptel.ac.in/courses/111104085/14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biostatistics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	3	2	1	3	2	3	3	2.4
CO-2	3	1	1	2	2	2	2	1	2	2	1	2	1.8
CO-3	2	1	1	1	1	1	1	1	1	1	1	2	1.2
CO-4	2	1	1	1	1	1	1	1	1	3	1	2	1.3
CO-5	3	2	2	3	2	2	2	1	2	1	3	2	2.1
CO-6	3	3	2	2	2	2	2	1	2	1	2	2	2.0
Average	2.7	1.7	1.5	1.8	1.8	1.8	1.7	1.0	1.8	1.7	1.8	2.2	

Engineering Mathematics II

COURSE CODE: 18B11MA211

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Engineering Mathematics I

Course Objectives:

1. The various methods of solving the second order differential equations with variable coefficients, to study the basic properties of Bessel Functions, Legendre polynomials, Chebyshev polynomials and their Applications.
2. To obtain solutions of Wave, Diffusion and Laplace Equation.
3. To study calculus of complex variables.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Solve problems related to convergence of series	Familiarity & Usage
CO-2	Understand basics of Ordinary Differential equation	Assessment
CO-3	Comprehend series solution with certain special functions e.g. Bessel, Legendre Eqn.	Usage
CO-4	understand partial differential Eqn and Solve Heat, wave & Laplace equation	Usage
CO-5	Understand Functions of a complex variable, Analytic functions, Mobius Transformation	Usage
CO-6	Solve Contour integration and find Taylor's and Laurent's series	Familiarity & Usage
CO-7	Evaluate certain real defnite and improper integrals.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Sequences and Series:** Convergence of sequence and series, tests for convergence; Power series, Fourier series: Half range sine and cosine series, Parseval's theorem.	7

2	**Differential Equations Part I:** Basics of first order Differential Equations, Second and Higher order differential equations with constant coefficients. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation;	**7**
3	**Differential Equations Part II:** Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties. Introduction to Partial Differential Equations, Solutions of One dimensional Wave, Heat Equation & Laplace Equation**.**	**12**
4	**Complex Variable – Differentiation:** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**8**
5	**Complex Variable – Integration:** Contour integrals, Cauchy Theorem, Cauchy Integral formula, Liouville's theorem and Maximum-Modulus theorem; Taylor's series, zeros of analytic functions, singularities, Laurent's series; **[CO-6]** Residues, Cauchy Residue theorem, Evaluation of definite integral involving sine and cosine, improper integrals.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Publishing House

Suggested Reference Book(s):

1. Simmons, G.F., Differential Equations with Applications, 2nd Ed, McGraw-Hill, 1991.
2. Brown, J.W., Churchill, R.V. , Complex Variables and Applications, 6th Ed., McGrawHill, 1996.
3. Spiegel, Murray R, Theory and Problems of Complex variables Schaum's series.
4. Sneddon I. N., Introduction to Partial Differential Equations, Dover Publications, 2006

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/122101003/2
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111104031/
   ii. https://nptel.ac.in/courses/111104031/8
   iii. https://nptel.ac.in/courses/122107037/29
   iv. https://nptel.ac.in/courses/111107056/
   v. https://nptel.ac.in/courses/117101055/14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Mathematics II)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	0	1	2	1	0	0	0	2	1	1	1
CO-2	2	2	1	1	1	2	0	0	0	1	2	2	1.5
CO-3	3	2	1	0	2	1	0	0	0	1	1	3	1.5
CO-4	3	1	2	1	2	2	0	0	0	2	1	2	1.5
CO-5	2	2	1	2	1	1	0	0	0	2	2	2	1.5
CO-6	3	2	2	1	2	1	0	0	0	1	2	1	1.5
CO-7	3	1	1	0	2	2	0	0	0	2	1	2	1.5
Average	2.71	1.57	1.14	1	1.71	1.42	0	0	0	1.57	1.42	1.85	

Basic Mathematics II

COURSE CODE: 18B11MA212

COURSE CREDITS: 04

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Basic Mathematics-I (18B11MA112)

Course Objectives:

1. To acquire the basic knowledge of sequence, series and advanced calculus.
2. To study the differential equations and their solutions applicable in Biotechnology and Bioinformatics.
3. To study the fundamentals and applications of Statistics and Numerical Techniques used in Bio sciences.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the idea of sequence and series and to learn about their convergence	Familiarity
CO-2	learn concepts of calculus of two or more variables	Familiarity
CO-3	learn the fundamentals of differential equations and their types	Familiarity
CO-4	Solve various types of differential equations	Assessment
CO-5	Understand basic statistics and learn to find mean mode, median and standard deviation.	Usage
CO-6	Numerically solve various problems using standard methods	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Sequence and series:** Convergence and divergence. Simple tests for convergence. Absolute convergence.	8
2	**Calculus of two or more variables:** Partial differentiation. Taylor's series. Differentiation of a vector. Tangent to a curve. Gradient of a scalar. Tangent to a surface. Integration of a vector. Line integral. Double integral.	8

3	**Elementary Differential Equations:** Definitions of order, degree, linear, nonlinear, homogeneous and nonhomogeneous Solution of first order equations. Complementary function and particular integral. Initial and boundary value problems. Linear differential equations with constant coefficients. Cauchy-Euler equation	**10**
4	**Basic Statistics**: Classification of data. Mean, mode, median and standard deviation. Method of least squares	**8**
5	**Numerical Methods:** Newton-Raphson method. Linear and quadratic interpolation. Simpson's rule	**8**
Total lectures		**42**

Suggested Text Book(s):

1. G. B Thomas, R. L. Finney Calculus and analytical geometry, 9th Ed., Pearson Education Asia (Adisson Wesley), New Delhi, 2000.
2. NCERT. Mathematics Textbook for class XI and XII.
3. Sharma, R.D. Mathematics, Dhanpat Rai Publications, New Delhi

Suggested Reference Book(s):

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
2. Dennis G. Zill, Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett Publishers, Inc; 4th Revised edition.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111104085/25

2. Link to topics related to course:

i. https://nptel.ac.in/courses/111108081/

ii. https://nptel.ac.in/courses/105103027/module2/lec5/1.html

iii. https://www.khanacademy.org/math/ap-statistics/summarizing-quantitative-data-ap/measuring-center-quantitative/v/statistics-intro-mean-median-and-mode

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment (2)- 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	1	1	1	1	1	1	1	1	2	2	1.3
CO-2	2	2	1	1	2	2	1	1	1	2	1	2	1.5
CO-3	2	3	2	2	1	2	2	1	2	1	2	2	1.8
CO-4	2	3	2	2	1	2	2	1	2	1	2	2	1.8
CO-5	3	2	2	3	3	3	2	1	3	2	3	3	2.5
CO-6	3	1	1	2	3	2	2	1	3	2	3	2	2.1
Average	2.3	2.2	1.5	1.8	1.8	2.0	1.7	1.0	2.0	1.5	2.2	2.2	

Numerical Methods

COURSE CODE: 18B11MA311

COURSE CREDITS:4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. Introduction to numerical errors and various techniques for obtaining roots of the nonlinear equations.
2. Learn to analyze system of linear equations and obtain its solutions.
3. To learn certain interpolation techniques.
4. To comprehend numerical differentiation and integration.
5. Learn to obtain solutions of IVP, BVP and partial differential equations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand numerical errors and obtain roots of the nonlinear equations & system of nonlinear equations.	Assessment
CO-2	Ability to solve the system of linear equations and finding eigenvalues of the matrices.	Assessment
CO-3	Perform polynomial interpolations using various techniques.	Usage
CO-4	Perform Cubic-spline interpolation and approximations.	Assessment
CO-5	Perform Numerical Differentiation, Numerical Integration.	Assessment
CO-6	Solve IVP, BVP and numerical solutions of parabolic, elliptic and hyperbolic partial differential equations.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to numerical errors and nonlinear equations:** Initial error, round-off error, Truncation error, Absolute error, relative error, percentage error. Root-finding methods: single nonlinear equation - Bisection method, False-Position method, Newton-Raphson method, Secant methods, (Fixed-point) Iteration method; more than one nonlinear equations- Newton's method. Convergence criteria. Iterative methods and the formula for calculation of the approximation.	6

2	**Numerical Linear Algebra:** Direct methods: Gauss-elimination method, LU-Decomposition methods. Iterative methods: Gauss-Siedel method, Successive Over-Relaxation (SOR) methods. Eigenvalue problem: Power method for largest eigenvalue, Jacobi's method for symmetric matrices.	**6**
3	**Interpolation & Approximation**: (i) Interpolating polynomial. Lagrange formula with error. Formulae for equally-spaced points. Divided differences: Newton's interpolating polynomials. (ii) Hermite interpolation. Cubic-spline interpolation. Pade and rational approximations. Least square approximation. Approximation by splines.	**5+5=10**
4	**Numerical Differentiation and Quadrature:** Approximation of derivatives, Newton-cote integration formulae. Gauss-Legendre quadrature formulae. Romberg integration. Double integration.	**9**
5	**Numerical Solutions of ODE and PDE:** Numerical solutions of ODEs using Picard, Euler, modified Euler, Runge-Kutta methods, Predictor corrector methods for IVPs. The Finite difference method and Shooting method for BVPs. Numerical solutions of parabolic, elliptic and hyperbolic partial differential equations.	**11**
Total lectures		**42**

Suggested Text Book(s):

1. C. F. Gerald and P.O Wheatley: Applied Numerical Analysis, 6th Edition, Pearson Education Asia, New Delhi, 2002.
2. Steven C. Chapra, Raymond P. Canale: Numerical Methods for Engineers, 7th Edition, Tata McGraw-Hill.
3. M. K. Jain, S.R.K. Iyengar, R. K. Jain: Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International.

Suggested Reference Book(s):

1. S. Joe D Hoffman: Numerical Methods for Engineers and Scientists, 2nd Edition, Marcel Dekker Inc.
2. Richard L. Burden & J. Douglas Faires: Numerical Analysis, 9th Edition, Cengage Learning.
3. B. S. Grewal: Numerical Methods, 11th Edition, Khanna Publishers.
4. S. S. Sastry: Introductory Methods of Numerical Analysis, 5th Edition, Prentice Hall India Learning Private Limited.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/122102009/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 15 Quizzes (1) - 5 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Numerical Methods)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	0	0	1	2	2	2	1.6
CO-2	2	2	1	2	3	3	0	0	1	2	2	2	1.7
CO-3	1	1	2	2	2	2	0	0	2	2	2	2	1.5
CO-4	2	2	2	2	1	2	0	0	2	1	1	2	1.4
CO-5	3	2	2	2	2	2	0	0	2	2	2	2	1.8
CO-6	2	2	1	2	2	2	0	0	2	1	1	1	1.3
Average	2	2	1.7	2	2	2	0	0	1.7	1.7	1.7	1.8	

Probability and Statistical Techniques

COURSE CODE: 18B11MA312

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Working knowledge of basic calculus and combinatorial skills.

Course Objectives: This course introduces students:

1. To the elementary concepts of descriptive and inferential techniques of statistical methodology.
2. To extend and formalize knowledge of the theory of probability and random variables.

Course Outcomes: At the end of the course, the students will be able to apply appropriate statistical concepts, methodologies and technologies in organizing, analyzing and interpreting various real-world situations and in coming up with relevant decisions:

S. No.	Course Outcomes	Level of Attainment
CO-1	Compute and Interpret Measures of Central Tendency and Dispersion of Data; Construct and Analyze Graphical Displays (Histogram, Bar & Pie Charts, Etc.) To Summarize Data.	Familiarity
CO-2	Construct Sample Spaces of Random Experiments; Identify and Specify Events; Apply Discrete/Continuous Probability Distributions to Evaluate Event Probabilities; Use *Central Limit Theorem* to Find Probabilities for Sampling Distributions.	Assessment
CO-3	Conduct Hypotheses Tests & Construct Point & Confidence-Interval Estimates Concerning Population Parameters Based on Sample Data; Perform and Interpret Chi-Square Test of Goodness-of-Fit and Test of Independence.	Usage
CO-4	Compute Correlation Coefficient to Decide The Linear Relationship that May Exist Between Two Variables of Interest; Find The Equation of Regression Line And Predict The Value of One Variable Based on the Value of the Other Variable.	Assessment
CO-5	Identify and Evaluate Common Sampling Techniques Such as F-Test in ANOVA - Evaluating or Approximating the P-Value of the Test Statistic - and Design Simple Experimental.	Applications

Course Contents:

Unit	Contents	Lectures Required

1	**Basics of Statistics:** Population, Sample, Attribute and Variable (Discrete and Continuous). Classification and Tabulation of Data. **Graphical Representation of Data** - Histogram, Frequency Polygon, Stem-and-Leaf Plots, Box Plot, Bar & Pie Charts. **[CO-1]**	**5**
2	**Descriptive statistics:** Measures of Central Tendency - Mean, Median, Mode. **Dispersion and its Measures** – Range, Quartile Deviation, Mean Deviation, Standard Deviation. Skewness and Kurtosis. **[CO-1]**	**6**
3	**Probability:** Random Experiment, Sample Space, Event, Types of Events. Three Approaches To Probability, Additive And Multiplicative Laws Of Probability, Conditional Probability, Total Probability Theorem and Bayes' Theorem. **[CO-2]**	**5**
4	**Random Variables:** Random Variable – Introduction: Probability Mass Function (PMF), Probability Density Function (PDF) and Cumulative Distribution Function (CDF). Moments of Random a Variable - Mean and Variance. Moment Generating Function of a Random Variable (Definition & Properties). Bernoulli, Binomial, Poisson and Normal Distributions – Problems with Applications. **[CO-2]**	**6**
5	**Statistical Inference:** Introduction to Random Sampling - The Central Limit Theorem, Sampling Distribution. Concept of Estimation and Testing of Hypotheses: Type-I & Type-II Errors, Level of Significance, Confidence Interval, P-Value, Critical Value, Critical Region; Tests for Population Means and Variances for Single and Double Samples (Z-Test, T-Test and F-Test). Chi-Square Test of Goodness of Fit and Independence of Attributes (mxn Contingency). **[CO-3]**	**8**
6	**Correlation And Regression:** Bivariate Data, Scatter Plots. Pearson Product-Moment and Spearman's Rank Correlation Coefficients, Properties of Correlation Coefficient. **Simple Linear Regression** - Regression Equations. **[CO-4]**	**6**
7	**ANOVA and Simple Designs:** One-Way and Two-Way (Without and With Interaction) ANOVA. Concept of Three Basic Principles of Design of Experiments, CRD and RBD. **[CO-5]**	**6**
Total Lectures		**42**

Suggested Text Book(s):

1. Richard A. Johnson Irwin Miller and John E. Freund, ``Probability and Statistics for Engineers", Prentice Hall, New Delhi, 11th Edition, 2011.

Suggested Reference Book(s):

1. Ronald E. Walpole , Raymond H. Myers , Sharon L. Myers and Keying E. Ye, ``Probability and statistics

for engineers and scientists'', 9th Edition, Pearson, 2011.
2. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.
3. P. Kousalya, "Probability, statistics and random processes", Pearson Education, 2013.

Other Useful Resource(s):

1. Link to NPTEL Course Contents:
   i. https://nptel.ac.in/courses/111106112/
   ii. https://nptel.ac.in/courses/111105090/
   iii. https://nptel.ac.in/courses/111105041/
   iv. https://nptel.ac.in/courses/102106051/
   v. https://nptel.ac.in/courses/102101056/
2. Link to Topics Related to Course:
   i. https://nptel.ac.in/courses/111106112/1- 5/
   ii. https://nptel.ac.in/courses/111106112/12-17/
   iii. https://nptel.ac.in/courses/111106112/18-21/
   iv. https://nptel.ac.in/courses/111105090/1-32/
   v. https://nptel.ac.in/courses/111105090/49-54/
   vi. https://nptel.ac.in/courses/111105090/61-79/
   vii. https://nptel.ac.in/courses/111105041/3-40/
   viii. https://nptel.ac.in/courses/102106051/32/
   ix. https://nptel.ac.in/courses/102106051/1-24/
   x. https://nptel.ac.in/courses/102101056/1-12/
   xi. https://nptel.ac.in/courses/102101056/15-40/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) Contribution to the Programme Outcomes (POs):

Course Outcomes (Probability & Statistics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	1	2	1	1	1	-	-	1	2	1	1.6
CO-2	3	3	1	2	2	1	1	-	-	1	2	2	1.8
CO-3	3	3	2	3	3	3	1	-	-	1	3	3	2.5
CO-4	3	3	3	3	2	3	1	-	-	2	3	3	2.7
CO-5	3	3	3	3	3	3	1	-	-	2	3	3	2.7
Average	3.0	3.0	2.0	2.6	2.4	2.2	1.0	-	-	1.4	2.6	2.4	

Probability and Statistics

COURSE CODE: 18B11MA313

COURSE CREDITS: 4

CORE/ELECTIVE : CORE

L-T-P: 3-1-0

Pre-requisite: Working knowledge of basic calculus from Engineering Mathematics-I (18B11MA111).

Course Objectives:

1. To introduce students, the theoretical knowledge of the probability of random variables.
2. To study the fundamental concepts of descriptive and inferential techniques of statistical methodology.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Construct sample spaces of random experiments; identify and specify events, and perform set operations on events; understand the axiomatic approach of probability theory; compute probabilities by counting; evaluate conditional probability, and apply Bayes' theorem to simple situations.	Familiarity & Assessment
CO-2	Express random variables by using distribution function and density functions; calculate moments related to random variables; understand the concept of inequalities and probabilistic limits; understand the intrinsic need of (functions of) random variables for the analysis of random phenomena.	Familiarity & Assessment
CO-3	Compute probability distributions and correlation measures of bivariate random variables; obtain marginal and conditional distributions of random variables; find probabilities for outcomes of various events related to an uncertain phenomenon using appropriate probability distributions as models.	Assessment & Usage
CO-4	Compute correlation coefficient to decide the linear relationship that may exist between two variables of interest; find the equation of regression line and second degree curve, and to predict the value of one variable based on the value of the other variable.	Familiarity & Assessment
CO-5	Use central limit theorem to find probabilities for sampling distributions; conduct hypotheses tests and construct confidence-interval estimates concerning population parameters based on sample data; perform and interpret chi-square test of goodness-of-fit and test of independence.	Familiarity & Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basic probability:** Random experiments; three basic approaches to probability, combinatorial probability problems; conditional probability, independence; total probability theorem, Bayes' theorem.	4
2	**Random variables:** Concept of random variables – discrete, continuous; probability distributions – probability mass function, density function and cumulative distribution function; expectation, variance and moment generating function of random variables; Chebyshev's inequality; bivariate distributions - conditional densities, distribution of sums and quotients, covariance (definition and interpretation).	10
3	**Probability distributions:** Binomial, multinomial and Poisson approximation to the binomial distribution; exponential, gamma, and normal distributions.	6
4	**Descriptive statistics:** Measures of central tendency & dispersion: evaluation of statistical parameters (mean and variance possibly from grouped data) for binomial, Poisson and normal distributions; Measures of skewness and kurtosis; correlation and regression - rank correlation and curve fitting of straight lines, second degree parabolas and more general curves.	10
5	**Inferential statistics:** Introduction to sampling distribution - central limit theorem; testing of hypotheses: critical value, critical region, confidence interval, level of significance, p-value; Large and small sample tests (Z-test, t-test and F-test): single proportion, difference of proportions, single mean, difference of means, difference of standard deviations, and tests for ratio of variances and correlation coefficients; Chi-square test of goodness-of-fit and independence of attributes.	12
Total Lectures		**42**

Suggested Text Book(s):

1. Richard A. Johnson Irwin Miller and John E. Freund, ``Probability and Statistics for Engineers", Prentice Hall, New Delhi, 11th Edition, 2011.
2. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.

Suggested Reference Book(s):

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, ``Probability and statistics for engineers and scientists'', 9th Edition, Pearson, 2011.
2. Henry Stark and John W. Woods: ``Probability and random processes with applications to signal processing'', Pearson education, 3rd Edition, Asia, 2002.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111106112
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111105090/
   ii. https://nptel.ac.in/courses/111101004/
   iii. https://nptel.ac.in/courses/111102111/

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1.0 Hour	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2.0 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 05 Quizzes (2) - 15 Attendance - 05

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Probability & Statistics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	1	2	1	1	1	-	-	1	2	1	1.6
CO-2	3	3	1	2	2	1	1	-	-	1	2	2	1.8
CO-3	3	3	2	3	3	3	1	-	-	1	3	3	2.5
CO-4	3	3	3	3	2	3	1	-	-	2	3	3	2.7
CO-5	3	3	3	3	3	3	1	-	-	2	3	3	2.7
Average	3.0	3.0	2.0	2.6	2.4	2.2	1.0	-	-	1.4	2.6	2.4	

Probability Theory and Random Processes

COURSE CODE: 18B11MA314

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P : 3-1-0

Pre-requisite: Knowledge of Differential & Integral Calculus from Engineering Mathematics-I.

Course Objectives:

1. To provide the students the elementary concepts of descriptive and inferential statistical methods.
2. To extend and familiarize the students with the basic concepts of random process for applications such as Random signals, signal noise, linear systems, etc in communication engineering.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Construct sample spaces of random experiments; identify and specify events, and perform set operations on events; compute probabilities by counting; evaluate conditional probability, and apply Bayes' theorem to simple situations.	Familiarity &Usage
CO-2	Express random variables by using CDFs, PMFs; calculate moments related to random variables; understand the concept of inequalities and probabilistic limits. Understand the axiomatic approach of probability theory and intrinsic need of (functions of) random variables for the analysis of random phenomena.	Familiarity & Assessment
CO-3	Compute probability distributions and correlation measures of bivariate random variables; obtain marginal and conditional distributions of random variables; find probabilities for outcomes of various events related to an uncertain phenomenon using appropriate probability distributions as models.	Assessment &Usage
CO-4	Conduct hypotheses tests concerning population parameters based on sample data; perform and interpret chi-square test of goodness-of-fit and test of independence; find the equation of regression line and second degree curve, and to predict the value of one variable based on the value of the other variable.	Assessment &Usage
CO-5	Identify and classify random processes and determine covariance and spectral density of stationary and ergodic random processes; demonstrate specific applications to Gaussian process.	Familiarity &Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basic probability:** Random experiments; Three basic approaches to probability, combinatorial probability problems; Conditional probability, total probability theorem, Bayes' theorem.	4L
2	**Random variables:** Univariate random variables – discrete, continuous and mixed random variables; probability distributions – probability mass function, density function and cumulative distribution function; Expectation, variance and moment generating function of random variables; Chebyshev's inequality; Bivariate distributions with properties - conditional densities, definition & interpretation of covariance with properties, distributions of sum and quotient of random variables.	10L
3	**Special distributions:** Bernoulli trials – binomial, multinomial and Poisson distributions; Exponential, gamma, uniform, and Gaussian distributions.	6L
4	**Basic statistics:** Measures of central tendency & dispersion: evaluation of statistical parameters (mean and variance possibly from grouped data) for binomial and normal distributions; Measures of skewness and kurtosis; Correlation and regression - rank correlation and curve fitting by the method of least squares regression - fitting of straight lines, second degree parabolas.	6L
5	**Applied statistics:** Introduction to sampling distribution; Testing of hypotheses: critical value, critical region, confidence interval, level of significance, p-value; Test for one sample proportion & Tests for mean and variance for single and double samples: Z-test, t-test and F-test; Chi-square test of goodness-of-fit and independence of attributes.	10L
6	**Stochastic processes:** Introduction and classification of random processes; Statistical averages – mean and auto-correlation functions; Stationary processes – SSS and WSS processes; Ergodic processes, Gaussian process - covariance matrix; Linear system with random inputs, power spectral density, noise in communication systems, white Gaussian noise.	6L
Total Lectures		42L

Suggested Text Book(s):

1. Richard A. Johnson Irwin Miller and John E. Freund, ``Probability and Statistics for Engineers", Prentice Hall, New Delhi, 11th Edition, 2011.
2. Oliver C. Ibe, ``Fundamentals of applied probability and random processes", Academic press, 2005.

Suggested Reference Book(s):

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, ``Probability and statistics for engineers and scientists'', 9th Edition, Pearson, 2011.
2. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111102111
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111101004/2
   ii. https://nptel.ac.in/courses/111106112/1
   iii. https://nptel.ac.in/courses/117105085/30
   iv. https://nptel.ac.in/courses/108103112/14

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1.0 Hours	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2.0 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 05 Quizzes (2) - 15 Attendance - 05

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes [Probability Theory & Random Processes]	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	1	1	1	1	1	-	-	1	2	1	1.6
CO-2	3	3	1	2	2	1	1	-	-	1	2	2	1.8
CO-3	3	3	2	3	3	3	1	-	-	1	3	3	2.5
CO-4	3	3	3	3	3	3	1	-	-	2	3	3	2.7
CO-5	3	2	2	2	3	3	2	-	-	1	3	3	2.3
Average	3.0	2.8	1.8	2.4	2.4	2.0	1.2	-	-	1.2	2.6	2.4	

Discrete Mathematics

COURSE CODE: 18B11MA413

COURSE CREDITS: 4

CORE / ELECTIVE: CORE L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. To learn various discrete structures (e.g., sets, relations, logic, lattices, graphs, linear transformations, structure of language etc.) that provide the mathematical formalizations for computational problems.
2. Learn Mathematical arguments and proof techniques.
3. Study of certain algebraic structures.
4. To comprehend Languages, grammars, FSA and FSM.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand set operations, various types of relations and their representations, solving recurrence relations.	Familiarity
CO-2	Comprehend the discrete structures of lattices, Propositions with proof of validity of arguments and quantifiers.	Assessment
CO-3	Understand various types of graphs, paths, spanning trees, planarity of graphs and coloring theorems.	Usage
CO-4	Recognize Algebraic structures; Groups, Subgroups, Rings, Fields with extension to concepts of vector spaces, dimensions and linear transformations.	Assessment
CO-5	Comprehend Languages, grammars, finite state automata and finite state machines.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Set, Relations and Functions:** Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Partitions and Duality.	8

	Different types of relations, their compositions and inverses. Different types of functions, Recursively defined functions, Recursive algorithms, generating functions and solutions of recurrence relations, Complexity of algorithms, Big-o notation, Euclidean algorithm for finding GCD, Evaluation of polynomial using Horner's method, Russian Peasant method for multiplication.	
2	**Lattices and Propositional Logic:** Ordered Sets and Lattices: Partial order relations and Hasse diagram, Supremum and infimum, total ordering, lattices – bounded, distributive, complemented, modular, Product of lattices. Simple and compound statement. logical operators. Implication and double implication, Tautologies and contradictions. Valid arguments and fallacy. Propositional functions and quantifiers.	**8**
3	**Graph Theory:** Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, Matrix representation of Graphs and properties, Planar Graphs, Homeomorphism, Kuratowski's theorem, Spanning trees, shortest spanning tree, Algorithms for finding shortest spanning tree Graph colorings. Four color problem, Digraphs and related definitions, connectivity in diagraphs.	**10**
4	**Algebraic structures & Vector Space:** Binary operations, Algebraic structures – semigroup, monoid, groups, subgroups, Rings, Integral domain and fields, Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity theorem.	**12**
5	**Introduction to Languages:** Introduction to Languages, finite state automata grammars, finite state machines.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. Kenneth H. Rosen: Discrete Mathematics and Its Applications with combinatorics and Graph Theory, 7th Edition, Tata McGraw-Hill, 2011.

2. Kolman B., Busby R., Ross S.: Discrete Mathematical Structures, 6th Edition, Pearson Education, 2009.

3. Lipschutz S, Lipson M: Linear Algebra, 3rd Edition, Schaum's outlines, Mc Graw-Hill International Edition, 2001.

Suggested Reference Book(s):

1. Liu, C. L.: Elements of Discrete Mathematics, 3rd Edition, Tata McGraw-Hill, 2008.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111107058/

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Quiz - 15 Tutorial Quiz - 5 Attendance - 5

Course Outcomes (COs) contribution to the programme Outcomes (POs):

Course outcomes (Discrete Mathematics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	0	0	1	1	1	1	1.3
CO-2	2	2	2	2	2	1	0	0	1	1	1	1	1.2
CO-3	3	2	2	3	1	1	0	0	1	1	1	1	1.3
CO-4	3	2	1	1	1	1	0	0	1	1	1	1	0.8
CO-5	3	2	3	2	3	1	0	0	1	1	1	1	1.1
Average	2.6	2.2	2	2	1.8	1	0	0	1	1	1	1	

Biostatistics (Revised)

COURSE CODE: 18B11MA411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Basic Mathematics-I and II.

Course Objectives:

1. To study multiple linear regression and correlation model.

2. To study non-parametric tests, stochastic process and clustering along with their application in Bio-informatics.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Perform correlation and regression analysis and draw conclusions and apply to bio-informatics models. Use method of least squares for curve fitting.	Familiarity
CO-2	Construct sample spaces of random experiments; Compute probability and apply Baye's theorem to simple situations. Understand random variables and probability distributions.	Familiarity
CO-3	Conduct hypotheses tests concerning population parameters based on sample data; perform and interpret chi-square test of goodness-of-fit and test of independence.	Assessment
CO-4	Execute non parametric tests and run tests and draw conclusions.	Usage
CO-5	Understand stochastic processes and find ensemble averages, WSS and SSS processes. Understand the Markov chains and apply Markov process and Poisson's process.	Usage

Course Contents:

Unit	Contents	lectures required
1	Bivariate data, scatter plots. Karl Pearson's correlation coefficients, Spearman's rank correlation coefficients, properties of correlation coefficient, curve fitting- method of least squares; overview of linear, multiple linear regression, nonlinear regression, logistic regression	**10**
2	**Probability:** Random experiment, sample space, event, types of events. three approaches to probability, additive and multiplicative laws of probability, conditional probability, total probability theorem and bayes' theorem. **Random Variables:** Introduction: probability mass function (PMF), probability density function (PDF) and cumulative distribution function	**12**

	(CDF)., mathematical expectation, moments of random a variable – mean and variance, moment generating function of a random variable. **Probability Distributions:** Binomial, Poisson distribution; uniform, exponential, gamma and normal distributions.	
3	**Parametric Tests:** Introduction to sampling distribution; testing of hypotheses: critical value, critical region, confidence interval, level of significance, p-value; test for one sample proportion & tests for mean and variance for single and double samples: z-test, t-test and F-test; chi-square test of goodness-of-fit and independence of attributes.	**6**
4	**Non-parametric Tests:** Need of non-parametric tests, sign test for one sample and two samples, signed-rank test, Wilcoxon test (Mann-Whitney test), run test for randomness, Kruskal- Wallis and Friedman's test.	**5**
5	**Stochastic Processes:** Introduction and classification of stochastic processes, ensemble averages – mean function, auto-correlation function, auto-covariance function, stationary processes – strict-sense stationary (SSS) process and widesense stationary (WSS) process. M**arkov processes** - Markov chains – Markov property, transition probability matrix, state-diagram, processes with independent increments - Poisson process, modeling (applications of Markov chains in bio-informatics), Brownian motion – simple random walk.	**9**
Total Lectures		**42**

Suggested Text Book(s):

1. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press, (2009).
2. Ronald E. Walpole , Raymond H. Myers , Sharon L. Myers and Keying E. Ye, ``Probability and statistics for engineers and scientists'', 9th Edition, Pearson, 2011.
3. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.
4. Oliver C. Ibe, ``Fundamentals of applied probability and random processes", Academic press, 2005.
5. T. Veerarajan: ``Probability, statistics and random processes", Tata McGraw-Hill, Third edition, 2008.
6. W. J. Ewens and G. R. Grant: "Statistical methods in bioinformatics", Springer 2001.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biostatistics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	3	3	3	3	3	3	4	4	4	3	**3.1**
CO-2	3	2	1	2	1	3	1	2	1	2	3	3	**2.0**
CO-3	3	2	3	4	4	2	3	3	4	3	3	3	**3.1**
CO-4	3	2	3	4	4	2	3	3	4	3	3	3	**3.1**
CO-5	3	3	3	2	3	3	3	2	3	2	2	3	**2.7**
Average	**3**	**2**	**2.6**	**3**	**3**	**2.6**	**2.6**	**2.6**	**3.2**	**2.8**	**3**	**3**	

Biostatistics Lab (Revised)

COURSE CODE: 18B11MA412

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Basic Knowledge of Excel and R

Course Objectives: After completion of this course, the students will be able to the following learning:

1. To develop programs for various probability and statistical concepts/procedures **in R**.
2. To execute and perform fundamental and specific statistical tests using R.

S. No.	Course Outcomes	Level of Attainment
CO-1	Getting familiar with R. Learn data input, vector functions, arrays and graphics. Understand to write R Functions and implementation.	Familiarity
CO-2	Understand to write and execute the programs for calculate correlation and regression analysis and curve fitting,	Usage
CO-3	Understand to write and execute the programs for discrete and continuous probability distributions.	Assessment
CO-4	Understand to write and execute the programs for parametric and non-parametric tests.	Assessment
CO-5	Understand to write and execute the programs for Markov and Poisson's processes.	Usage

List of Experiments:

S.No	Description	Hours
1	Getting started with R, simple calculations, generating sequences, vectors, vector functions, matrices and array.	2
2	Loops and repeats, writing R functions, data inputs, graphics.	2
3	Tables, mathematical functions, probability functions.	2
4	To write and execute a program to calculate correlation and simple linear regression coefficients.	2
5	To write and execute a program for multiple linear regression and nonlinear regression.	2
6	To write and execute a program for binomial and Poisson's distributions.	2
7	To write and execute a program for uniform, normal, exponential and gamma distributions	2
8	To write and execute a program for parametric tests (t and F tests)	2

9	To write and execute a program for parametric tests (Chi-square tests)	2
10	To write and execute a program for non-parametric tests (sign test, Wilcoxon test).	2
11	To write and execute a program for non-parametric tests (run test, Kruskal-Wallis test and Friedman's test).	2
12	To write and execute a program to obtain one-step and n-step transition probability distributions for a given homogeneous Markov chain.	2
13	To write and execute a program to obtain steady state probability distribution for a given homogeneous Markov chain with n states.	2
14	To write and execute a program to obtain probability distribution for Poisson process for given arrival rate and time-interval with a specified detecting probability.	2
Total Lab Hours		**28**

Suggested Text Book(s):

1. Crawley M. J., `` The R Book", Wiley, 2nd Edition, Reprint, 2017.
2. Baclawski K., " Introduction to Probability with R", 1st Edition, Reprint, Chapman & Hall/CRC, 2011
3. Kabacoff R. I., " R in Action", Dream Tech Press, 2nd Edition, 2015.
4. Ugarte, M. D., Militino, A. F., & Arnholt, A. T., " Probability and Statistics with R", CRC press, 2008

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 Marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biostatistics Lab)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	1	2	3	4	3	3	3	4	3	4	3	**3**
CO-2	3	2	1	2	4	2	3	3	2	2	2	3	**2.4**
CO-3	3	2	2	3	4	3	3	3	4	3	3	3	**3**
CO-4	3	2	2	3	4	3	3	3	4	3	3	3	**3**
CO-5	3	1	3	2	4	3	3	3	4	3	3	3	**2.9**
Average	**3**	**1.6**	**2**	**2.6**	**4**	**2.8**	**3**	**3**	**3.6**	**2.8**	**3**	**3**	

Discrete Computational Mathematics

COURSE CODE: 18B11CI414

COURSE CREDITS: 3

CORE/ELECTIVE: COR

L-T-P: 3-0-0

Pre-requisite: Basic Mathematics Algebra

Course Objectives

1. To simplify and evaluate any logical expression and to express logical statements in terms of logical connectives, predicates and quantifiers.
2. Use of various set operations, relations and functions concept to solve applied problems.
3. To solve counting problems using elementary counting techniques.
4. To learn and perform various graphs and trees terminologies, traversals & their applications.
5. Problem solving using recursion and recurrence relations by analyzing algorithms.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to express logical statements in terms of logical connectives, predicates and quantifiers.	Familiarity
CO-2	Students will be able to apply various proving techniques such as direct, indirect proofs, mathematical induction, etc.	Assessment
CO-3	They will learn basic set operations along with relations & functions with their types and usage.	Familiarity
CO-4	They will be familiar with graph & tree terminologies along with their various applications in computer science.	Familiarity
CO-5	Students will be able to solve counting problems using permutation, combinations techniques.	Assessment
CO-6	They will learn about algebraic structures such as group, abelian group, rings, integral domain, fields, etc	Familiarity
CO-7	Students will be able to analyze and solve various algorithms using recurrence relation methods	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**I**ntroduction and Applications of Discrete Mathematics, Mathematical Logic: Propositional & Predicate; Quantifiers, Proving Techniques: Direct Proof, Contra positive, Contradiction, Principle of Mathematical Induction; Pigeonhole Principle	6

2	Sets, Types of Sets, Various set operations, Venn Diagrams, Identities in sets, Principle of Inclusion & Exclusion	3
3	Relations: Types & Representation; Properties of Binary Relations, Equivalence Relations, Partial Ordering Relations, Partitions. Functions, Types of Functions, inverse of function, composition of functions.	5
4	Graph, Graph Terminologies, Types of Graphs, Paths & Circuits, Euler & Hamiltonian Graphs, Planar Graphs, Graph Traversals: Breadth First Search & Depth First Search, Shortest Path Algorithms.	7
5	Trees, Tree Terminologies, Types of Trees: General, Binary, Strictly Binary, Full & Complete Binary Tree; Tree Traversals, Binary Search Tree, AVL Trees.	7
6	Basic Counting Techniques, The Sum and Product Rule, Permutations, Combinations, Generation of Permutations and Combinations	4
7	Properties of Algebric Structures, Semigroups, Monoids, Groups, Abelian Groups, Subgroups, Homomorphism & Isomorphism of Groups, Rings, its characteristics & its types, Integral Domain & Fields.	6
8	Recurrence Relations, Linear Recurrence Relations with constant coefficients (homogeneous & non-homogeneous) with their solving techniques.	4
Total lectures		**42**

Suggested Text Book(s):

1. C.L. Liu & D.P. Mohapatra, "Elements of Discrete Mathematics: A Computer Oriented Approach", 4th Edition, TMH
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 7th Edition, TMH

Suggested Reference Book(s):

1. B. Kolman, R. Busby & S.C. Ross, "Discrete Mathematical Structures", 6th Edition, Pearson Education.
2. S. Lipschutz & M. Lipson, "Discrete Mathematics", 3rd Edition, TMH.
3. J.P. Tremblay & R. S. Manohar, "Discrete Mathematical Structures with Applications to Computer Science, TMH, New York 1997.
4. Richard Hammack, "Book of Proof", 2nd Edition, VCU Mathematics Text Book Series

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_cs53/preview
2. Link to topics related to course:
   i. https://www.youtube.com/watch?v=xlUFkMKSB3Y
   ii. https://www.youtube.com/watch?v=RMLR2JHHeWo
   iii. https://www.youtube.com/watch?v=9AUCdsmBGmA
   iv. https://www.youtube.com/watch?v=7cTWea9YAJE

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Discrete Computational Mathematics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-2	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	2	1	2	2	2	2	1	2	1	2	**1.8**
CO-5	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-6	3	2	3	1	1	3	2	1	1	3	2	1	**1.9**
CO-7	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.6**	**2.3**	**1.1**	**1.6**	**2.6**	**2.6**	**1.7**	**1.9**	**2.6**	**2**	**1.4**	

LINEAR ALGEBRA

COURSE CODE: 22BS1MA112

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Course Objectives: On successful completion of this course, a student will be able

1. To solve system of linear equations, and interpret existence and uniqueness of solutions geometrically.
2. To learn and recognize linear independence, span and dimension, and apply them to vector spaces.
3. To learn eigenvalues, eigenvectors and understand the idea behind diagonalization process.
4. To understand the relationship between a linear transformation and its matrix representation.
5. To describe vector projections, compute orthonormal basis and spectral decomposition.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the roll of matrices and their properties to solve the system of linear equations;	Familiarity
CO-2	Find eigenvalues, eigenvectors of matrices and perform diagonalization.	Assessment
CO-3	Understand linear transformation and find the matrix representation; Compute eigenvalues and eigenvectors of a square matrix; Perform factorization of a square matrix.	Assessment
CO-4	Understand basic concepts of inner product on vector spaces; Compute the orthogonal projection of a vector onto a subspace; Construct an orthonormal basis for an inner product space using the Gram Schmidt process.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Matrices:** Algebra of matrices, row echelon form, row reduced echelon form, inverse and rank of a matrix; Kernel or Null space and solutions of linear system of equations by Gauss Elimination, Gauss-Jordan method, LU decomposition (of a matrix); Cayley-Hamilton Theorem.	**8**
2	**Vectors space:**Basics of groups, rings and fields; real and complex vector spaces; properties of vector spaces;linear dependence, basis and change of coordinates in R^n; linear span, dimension of vector space; Steinitz exchange lemma; row and column spaces associated to a matrix.	**8**
3	**Vectors and transformations:** Linear transformations - image and kernel of a linear transformation; Rank-Nullity theorem; matrix representations, change of basis, dual bases;implications for linear systems.	**8**

4	**Inner product spaces:** Introduction, norm of a vector, Cauchy-Schwarz Inequality, Triangle Inequality, generalized theorem of Pythagoras; direct sum of subspaces and its orthogonal complement; fundamental subspaces associated to a matrix and Fundamental theorem of Linear Algebra; Gram-Schmidt orthonormalization, orthogonal projections and least-square problems; Adjoint of a linear operator and linear functional.	**10**
5	**Matrix Factorization:**Eigenvalues and Eigenvectors, diagonalization – orthogonal diagonalization of symmetric matrices; Complex matrices and eigenvalues - Hermitian and unitary and normal matrices; Spectral theorem; Application of eigenvalues and in discrete dynamical systems.	**8**
Total Lectures		**42**

Suggested Text Book(s):

1. Gilbert Strang, ``Linear Algebra and Learning from Data,'' Wellesley-Cambridge Press, 2019.
2. R. K. Jain & S. R. K. Iyenger, ``Advanced Engineering Mathematics,'' 5th Edition, Narosa Publishing House, New Delhi, India, 2017
3. Ward Cheney, David R. Kincaid, ``Linear Algebra: Theory and Applications,"2nd Edition,Jones & Bartlett Learning, 2012.
4. David Poole, `` Linear Algebra: A Modern Introduction," 3rd Edition, Cengage, 2011.

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Linear Algebra)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	2	2	2	2	1	2	1	2	2	2	2	**1.9**
CO-2	2	3	2	3	2	1	2	1	2	2	2	2	**2**
CO-3	2	2	3	2	2	1	2	1	2	2	2	2	**1.9**
CO-4	3	3	3	3	2	1	2	1	2	3	3	2	**2.3**
Average	**2.5**	**2.5**	**2.5**	**2.5**	**2**	**1**	**2**	**1**	**2**	**2.3**	**2.3**	**2**	

CALCULUS

COURSE CODE: 22BS1MA111

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives: This course gives a foundation on Calculus Differential &Integral and emphasizes

- To learn fundamental concepts of one variable calculus and its applications.
- To study the hyperbolic functions, and basics of curves.
- To learn basic concepts of definite integrals and its applications.
- To study fundamentals of the sequence and series.
- To introduce the extension of single variable calculus to multivariable calculus.

Course Outcomes: On Completion of this course the students will be able to:

S.No.	Course Outcomes	Level of Attainment
CO-1	Compare and contrast the ideas of continuity and differentiability. To find maxima and minima, critical points and inflection points of functions	Familiarity
CO-2	Recognize the appropriate tools of calculus to solve applied problems, curve tracing and understand the special functions and various co-ordinate systems	Assessment
CO-3	To understand the fundamental theorem of calculus, and some applications of definite integrals to investigate length of curves, moments and center of mass, surfaces of revolutions, and improper integrals**.**	Assessment
CO-4	To understand various types of convergence of sequence and series, Power series. Moreover, a brief introduction to multivariable calculus: limits and continuity, partial derivatives,Homogeneous Functions and Euler's theorem withapplications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Single Variable Calculus: Limits and continuity of single variable functions, differentiation and applications of derivatives,Maxima and Minima, Extrema on an interval, Rolle's Theorem, Mean Value Theorem and Applications, Fundamental Theorem of Calculus.	9
2	Transcendental Functions, Hyperbolic functions, higher order derivatives, Leibnitz rule, curvature, curve tracing in Cartesian coordinates. Polar coordinates, parametric equations, Parameterization of a curve, arc length of a curve.	9
3	Definite integrals, fundamental theorem of calculus, Applications to	9

	length, moments and center of mass, surfaces of revolutions, improper integrals.	
4	Sequences, Series and their convergence, absolute and conditional convergence, Uniform convergence, power series, Taylor's and Maclaurin's series	8
5	Introduction to Multi-variable Calculus: Functions of several variables-limits and continuity, partial derivatives, Chain rule, Homogeneous Functions and Euler's Theorem and Applications.	7
Total Lectures		42

Suggested Text Book(s):

5. G.B. Thomas and R.L. Finney, ``Calculus and Analytic Geometry, Pearson Education India.
6. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

Suggested Reference Book(s):

7. Gilbert Strang, "Calculus", Wellesley-Cambridge Press; 2nd edition, 2010.
8. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Calculus)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	
Average													

Soft Computing & Optimization Algorithms

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Course Objectives: On successful completion of this course a student will be able

1. To describe various types of soft computing techniques, and applications of soft computing.
2. To describe the fuzzy sets and fuzzy logic
3. To describe the fuzzy controller and fuzzy rule base and approximate reasoning.
4. To describe the evolutionary computing.
5. To understand the concepts of genetic algorithm.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic tools of soft computing.	Familiarity
CO-2	Understand the fuzzy sets and crisp sets, fuzzy set theory and operations.	Assessment
CO-3	Understand the fuzzy controller and fuzzy rule base and approximate reasoning.	Assessment
CO-4	Understand the basic evolutionary processes.	Familiarity
CO-5	Understand the working principle and procedures of genetic algorithm.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Introduction, soft computing vs. hard computing, various types of soft computing techniques, and applications of soft computing. Basic tools of soft computing - Fuzzy logic, neural network, evolutionary computing. Introduction: Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.	08
2	**Fuzzy Sets and Logic:** Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications and Defuzzifications.	08

3	**Fuzzy Systems:** Fuzzy Controller, Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules, decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems.	**10**
4	**Evolutionary Computing:** Basic Evolutionary Processes: A Simple Evolutionary System, Evolutionary Systems as Problem Solvers, A Historical Perspective, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple EAs- A Common Framework, Population Size.	**06**
5	**Genetic Algorithm:** Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional algorithm vs genetic algorithm, simple GA, general genetic algorithm, schema theorem, Classification of genetic algorithm, Holland classifier systems, genetic programming, applications of genetic algorithm, Convergence of GA. Applications and advances in GA, Differences and similarities between GA and other traditional method, applications.	**10**
Total Lectures		**42**

Suggested Text Book(s):

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, International Editions, Electrical Engineering Series, Singapore, 1997.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.

Suggested Reference Book(s):

1. Stamatios V. Kartalopoulos "Understanding Neural Networks and Fuzzy Logic Basic concepts & Applications", IEEE Press, PHI, New Delhi, 2004
2. Vojislav Kecman, "Learning & Soft Computing Support Vector Machines, Neural Networks, and Fuzzy Logic Models", Pearson Education, New Delhi,2006.
3. S. Rajasekaran & GA Vijayalakshmi Pai "Neural Networks, Fuzzy Logic, and Genetic Algorithms synthesis and application", PH

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Linear Algebra for Data Science and Machine Learning

COURSE CODE: 22B1WMA731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Course Objectives: This course gives a foundation on applied linear algebra concepts, and emphasizes their usage in data science and machine learning. On successful completion of this course a student will be able

1. To learn orthogonality and obtain orthonormal bases using Gram-Schmidt process.
2. To learn eigenvalues, eigenvectors and understand the idea behind diagonalization process.
3. To describe vector projections and implement the least-squares solution to Ax=b.
4. To describe and interpret singular value decomposition and principal component analysis
5. To learn and describe how to find minimum value of cost function with gradient descent.
6. To gain understanding of theoretical results in linear algebra with implementation with coding.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the roll of matrices and their properties in data science; Understand linear transformation and find the matrix representation of a linear transformation given bases of the relevant vector spaces.	Familiarity
CO-2	Find orthogonalization, eigenvalues, eigenvectors of matrices and perform diagonalization.	Assessment
CO-3	Make use of the matrix algebra techniques to solve computational problems such as finding principal components and reducing dimensionality for datasets.	Assessment & Usage
CO-4	Appraise the matrix algebra techniques for implementing the machine learning algorithms. Identify minimum values of cost function and calculate the gradient descent.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Fundamental concepts:** Notion of vectors and matrices in data science: basics of matrix algebra, vector space; linear combination of input variables from data; role of basis vectors in reducing data storage; definition and meaning of eigenvalues and eigenvectors in the rotation of a image; orthogonal and identity matrices in Machine learning; probability fundamentals.	10
2	**Matrices and Machine learning:** Data representation by system of linear equations Ax = b; linear transformations, range and null spaces; orthogonal complement of the column space of A, orthogonal projections; finding the best fit line for the data points with regression - minimizing the residual sum of squares to find the scalar weights from the data set.	12

3	**Matrix operations & approximations:** Fundamental theorem of linear algebra: rank-nullity theorem; eigendecomposition, spectral decomposition, singular value decomposition (SVD) - Moore-Penrose matrix pseudoinverse and data compression; principal component analysis (PCA) and dimensionality reduction; low-rank approximations; Python implementation of SVD, PCA.	**12**
4	**Applications:** Computing singular values and reduction of image size; optimizing cost/loss function: gradient of function, gradient descent and stochastic gradient descent, back propagation algorithm.	**8**
Total Lectures		**42**

Suggested Text Book(s):

1. Jason Brownlee, ``Basics of Linear Algebra for Machine Learning,'' Machine Learning Mastery, 2018.

Reference Book(s):

1. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, ``Mathematics for Machine Learning,'' Cambridge University Press, 2020.
2. Gilbert Strang, ``Linear Algebra and Learning from Data,'' Wellesley-Cambridge Press, 2019.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Linear Algebra for Data Science and Machine Learning)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.75**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.0**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.25**	**1.5**	**2**	

Basics of Mathematics and Statistics **Course Code:** 20MS1MA111 Credits 2 **L-T-P** :2-0-0	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.	**Students Learning outcomes** On successful completion of this course, student will be able to: •Gain broad understanding in mathematics and statistics; • Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines

Unit I Algebra 6 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models etc.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices
Unit II Calculus 4 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series etc.).
Unit III **Mathematical Models in Biology** 4 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks.
Unit IV **Statistics** 5 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., &Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science.
3. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
4. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley.

17P1WMA112 Intuitionistic Fuzzy Set Theory and Similarity Measures

L T P (3 0 0)

Offered to PhD Mathematics

Objective: The primary objectives of the course are

to provide the students a basic knowledge of fuzzy sets, information, intuitionistic fuzzy sets, operations and various distance norms, similarity measures, expressing the engineering problems mathematically and to study various applications in pattern recognition, images etc.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Topics covered:

Intuitionistic Fuzzy Sets as a generalization of Fuzzy sets, Operations on Fuzzy Sets, Two Geometrical Representations of the Intuitionistic Fuzzy Sets, Operations Over the Intuitionistic Fuzzy Sets, Intuitionistic Fuzzy Relations, Interrelationships: Crisp Sets, Fuzzy Sets, Intuitionistic Fuzzy Sets, Deriving the Intuitionistic Fuzzy Sets from Data, Derivation of the Intuitionistic Fuzzy Sets by Experts, Automatic Method of Deriving Intuitionistic Fuzzy Sets from Relative Frequency Distributions (Histograms), Distances Norms and Metrics Over the Intuitionistic Fuzzy Sets, Similarity measures and their properties, application of measures in pattern recognition, images etc, introduction to soft sets and soft matrices and various operations.

Book:

- "Distances and Similarity measures in intuitionistic fuzzy sets", Springer, Eulalia Szmidt.
- "Intuitionistic Fuzzy Sets", Springer-Verlag Berlin Heidelberg, K T Attanasov,

Advanced Numerical Analysis

Course Code: 17P1WMA113
Credits: 03
Lectures 3 Tutorials 0 Practical 0

Offered to Ph.D (Mathematics)

Pre-requisites: Basics of linear algebra, differential equations and Numerical methods

Objective:The primary objective of the course is to study various advanced numerical techniques for solving problems that arise in science and engineering.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: At the end of the course, the students would be acquainted with the understanding of theoretical and practical aspects of the use of advanced numerical techniques and will be able to solve various problems arising in science and engineering using an appropriate numerical method

Unit 1: Exact and approximate numbers, rounding of numbers, Significant digits, correct digits, various types of errors encountered in computations, Propagation of errors. Bisection Method, Regula Falsi method, Newton-Raphson method, direct iterative method with convergence criteria for finding roots of non-linear equations, Newton-Raphson method for solution of a pair of non-linear equations.

Unit 2: Solution of system of linear equations using (i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU-decomposition method. (ii)Iterative methods: Jacobi and Gauss-Seidel methods.

Unit 3: Computations of Eigen Values of a Matrix using Power method for dominant, sub dominant and smallest Eigen-values

Unit 4: Parabolic PDE: Concept of compatibility, convergence and stability, Explicit, full implicit, Crank-Nicholson, du-Fort and Frankel scheme, ADI methods to solve two-dimensional equations with error analysis. Finite difference method for solving PDEs

Unit 5**:** Weighted residual methods: Collocation, least squares, Galerkins, Rayleigh-Ritz methods and their compatibility

Suggested Books:

1. Gerald, C. F. and Wheatly P. O., “Applied Numerical Analysis”, 6th Ed., Addison-Wesley Publishing 2002
2. Fausett, L. V., “Applied Numerical Analysis”, Prentice Hall, 2nd Ed, 2007

Reference Books

1. Smith, G. D., " Numerical Solution of Partial Differential Equations", Oxford University Press,2001
2. Jain, M. K., " Numerical Solution of Differential Equations", John Wiley. 1991

ADVANCED LINEAR ALGBERA 17P1WMA231

Lectures 3, Tutorials 0, Practical 0 Credits 3

Prerequisites: An undergraduate class on Linear Algebra

Objectives: The goal of the course is to provide a thorough and comprehensive treatment of the main concepts and theorems of linear algebra.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test-1	15	1 Hour
Test-2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: Upon successful completion of this course students will be able to:

- understand the linear algebra associated to eigenvalue problems, inner product spaces, Gram-Schmidt and other decomposition theorems with their applications and significance.
- familiarize the theory and computation of the Jordan canonical form of matrices and linear maps; bilinear forms, quadratic forms, and choosing canonical bases for these.
- compute the QR-factorization of a square matrix; utilize the Least Squares method to solve linear systems of equations.
- use geometric properties and strategies to model, solve problems, and conceptually extend these results to higher dimensions; to critically analyze and construct mathematical arguments that relate to the study of introductory linear algebra (theorem-proofs and reasoning).

Topics Covered:

Unit-I: Vector spaces, subspaces, basis, change of bases, eigenvalues, eigenvectors, characteristic polynomial, minimal polynomial, Cayley-Hamilton theorem, algebraic and geometric multiplicity, diagonalization.

Unit-II: Cauchy-Schwartz inequality, orthonormality, Gram-Schmidt orthogonalisation process, linear functionals, dual spaces and dual bases, Hermitian adjoint of a matrix and transformation, orthogonal matrices and the QR-Decomposition, least squares solutions of linear systems.

Unit-III: Unitary matrices and transformations, normal matrices and transformations, unitary diagonalization of normal matrices, Spectral theorem and applications to hypersurfaces; Jordan canonical form, rational canonical form, invariant factors, elementary divisors, Primary Decomposition Theorem (Hermitian, unitary and normal matrices and their applications).

Text books:

1. Gilbert Strang, ``Introduction to Linear Algebra,'' Fifth Edition, Wellesley-Cambridge Press, 2016.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence,``Linear Algebra,'' Fourth edition, N.J: Pearson Education, 2003.

Reference Books:

3. K. Hoffman and R. Kunze, ``Linear Algebra,'' Second Edition, Prentice Hall of India, 2005.
4. Steven. J. Leon, ``Linear Algebra with Applications,'' Eighth Edition, Pearson, 2009.

Mathematical Analysis (Ph.D. II Semester) (Credits: 3)

Course code: 13P1WMA232 (L T P: 3 0 0)

Instructor: Dr. Pradeep Kumar Pandey

Course Objective: To equip students with fundamentals of Real, Complex and Functional Analysis.

Corse outcomes: On successful completion of this course, students will be able to:

- Understand the important properties of Metric spaces, limsup, liminf. Bolzano Weierstrass theorem, Heine –Borel theorem, uniform continuity, uniform convergence.
- Construct certain mathematical proofs and results on Cauchy's Integral theorem, Liouville theorem, Maximum-modulus principle; Taylor's Series, Zeros of analytic functions, Schwarz lemma, Open mapping theorem; Laurent's series.
- Comprehend Normed (linear) spaces; Banach spaces and basic properties. Hilbert Spaces and examples.

Course Assessment:

Teacher Assessment (Based on Quizzes, Assignments etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1.5 Hour
End Semester Exam	35	2 Hours
Total	100	

Syllabi Coverage:

1. Test 1 Syllabi covered up-to T-1.
2. Test 2: (Mid Term) Syllabi covered up to T-2 (including T1 syllabus).
3. End Semester Exam: Entire Syllabus.

Topics covered

Unit I: Metric spaces, Cauchy sequence, Completeness, limsup, liminf, Bolzano Weierstrass theorem, Heine Borel theorem. Continuity and Uniform continuity. Differentiability, Mean value theorem. Sequences and series of functions, Uniform convergence.

Unit II: Analytic functions, Singularities, Contour Integration, Cauchy's Integral theorem, Taylor's Series, Laurent's series, Classification of singularities, Zeros of Analytic functions, Liouville theorem, Maximum-modulus principle; Schwarz lemma, Open mapping theorem.

Unit III: Normed linear spaces, Banach spaces and basic properties, Continuous linear transformations. Hahn-Banach Theorem, Open mapping theorem, closed graph theorem. Inner product spaces, Schwarz's inequality, Hilbert Spaces and examples.

References:

(1) H.L. Royden, P.M. Fitzpatrick: Real Analysis, Fourth Edition, Pearson.
(2) W. Rudin, Principles of Mathematical Analysis, Mc-Graw Hill, 1976.
(3) J.B. Conway, Functions of One Complex Variable, 2nd Edn., Narosa, 1973.
(4) Lars V. Ahlfors, Complex Analysis, Third Edition, McGraw Higher Education.
(5) E. Kreyszig, Introductory functional analysis with Applications, Wiley 1989.
(6) G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill.

Department of Mathematics

Mathematical Foundations for Data Science

COURSE CODE: 22M11MA111

COURSE CREDITS: 3

CORE/ELECTIVE:

L-T-P: 3-0-0

Pre-requisite: Knowledge of mathematical concepts in undergraduate level

Course Objectives:

1. To introduce students to the fundamental mathematical concepts of multivariate calculus and linear algebra required for data analysis & machine learning.
2. To provide an understanding for the Data science students on inferential statistical concepts to include sampling, estimation, parametric & non-parametric hypothesis testing, correlation & multiple regression.
3. To extend and familiarize the students with the concepts of Stochastic models with Bayesian inference.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Demonstrate understanding of concepts of multivariable calculus	Familiarity
CO-2	Understand the use of eigenvalues, eigenvectors in Matrix factorizations and vector space concepts.	Assessment
CO-3	Demonstrate proficiency on computing probabilities of discrete and continuous probability distributions and their modeling applications.	Assessment
CO-4	Develop appropriate optimization models for some applications in Data science	Usage

Course Contents:

Unit	Contents	Lectures required
1	Functions of several variables - Directional Derivative and Gradient vectors - Lagrange Multipliers. Matrix factorizations: Singular value decomposition (SVD); Basics of *vector space;* Projections: hyperplanes; Least-Squares problem.	10
2	Probability distributions of joint random variables; conditional expectation, covariance and correlation; standard univariate and multivariate distributions. Correlation & linear regression, classification by logistic regression; sampling distributions; Point & interval estimation, maximum likelihood estimation; concept of hypothesis testing; confidence intervals; tests of significance for comparing two	18

	population means and variances. Non-parametric tests: Mann-Whitney test, Kolmogorov-Smirnov test (KS test).	
3	Classification of random processes; Markov chains (discrete & continuous); Bayesian inference: Gibbs Sampling and data augmentation, Metropolis-Hastings independence sampling algorithm; Introduction to Optimization; Unconstrained optimization - Gradient Descent, Conjugate Gradient Descent; Constrained optimization - KKT conditions.	**14**
Total Lectures		**42**

Suggested Text Book(s):

1. G. Strang: ``*Introduction to Linear Algebra"*, Wellesley-Cambridge Press, Fifth edition, USA, 2016.
2. Oliver C. Ibe: ``Fundamentals of applied probability and random processes", Academic press, 2005.
3. Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright: `` *Optimization for machine learning"*, Mit Press, 2012.
4. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining: ``Introduction to Linear Regression Analysis", John Wiley and Sons, Inc. NY, 2003.
5. Sheldon M. Ross, Stochastic Processes, Wiley, 1995.
6. W. R. Gilks, S. Richarson and D. Spiegelhalter, ``Markov chain Monte Carlo methods in Practice", Chapman and Hall, 1996.

Suggested Reference Book(s):

1. S. M. Ross: ``Introduction to Probability Models", Academic Press.
2. David G. Luenberger: ``Optimization by Vector Space Methods", John Wiley & Sons (NY), 1969.
3. Cathy O'Neil and Rachel Schutt: ``Doing Data Science", O'Reilly Media, 2013.
4. Larry A. Wasserman, ``All of Statistics: A Concise Course in Statistical Inference", Springer Texts in Statistics Springer, New York, 2004.
5. Samprit Chatterjee and A. S. Hadi, ``Regression Analysis by Example", 4th Ed., John Wiley and Sons, Inc, 2006.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	
Average													

LAB - Mathematical Foundations for Data Science

COURSE CODE : 22M17MA171

COURSE CREDITS: 2

CORE/ELECTIVE :

L-T-P : 0-0-2

Pre-requisite: Mathematical Foundations for Data Science (Theory)

Course Objectives:

1. To introduce students to the fundamental mathematical concepts of multivariate calculus and linear algebra required for data analysis & machine learning.
2. To provide an understanding for the Data science students on inferential statistical concepts to include sampling, estimation, parametric & non-parametric hypothesis testing, correlation & multiple regression.
3. To extend and familiarize the students with the concepts of Stochastic models with Bayesian inference.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the theoretical concepts of calculus of several variables.	Familiarity
CO-2	Understand the concept of matrix factorization and notion of vector space and their applications.	Assessment & Usage
CO-3	Understand random variables and their distributions in modeling random phenomenon	Assessment & Usage
CO-4	Understand and solve min/max problems of constrained optimization.	Assessment & Usage

List of Experiments

S. No.	Description	Hours
1	Find the gradient and Hessian for the given function of several variables. Determine the extrema of an unbounded f(x, y). Are the point(s) you have found maxima, minima, or saddle points?	2
2	Compute calculations of singular-value decomposition.	2
3	Generate two vectors x and y of n independent N(0,1) random variables. Illustrate their joint probability distribution through graph: y versus x	2
4	Generate a NxK matrix X, with K = 256 realizations of the stochastic process x[n], n = 1, 2, . . . , N. For a given value of N, and let each x[n] be N(0,1). Plot the ensemble average.	2
5	Write a program to demonstrate *Binomial* for the given parameters.	2
6	Generate n random variables from N(0,1) and U(0,1) distributions respectively. Plot the histograms.	2
7	Calculate regression coefficients and the equation of regression line for the given data.	
8	Simulate the *distribution of the mean* for specified distribution – normal; obtain the parameters; Display histogram.	2
9	From the frequency distribution table for a given date, write a program to calculate mean and standard deviation.	2
10	Hypothesis testing for two population means for the given data.	2
11	Non-parametric test: Kolmogorov-Smirnov normality test.	2
12	Implement the conjugate gradient descent algorithm for the given problem.	2
13	Obtain a Bayesian estimate of the mean and variance of the given data and compare it to the MLE.	
14	Write a code to solve the given constrained optimization problem with inequality Constraints.	2
Total Lab hours		**28**

Suggested Resources:

9. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, ``Mathematics for Machine Learning,'' Cambridge University Press, 2019.
10. Steven J. Leon and Lisette de Pillis, ``Linear Algebra with Applications,'' Pearson, 10th ed, 2019.
11. Gene H. Golub and Charles F. Van Loan, Matrix Computations, The Johns Hopkins University Press, Baltimore, 4th Ed., 2013.
12. Andreas Antoniou, Wu-Sheng Lu, ``Practical Optimization: Algorithms and Engineering Applications,'' Springer US, 2021.
13. S. L. Miller and D. G. Childers, Probability and Random Processes With Applications to Signal Processing and Communications. Elsevier Academic Press, Burlington, MA, 2004.

14. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining: ``Introduction to Linear Regression Analysis", John Wiley and Sons, Inc. NY, 2003.
15. W. R. Gilks, S. Richarson and D. Spiegelhalter, ``Markov chain Monte Carlo methods in Practice", Chapman and Hall, 1996.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Average	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Applied Soft Computing Techniques

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Course Objectives: On successful completion of this course a student will be able

6. To describe various types of soft computing techniques, and applications of soft computing.
7. To describe the fuzzy sets and fuzzy logic
8. To describe the fuzzy controller and fuzzy rule base and approximate reasoning.
9. To describe the evolutionary computing.
10. To understand the concepts of genetic algorithm.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic tools of soft computing.	Familiarity
CO-2	Understand the fuzzy sets and crisp sets, fuzzy set theory and operations.	Assessment
CO-3	Understand the fuzzy controller and fuzzy rule base and approximate reasoning.	Assessment
CO-4	Understand the basic evolutionary processes.	Familiarity
CO-5	Understand the working principle and procedures of genetic algorithm.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Introduction, soft computing vs. hard computing, various types of soft computing techniques, and applications of soft computing. Basic tools of soft computing - Fuzzy logic, neural network, evolutionary computing. Introduction: Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.	08
2	**Fuzzy Sets and Logic:** Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications and Defuzzifications.	08
3	**Fuzzy Systems:** Fuzzy Controller, Fuzzy rule base and	10

	approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules, decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems.	
4	**Evolutionary Computing:** Basic Evolutionary Processes: A Simple Evolutionary System, Evolutionary Systems as Problem Solvers, A Historical Perspective, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple EAs- A Common Framework, Population Size.	**06**
5	**Swarm Intelligence:** Swarm intelligence, Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO.	**10**
Total Lectures		**42**

Suggested Text Book(s):

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, International Editions, Electrical Engineering Series, Singapore, 1997.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.

Suggested Reference Book(s):

1. Stamatios V. Kartalopoulos "Understanding Neural Networks and Fuzzy Logic Basic concepts & Applications", IEEE Press, PHI, New Delhi, 2004
2. Vojislav Kecman, "Learning & Soft Computing Support Vector Machines, Neural Networks, and Fuzzy Logic Models", Pearson Education, New Delhi,2006.
3. S. Rajasekaran & GA Vijayalakshmi Pai "Neural Networks, Fuzzy Logic, and Genetic Algorithms synthesis and application", PH

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5