

KLU CENTRE FOR DISTANCE & ONLINE EDUCATION

M.Sc. APPLIED MATHEMATICS

ONLINE PROGRAMME STRUCTURE

JANUARY 2021 BATCH

Semester-1									
Sl#	Year	Semester	Course Code	Course Title	L	T	P/S	Cr	CH
1	1	1	20AM1101O	Real Analysis	5	0	0	5	5
2	1	1	20AM1102O	Ordinary Differential Equations	4	0	0	4	4
3	1	1	20AM1103O	Numerical Methods	4	0	0	4	4
4	1	1	20AM1104O	Computer Programming	3	0	2	4	5
5	1	1	20AM1105O	Mathematical Statistics	4	0	0	4	4
Total					20	0	2	21	22

Semester-2									
Sl#	Year	Semester	Course Code	Course Title	L	T	P/S	Cr	CH
1	1	2	20AM2101O	Statistics with R Programming	3	0	2	4	5
2	1	2	20AM1202O	Mathematical Modeling	4	0	0	4	4
3	1	2	20AM1203O	Statistical Inference	4	0	0	4	4
4	1	2	20AM1204O	Discrete Mathematics	4	0	0	4	4
5	1	2	20AM1205O	Complex Analysis	4	0	0	4	4
Total					19	0	2	20	21

Semester-3									
Sl#	Year	Semester	Course Code	Course Title	L	T	P/S	Cr	CH
1	2	3	20AM2101O	Partial Differential Equations	4	0	0	4	4
2	2	3	20AM2102O	Data visualization tools and Techniques	3	0	2	4	5
3	2	3	20AM2103O	Abstract Algebra	4	0	0	4	4
4	2	3	20AM2104O	Transform Techniques	3	0	2	4	5
5	2	3	20AM2105O	Applied statistics.	4	0	0	4	4
Total					18	0	4	20	22

Semester-4									
Sl#	Year	Semester	Course Code	Course Title	L	T	P/S	Cr	CH
1	2	4	20AM2201O	Topology	4	0	0	4	4
2	2	4	20AM2202O	Operational Research	3	0	0	3	3
2	2	4	20AM2203O	Mathematical tools for Big Data Analytics	3	0	0	3	3
3	2	4	20AM2204O	Cloud Computing	4	0	0	4	4
5	2	4	20AM2205O	Project	0	15	0	15	15
Total					14	15	0	29	29

Total- 90 Credits

SYLLABUS

I Semester

SN	Course Code	Course title	Credits	L-T-P-S	CH
01	20AM11010	Real Analysis	5	5-0-0-0	5

COURSE OUTCOMES

CO. No.	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Describe the fundamental properties of the real numbers that lead to the formal development of real analysis.	PO2, PO5, PO6,PO7	3
CO2	Demonstrate an perceptive of limits and how they are used in sequences, series, differentiation and integration	PO2, PO5, PO6,PO7	3
CO3	Describe and apply the important properties of the limit and continuity and the differentiation and integration of the sequences and series of functions.Explain the basic properties of the Riemann integration	PO2, PO5, PO6,PO7	3
CO4	Determine the Riemann integrability of a bounded or unbounded function and prove a selection of theorems concerning integrations.	PO2, PO5, PO6,PO7	3

SYLLABUS

CO 1: Real number system, ordering, bounded sets, order completeness axiom, mathematical induction, well ordering principle; Archimedian property, Dedekind's theorem, complete ordered field, limit point of a set, Bolzano- Weierstrass theorem, open and closed sets, compact sets and Heine-Borel theorem.

CO 2: Sequences, Cauchy's first and second limit theorems, Cauchy sequences, Cauchy criterion for convergent sequences, bounded and monotonic sequences, Euler's constant, subsequences, limit superior and limit inferior. Series of real valued functions and their Tests for convergence. Limit and continuity, uniform continuity, monotonic functions, functions of bounded variation, absolutely continuous functions,

CO 3: Taylor's theorem (finite form), Lagrange's form of remainder.

Sequences and series of real valued functions, their point-wise, absolute and uniform convergence, Cauchy's general principle of uniform convergence, continuity of the limit (sum) function, differentiation and integration of the sequences and series of functions, Weierstrass approximation theorem. Riemann integration, Darboux's theorem, necessary and sufficient conditions for integrability.

CO 4: Functions defined by integrals, fundamental theorem of calculus, first and second mean value theorems of integral calculus. Improper Integrals: Introduction, Integration of unbounded functions with finite limit of Integration, comparison tests for Integral as a product of functions.

SUGGESTED BOOKS:

1. Royden. H.L. and Fitzpatrick. P.M., Real Analysis, Prentice Hall India Pvt. Ltd.
2. Apostol, T. M., Mathematical Analysis, Narosa Publishing House.
3. Lang. S., Real and Functional Analysis, Springer - Verlag.
4. Rudin. W., Principles of Mathematical Analysis, McGraw-Hill Book Company.
5. Goldberg, R.R., Methods of Real Analysis, Oxford and IBH Publishing company Pvt. Ltd.

SN	Course Code	Course Title	Credits	L-T-P-S	CH
02	20AM11020	Ordinary Differential Equations	4	4-0-0-0	4

COURSE OUTCOMES

Co.	Course Outcome's	PO	BTL
CO 1	Apply the existence and uniqueness conditions of solution of the homogeneous/non-homogeneous differential equation and the system of differential equations.	PO2, PO3, PS01	3
CO 2	Apply the power series method of solution to second order ODE arising in mathematical physics- Gauss hyper geometric, Hermit and Chebyshev polynomials.	PO1, PO2 PS04	3
CO 3	Apply Green's function method to study behavior of the Boundary Value Problems (BVP) for second order ODE.	PO2 PS01	3
CO 4	Determine the oscillatory solutions of BVP and illustrate their qualitative properties.	PO2, PS04	3
CO 5	Verify the solution of the ODE through MATLAB.	PSO3	3

SYLLABUS

CO 1:Existence, uniqueness and continuation of solutions of a differential equation and system of differential equations; Applications. Differential and integral inequalities. Fixed point methods.

CO 2:Linear systems, properties of homogeneous and non- homogeneous systems, behaviour of solutions of n^{th} order linear homogeneous equations.

CO 3:Review of power series, Power series solution of second order homogeneous equations, ordinary points, regular singular points, solution of Gauss hypergeometric equations, Hermite and Chebyshev polynomials.

CO 4:Boundary value problems for second order differential equations, Green's function and its applications. Eigen value problems, self adjoint form, Sturm -Liouville problem and its applications. Oscillation Theory and boundary value problems: Qualitative properties of solutions -The Sturm comparison theorem-Eigen values, Eigen functions and the vibrating string.

SUGGESTED BOOKS:

1. Braun, M. "Differential Equations and Their Applications", 4th Ed., Springer
2. Brauer, F. and Nohel, J.A., "The Qualitative Theory of Ordinary Differential Equations", Dover Publications
3. Coddington E.A., "Ordinary Differential Equations", Tata McGraw Hill
4. Simmons G.F., "Ordinary Differential Equations with Applications".

SN	Course Code	Course title	Credits	L-T-P-S	CH
03	20AM11030	Numerical Methods	4	4-0-0-0	4

COURSE OUTCOMES

Co. No.	Course Outcome's	PO	BTL
CO 1	Identify the difference between solutions of system linear and roots of non-linear equations by direct, bisection methods.	PO2, PO3, PS01	3
CO 2	Construct the interpolation forward and backward tables and find the Eigen values and vectors by using mat lab also.	PO1, PO2, PS04	3
CO 3	Apply Numerical differentiation and integration problems for different methods and find the values and compare the values by using mat lab also.	PO2, PS01	3
CO 4	Construct numerical solutions of first and second order ordinary differential equations and compare the numerical values with mat lab also.	PO2, PS04	3
CO 5	Verify the solution of the N.M. through MATLAB.	PS03	3

SYLLABUS

Solution of system of linear equations: (i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU-decomposition method. (ii) Iterative methods: Jacobi and Gauss-Seidel methods. Roots of non-linear equations: Bisection method, Regula-Falsi method, Newton-Raphson method, direct iterative method with convergence criteria, Newton-Raphson method for solution of a pair of non-linear equations. Eigen values and Eigen vectors: Dominant and smallest Eigen values/Eigen vectors by power method. Interpolation: Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation. Numerical differentiation: First and second order derivatives by various interpolation formulae. Numerical integration: Trapezoidal, Simpsons $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rules with errors and their combinations, Gauss Legendre 2-points and 3-points formulae. Numerical solution of first and second order ordinary differential equations: Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods, Predictor-Corrector, Method's- Milne's method.

SUGGESTED BOOKS:

1. Gerald, C. F. and Wheatly, P. O., "Applied Numerical Analysis", 6th Ed., Wesley.
2. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.
3. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw- Hill Publisher
4. Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication.

SN	Course Code	Course title	Credits	L-T-P-S	CH
04	20AM11040	Computer Programming	4	3-0-2-0	5

COURSE OUTCOMES

Co. No.	Course Outcome's	PO	BTL
CO 1	Introduction to basic computer organization and computer fundamentals. Introduction to Programming language fundamentals. Illustrate and use Control Flow Statements in C++.	PO1, PSO2	1
CO 2	Introduction to functions in C++ and Decomposition of programs through function.	PO1, PSO2	2
CO 3	Interpret & Illustrate user defined C++ functions and different operations on list of data.	PO1, PSO2,3	3
CO 4	Illustrate Object Oriented Concepts and implement linear data structures	PO1, PSO2	3
CO 5	Develop the code for the algorithms in C++	PO8, PSO3	

SYLLABUS

CO 1: Basic Computer Fundamentals: Introduction to computer systems; number system, integer, signed integer, fixed and floating point representations; IEEE standards, integer and floating point arithmetic; CPU organization, ALU, registers, memory, the idea of program execution at micro level.

CO 2: Basic Programming in C++: Input/output; Constants, variables, expressions and operators; Naming conventions and styles; Conditions and selection statements; Looping and control structures (while, for, do-while, break and continue); Arrays; File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking.

CO 3: Programming through functional decomposition: Design of functions, void and value returning functions, parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference, recursive functions; Function overloading and default arguments; Library functions.

CO 4: Object Oriented Programming Concepts: Data hiding, abstract data types, classes, access control; Class implementation-default constructor, constructors, copy constructor, destructor, operator overloading, friend functions; Introduction to data structures, use of pointers in linked structures. **Pointers:** Pointers; Dynamic data and pointers, dynamic arrays. Object oriented design (an alternative to functional decomposition) inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.

SUGGESTED BOOKS:

- 1.H.M. Deitel and P.J. Deitel. C++ How to Program. 8thEd.,Prentice Hall.
- 2.Eckel. Thinking in C++ Volume 1 & 2. 2ndEd., Prentice Hall
- 3.I. Koren. Computer Arithmetic Algorithms. 2ndEd., A.K. Peters
- 4.S.B. Lippman, J. Lajoie, and B.E. Moo. The C++ Primer.Addison-5thEd., Wesley Professional.
- 5.S. Prata. C++ Primer Plus. 5thEd.,Sams.
- 6.W. Stallings. Computer Organisation and Architecture Designing for Performance. 7thEd.,Prentice-Hall.
7. Stroustrup. The C++ Programming Language. Addison-3rd
- 8.R. Lafore. Object-Oriented Programming in C++.4thEd., Sams

SN	Course Code	Course title	Credits	L-T-P-S	CH
05	20AM11050	Mathematical Statistics	4	4-0-0-0	4

COURSE OUTCOMES

Co. No.	Course Outcome's	PO	BTL
CO 1	Explain the concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments, and calculate expected values and probabilities associated with the	PO3,PS02	3
CO 2	Explain the concepts of independence, jointly distributed random variables and conditional distributions, and use generating functions to establish the distribution of linear combinations of independent	PO2,PS01	3
CO 3	Explain the concepts of random sampling, statistical inference and sampling distribution, and state and use basic sampling distributions. State the central limit theorem, and apply it.	PO1,PS02	3
CO 4	Construct the sampling distribution of mean and variance and calculation of mean and variance of sampling distribution of mean and variance.	PO3,PS02	3

SYLLABUS

Concept of probability, axioms of Probability, Conditional Probability, Addition, Multiplication and Baye's Theorem, random variable and distribution function: discrete and continuous distributions, moments and moment generating functions. Some discrete distributions : Binomial, Poisson, Geometric, Hypergeometric. Some continuous distributions: Uniform, Exponential, Gamma, Normal. Bivariate random variables: joint, marginal, conditional distribution, Statistical independence, product moment, correlation, regression, transformation of random variables, distribution of distribution function. Law of large numbers, central limit theorem. Simple random sampling with replacement and without replacement, mean and variance of sample mean and variance, parameter and statistics, order statistics and distribution of order statistics, fundamental sampling distribution from normal population viz. χ^2 , t, f and Z (central)

SUGGESTED BOOKS:

1. Bhatt B.R., "Modern Probability Theory", New Age International Ltd, 3rd Ed.
2. Miller, I. and Miller, M., "Freund's Mathematical Statistics with Applications", Prentice Hall PTR, 7th Ed
3. Hogg, R. V. and Craig, A., "Introduction to Mathematical Statistics", Pearson Education, 6th Ed
4. Rohatgi, V. K. and Md. Ehsanes Saleh, A. K., "An Introduction to Probability and Statistics", John Wiley and Sons, 2nd edition.
5. Papoulis, A., Pillai, S.U., Probability, "Random Variables and Stochastic Processes", Tata McGraw-Hill, 4th Ed.

II Semester

SN	Course Code	Course title	Credits	L-T-P-S	CH
01	20AM21010	Statistics with R Programming	4	3-0-2-0	4

CO No:	Course Outcomes	PO's/PSO's	BTL
CO 1	To understand the basic concepts of statistics and explains the various collection and analysis	PO2,PO3, PS01	3
CO 2	Identify the different measures of central tendency and measure of dispersion to apply the real world problems.	PO1,PO2	3
CO 3	Predict the relationship between two variables and construct the linear and non-linear regression lines for the given data	PO2, PS01	3
CO 4		PO2,PS04	3
CO5	Verify the solution of the problems through R	PO3,PS02	2

SYLLABUS

Basic Statistics with R: Importance of Statistics-Primary and secondary data-Data collection methods Presentation of numerical and categorical data.Classification and Tabulation of Data, Diagrammatic Presentation of Data,Graphical Presentation of Data-Graphical Presentation of Data-

Introduction to R, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes.

Descriptive statistics:Analysis of Quantitative Data,

Measures of central tendency:Mean, Median, Mode, Geometric mean and Harmonic mean. Absolute and relative measures of dispersion: Range, quartile deviation, mean deviation and Standard deviation.

Moments:Central and Non-central (Raw) moments, Importance of moments and their inter-relationships. Sheppard's corrections for moments for grouped data.

Measures of Skewness:Karl Pearson, Bowley's formula (based on quartiles), Moments and Kurtosis based on moment Simple problems and Applications.

Correlation of Bivariate Data, Fitting of Curves, Correlation Coefficient, Rank Correlation, Intra-Class Correlation,Regression and Multiple Correlations, Linear Regression, Plane of Regression, Multiple Correlation, Partial Correlation.

SUGGESTED BOOKS:

- 1.Applied Statistics and Probability for Engineers, 6ed, Douglas C. Montgomery George.
- 2.Fundamental of Statistics,S.C.Gupta, Himalaya Publishing House.
- 3.Mathematical Statistics with Applications,K.M.Ramachandran and Chris P.Tsokos Academic Press (Elsevier), Haryana.
- 4.The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition (Springer Series in Statistics,by Trevor Hastie and Robert Tibshirani).

SN	Course Code	Course title	Credits	L-T-P-S	CH
02	20AM12020	Mathematical Modeling	4	4-0-0-0	4

COURSE OUT COMES

CO No:	Course out come	PO/PSO	BTL
1	Understand the Merits and Demerits of Mathematical Modeling.	PO1, PO2, PSO1	3
2	Solve linear, Non-linear Difference equations.	PO1, PSO1	3
3	Identify various mathematical models and solve them.	PO1, PSO1	3
4	Solve the wave equation, Vibrating string, Traffic flow problems	PO1, PSO1	3

SYLLABUS

Mathematical Modeling, History of Mathematical Modeling, latest development in Mathematical Modeling, Merits and Demerits of Mathematical Modeling.

Introduction to difference equations, Non-linear Difference equations, Steady state solution and linear stability analysis. Introduction to Discrete Models, Linear Models, Growth models, Decay models, Newton's Law of Cooling, Bank Account Problem and mortgage problem, Drug Delivery Problem, Harrod Model of Economic growth, War Model, Lake pollution model, Alcohol in the bloodstream model, Arm Race models, Linear Prey-Predator models, Density dependent growth models with harvesting,

Introduction to Continuous Models, Carbon Dating, Drug Distribution in the Body, Growth and decay of current in a L-R Circuit, Horizontal Oscillations, Vertical Oscillations, Damped Force Oscillation, Dynamics of Rowing, Combat Models, Mathematical Model of Influenza Infection (within host), Epidemic Models (SI, SIR, SIRS, SIC), Spreading of rumour model, Steady State solutions, Linearization and Local Stability Analysis, logistic and gomperzian growth, prey-predator model, Competition models.

Fluid flow through a porous medium, heat flow through a small thin rod (one dimensional), Wave equation, Vibrating string, Traffic flow, Theory of Car-following, Crime Model, Linear stability Analysis: one and two species models with diffusion, Conditions for diffusive instability with examples.

SUGGESTED BOOKS:

1. Albright, B., "Mathematical Modeling with Excel", Jones and Bartlett Publishers.
2. Marotto, F. R., "Introduction to Mathematical Modeling using Discret Dynamical Systems", Thomson Brooks/Cole.
3. Kapur, J. N., "Mathematical Modeling", New Age International
4. Barnes, B. and Fulford, G. R., "Mathematical Modelling with Case Studies", CRC Press, Taylor and Francis Group.
5. Edsberg, L., "Introduction to Computation and Modeling for Differential Equations", John Wiley and Sons.

SN	Course Code	Course title	Credits	L-T-P-S	CH
03	20AM12030	Statistical Inference	4	4-0-0-0	4

SYLLABUS

Theory of Estimation: Basic concepts of estimation, Point estimation, , methods of estimation; method of moments, method of maximum likelihood; Unbiasedness, Minimum variance estimation, Cramer - Rao bound and its generalization, Rao Blackwell theorem, Existence of UMVUE estimators. Interval Estimation, Someresults for normal population case. Principle of Data Reduction: Sufficiency principle, Factorization criterion, minimal sufficiency, Completeness and bounded completeness, Likelihood principle, Equivariance principle.

Testing of Hypothesis: Null and alternative hypothesis, Type I and II errors error probability and power function, Method of finding tests, Neyman - Pearson lemma, Uniformly most powerful tests, Likelihood ratio principle, Likelihood ratio test, Sequential probability ratio test, Some results based on normal population. Analysis of Variance: one way classification; simple linear regression analysis with normal distribution.

SUGGESTED BOOKS:

1. Miller, I. and Miller, M., "Freund's Mathematical Statistics with Applications", 7th Ed., Prentice Hall PTR.
2. Lehman, E.L., "Testing of Statistical Hypothesis", Wiley Eastern Ltd
3. G. Casella, R. L. Berger, "Statistical Inference", Duxbury Press
4. Lehman, E.L., "Point Estimation", John Wiley & sons
5. Rohatgi, V.K., "Statistical Inference", Dover Publications

SN	Course Code	Course title	Credits	L-T-P-S	CH
04	20AM12040	Discrete Mathematics	4	4-0-0-0	4

Syllabus

Proposition, predicate logic, logic connectives, methods of proofs. Mathematical induction. Relation and Function: Definitions and properties, pigeonhole principle, extended pigeonhole principle, equivalence relations and equivalence classes. representation of relations by binary matrices and digraphs; operations on relations. closure, Warshall's algorithm, discrete numeric functions, growth of functions, big O, big

hash function. Partial Order

Partially ordered sets, lattices, isomorphism of lattices - Boolean algebra and Boolean functions, different representations of Boolean functions, application of Boolean functions to synthesis of circuits, circuit minimization and simplification, Karnaugh map.

Recurrence Relation: Linear recurrence relations with constant coefficients, homogeneous and non-homogeneous relations, discussion of several special cases to obtain particular solutions.

Generating functions, solution of linear recurrence relations using generating functions. Some recursive algorithms.

Definition of Graphs, Finite & infinite graphs, Incidence & degree, Walks, paths and circuits, trees, their properties and fundamental circuits, cut-sets and cut-vertices, Euler, Hamiltonian path & circuit,

planar graphs, colouring theorems, isomorphism of graphs.

Suggested Books:

1. Kenneth, H. R., Discrete Mathematics and its Applications, 7th Ed., Tata McGraw Hill, 2012

2. Liu, C. L., Elements of Discrete Mathematics, Tata McGraw Hill, 2007

3. Johnsonbaugh, R., Discrete Mathematics, 6th Ed., Maxwell Macmillan International, 2006.

4. Mott, J.L., Kandel, A. and Baker, T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall India Pvt Ltd, 2001

5. Kolman, B., Busby, R. and Ross, S.C., Discrete Mathematical Structure, 6th Ed., Pearson, 2008

SN	Course Code	Course title	Credits	L-T-P-S	CH
05	20AM12050	Complex Analysis	4	4-0-0-0	4

SYLLABUS

Analytic Functions: Functions of a complex variable. Limits, continuity, uniform continuity, differentiability and analyticity of functions, C-R equations, necessary and sufficient conditions, applications to the problems of potential flow, Harmonic functions, Harmonic conjugates, Milne's method. Sequences, Series, Uniform convergence, power series.

Complex integration: Rectifiable arcs, contours, complex line integration, Cauchy's theorem for simply and multiply connected domains, Cauchy's integral formula for the derivatives of an analytic function, Winding Numbers, Cauchy's estimate, Morera's theorem, Liouville's theorem, Fundamental theorem of Algebra. Maximum modulus principle, Schwarz Lemma, Taylor series, Laurent series, Zeros and poles of a function, Meromorphic function.

Residue Calculus: The residue at a singularity, Residue theorem, the argument principle, Rouché's theorem, contour integration and its applications to improper integrals, evaluation of a real integrals, improper integrals involving sines and cosines, definite integrals involving sines and cosines, integration through branch cut.

Conformal Mapping: Definition of Conformal and Bilinear transformations, Cross ratio, the mappings from disc to disc, disc to half plane and half plane to half plane. Mapping of elementary transformations. Space of continuous functions, the space of analytic functions, the space of meromorphic functions, Riemann-mapping theorem.

Applications: Applications of conformal mapping to steady temperature, electrostatic potential, two-dimensional fluid flow, stream function.

SUGGESTED BOOKS:

1. Churchill, J. W. and Brown, R. V., "Complex Analysis", Mcgraw- Hill.
2. Gamelin, T. W., "Complex Analysis", Springer-Verlag
3. Greene R., and Krantz, S. G., "Function Theory of One Complex Variable", 3rd Ed., GSM, Vol. 40, American Mathematical Society.
4. Kreyszig, E., "Advanced Engineering Mathematics", Wiley, New York
5. Lang, S., "Complex Analysis", Springer -Verlag.
6. Mathews, J. H. and Howell, R. W., "Complex Analysis for Mathematics and Engineering", Narosa

III Semester

SN	Course Code	Course title	Credits	L-T-P-S	CH
01	20AM21010	Partial Differential Equations	4	4-0-0-0	4

SYLLABUS

Modelling with partial differential equations, Partial differential equations of first order, Cauchy problem, Linear first order P.D.E., Method of characteristics, Lagrange, Charpit's and Jacobi's method. Partial differential equation of second order, Classification of second order equation, Hyperbolic, Parabolic and Elliptic equations, Linear second order partial differential equations with constant coefficients

Elliptic Equations: Laplace equation in Cartesian, polar, spherical and cylindrical coordinates and its solution by Fourier series method, Poisson equation in 2D.

Hyperbolic differential equations, One dimensional wave equation, Solution of the wave equation by separation of variables, d'Alembert's solution, Boundary and initial value problem of two dimensional wave equation.

Parabolic differential equations, One dimensional diffusion equation, Boundary conditions; Dirichlet, Neumann and Robin type boundary conditions, Method of separation of variables, Solutions in cylindrical and spherical equation, The maximum principle for the heat equation.

SUGGESTED BOOKS:

- 1.Zachmanoglou, E.C., Thoe, D.W., "Introduction to Partial Differential Equations with Applications", Dover Publications.
- 2.Sneddon, I. N., "Elements of Partial Differential Equations", McGraw-Hill Book Company.
- 3.Amarnath, T., "An Elementary Course in Partial Differential Equations", 2ndEd., Narosa Publishing House.
- 4.Rao, K. S., "Introduction to Partial Differential Equations", 2ndEd., PHI Learning Pvt. Ltd.
- 5.Lawrence C. Evans, "Partial Differential Equations", Mathematical Society

SN	Course Code	Course title	Credits	L-T-P-S	CH
02	20AM21020	Data visualization tools and Techniques	4	3-0-2-0	5

SYLLABUS

Importance of analytics and visualization in the era of data abundance. Review of probability, statistics and random processes. Brief introduction to estimation theory. Introduction to machine learning, supervised and unsupervised learning, gradient descent, over fitting, regularization.

Clustering techniques: K-means, Gaussian mixture models and expectation-maximization, agglomerative clustering, evaluation of clustering - Rand index, mutual information based scores, Fowlkes-Mallows index

Regression: Linear models, ordinary least squares, ridge regression, LASSO, Gaussian Processes regression.

Supervised classification methods: K-nearest neighbour, naive Bayes, logistic regression, decision tree, support vector machine. Introduction to artificial neural networks (ANNs), deep NNs, convolution neural network(CNN).

Data visualization: Basic principles, categorical and continuous variables. Exploratory graphical analysis - Creating static graphs, animated visualizations - loops, GIFs and Videos. Data visualization in Python and R- examples.

TEXTBOOK:

- 1.Hastie, T., Tibshirani, R.Friedman, J. (2009). The elements of statistical learning: data mining, inference and prediction. Springer.
- 2.Richard O. Duda, Peter E. Hart, and David G. Stork. 2000. Pattern Classification (2nd Edition). Wiley- Interscience, New York, NY, USA.
- 3.Christopher M. Bishop. 2006. Pattern Recognition and Machine Learning (Information Science and Statistics). Springer-Verlag, Berlin, Heidelberg.

SN	Course Code	Course title	Credits	L-T-P-S	CH
03	20AM21030	Abstract Algebra	4	4-0-0-0	4

SYLLABUS

Group theory: Definition and some examples of groups, some preliminary lemmas, subgroups. Homeomorphisms, auto orphisms, Canley's theorem, permutation groups, Solow's theorems.

Ring theory: Definition and examples of Rings, some special classes of Rings, homomorphisms Ideal and Quotient rings. Maximal Ideal, Integral domain, Principal Ideal domain(PID), unique factorization.

Vector Spaces, Sub Spaces, Dimension, Basis, Inner Product Space, Schewarz inequality, Grahm-Smith Orthogonalization process, Modules, Modules over PID, Modules with chain conditions. Definition of field and some examples, the field of Quotients of an Integral domain, Euclidean rings, polynomial rings.

SUGGESTED BOOKS:

1. Herstein, I. N., "Topics in Algebra", 2nd Ed., John Wiley & Sons, 2004
2. Fraleigh, J. B., "A First Course in Abstract Algebra", 7th Ed., Pearson, 2003
3. Dummit, D. S. and Foote, R. M., "Abstract Algebra", 3rd Ed., John Wiley & Sons, 2004
4. Artin M., "Algebra", 2nd Ed., Prentice Hall India, 2011
5. Gallian J. A., "Contemporary Abstract Algebra", 8th Ed., CengageLearning, 2013

SN	Course Code	Course title	Credits	L-T-P-S	CH
04	20AM21040	Transform Techniques	4	3-0-2-0	5

SYLLABUS

Laplace Transform: Laplace of some standard functions, Existence conditions for the Laplace Transform, Shifting theorems, Laplace transform of derivatives and integrals, Inverse Laplace transform and their properties, Convolution theorem, Initial and final value theorem, Laplace transform of periodic functions, Heaviside unit step function and Dirac delta function, Applications of Laplace transform to solve ODEs.

Finite Laplace Transform: Definition and properties, Shifting and scaling theorem.

Z-Transform: Z-transform and inverse Z-transform of elementary functions, Shifting theorems, Convolution theorem, Initial and final value theorem, Application of Z-transforms to solve difference equations.

Mellin Transform: Definition and properties of Mellin transform, Shifting and scaling properties, Mellin transforms of derivatives and integrals, Applications of Mellin transform.

Fourier series: Trigonometric Fourier series and its convergence. Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval's identity, Complex form of Fourier series. Solving ODE using Fourier series.

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, Application of Fourier transforms to Boundary Value Problems.

SUGGESTED BOOKS:

1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons, 2011
2. Jain, R. K. and Iyenger, S. R. K., "Advanced Engineering Mathematics", Narosa Publishing House, 2009
3. Hildebrand F. B., "Methods of Applied Mathematics", Courier Dover Publications, 1992.
4. Debanth L. and Bhatta D., "Integral Transforms and Their Applications", 2nd Ed., Taylor and Francis Group, 2007

SN	Course Code	Course title	Credits	L-T-P-S	CH
05	20AM21050	Applied statistics	4	4-0-0-0	4

COURSE OUTCOMES:

CO	Course out come	PO	BTL
1	Apply discrete and continuous random variables to analyze various numerical problems based on a real-world situation.	1	3
2	Apply statistical tests for large and small samples to test the hypothesis	1	3
3	Analyze the variance by using completely randomized, randomized, Latin square designs and also apply queuing models	1	3
4	Construct control charts for variables and attributes to the real world problems	1	3

SYLLABUS:

Review Of Probability Distribution And Statistical Inference Regression, Linear, Multiple, Curvilinear, Nonparametric Tests, Sign, Signed Rank, Randomness And Other Parametric Tests. Design Of Experiments, Single Factor, Randomized Block, Latin Square. Statistical Quality Control, Control for Charts for Measurements and for Attributes. Tolerance Limits, Acceptance Sampling. Reliability and Life Testing.

TEXTBOOKS:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, "Probability and Statistics for Engineers and Scientists", Pearson publishers, Ninth Edition
2. Miller and Freund's, "Probability and Statistics for Engineers", Prentice Hall of India, Eighth Edition

REFERENCE BOOKS:

1. D. C. Montgomery, G. C. Runger, Applied Statistics and Probability for Engineers, Third Edition, John Wiley and Sons, 2007
2. Walpole, R.E., Myer, R.H., Myer, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, 7th edition, Pearson Education, Delhi, 2.

WEB REFERENCES/MOOCs:

1. <https://nptel.ac.in/courses/117103067/3>
2. <https://www.khanacademy.org/math/ap-statistics/random-variables-ap/discrete-random-variables/v/discrete-probability-distribution>
3. <https://nptel.ac.in/courses/105105150/24>
4. <https://www.khanacademy.org/math/statistics-probability/describing-relationships-quantitative-data/regression-library/v/introduction-to-residuals-and-least-squares-regression>
5. <https://nptel.ac.in/courses/103106120/>
6. <https://www.khanacademy.org/math/statistics-probability/significance-tests-one-sample/more-significance-testing-videos/v/small-sample-hypothesis-test>

IV SEMESTER

SN	Course Code	Course title	Credits	L-T-P-S	CH
01	20AM22010	Topology	4	4-0-0-0	4

SYLLABUS

Introduction: Finite, countable, uncountable sets, functions, relations, Axiom of choice, Zorn's Lemma

Topological Spaces and Continuous functions: Open sets, closed sets, basis for a topology, Sub basis, T_1 and T_2 Spaces, Order topology, product topology, subspace topology, limit point, continuous function, general product topology, metric space and its Topology, quotient topology

Connectedness and Compactness: Connected spaces, connected subspaces, Local connectedness, compact subspace, limit point compactness, Local compactness

Countability and Separation axiom: Countability axioms, separation axioms. Regular and Normal Spaces, Urysohn's Lemma, Urysohn metrization Theorem, Tietze Extension Theorem, Tychonoff Theorem

SUGGESTED BOOKS:

1. Munkres, J.R., "Topology", 2nd Ed., PHI, 2010
2. Mansfield, M.J., "Introduction to Topology", East-West student Edition, 1973
3. Simmons, G.F., "Introduction to Topology & Modern Analysis", Krieger Publishing Company, 2003
4. Mendelson, B., "Introduction to Topology," 3rd Ed., Dover Publications, 1988
5. Gamelin, T.W. and Greene, R.E., "Introduction to Topology", 2nd Ed., Dover Publications, 1999
6. Min, Y., "Introduction to Topology: Theory & Applications", Higher Education Press, 2010

SN	Course Code	Course title	Credits	L-T-P-S	CH
02	20AM22020	Operational Research	3	3-0-0-0	3

SYLLABUS

Introduction to linear programming: Convex Sets, Graphical Method, Simplex Method, Big - Method, Two Phase Method, Revised Simplex Method

Duality Theory, Dual Simplex Method, Sensitivity Analysis, Parametric Linear Programming

Transportation Problems and Assignment Problems

Non-linear optimization: Unconstrained and constrained optimization of several variables, Lagranges multipliers, Khun-Tucker theory, numerical methods for optimization.

SUGGESTEDBOOKS:

1. Taha, H.A., "Operations Research: An Introduction", MacMillan PubCo., NY, 9th Ed. (Reprint).2013
2. Mohan, C. and Deep, K., "Optimization Techniques", New Age IndiaPvt. Ltd, New Delhi.2009
3. Mittal, K.V. and Mohan, C., "Optimization Methods in System Analysis and Operations Research", New Age India Pvt. Ltd, New Delhi.1996
4. Ravindran, A., Phillips, D.T. and Solberg, J.J., "Operations Research:Principles and Practice", John Wiley and Sons, NY, 2nd Ed. (Reprint).2012
5. Pant, J.C., "Introduction to Optimization/Operations Research", JainBrothers, New Delhi, 2nd Ed.2012

SN	Course Code	Course title	Credits	L-T-P-S	CH
03	20AM22030	Mathematical tools for Big Data Analytics	3	3-0-0-0	3

SYLLABUS

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Findings, Operationalizing. Initial Analysis of the Data: Initial Exploration and Analysis of the Data, Basic Data Visualization. Basic data analytics, reporting, and apply basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypothesis. Experimentation and demonstration of initial analysis of data using R.

Advanced Analytics and Statistical Modeling for Big Data – Theory and Methods: Need of analytic and select an appropriate technique based on business objectives; initial hypotheses; and the data's structure and volume. Apply some of the more methods in Analytics solutions, algorithms and the technical foundations for the methods. The environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use Random-data base analytical functions to fit, score and evaluate models.

Advanced Analytics and Statistical Modeling for Big Data – Technology & Tools: Tool to Perform Analytics on Unstructured data using Map Reduce Programming paradigm. Use Hadoop, HDFS, HIVE, PIG and other products in the Hadoop ecosystem for unstructured data analytics, Effectively use advanced SQL functions and Green plum extensions for in-database analytics.

SUGGESTED BOOKS:

- 1.Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services, 2014
- 2.EMC Material/Courseware :<https://education.etnc.com/>, 2012
- 3.MapReduce Design Patterns, Author: Donald Miner, Publisher:O'Reilly, ISBN-3:-9789350239810, 2012
- 4.Practical Data Science with R-Nina Zumel, John Mount-Manning Publications, 2014
- 5.R for Business Analytics-A. Ohri-Springer, 2013
- 6.Agile data science: building data analytics applications with Hadoop- Russell Journey- O'Reilly Media
- 7.An Introduction to Applied Multivariate Analysis with R -Brian Everitt,Torsten Hothorn-Springer-2011
- 8.Statistical Modeling and Analysis for Database Marketing: Effective Techniques for Mining Big Data-Bruce Ratner-Chapman and Hall/CRC- 2013
- 9.Big Data Analytics with R andHadoop-VigneshPrajapati-Packt, Publishing-2013

SN	Course Code	Course title	Credits	L-T-P-S	CH
04	20AM22040	Cloud Computing	3	3-0-0-0	3

Syllabus

Cloud Computing: Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers Properties, Characteristics & Disadvantages: Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing

Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud

Introduction to IaaS IaaS definition, Introduction to virtualization, Infrastructure as a Service(IaaS) Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM) Resource Virtualization

- Server
- Storage
- Network

Virtual Machine(resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service)

Implementation of cloud services

- AmazonEC2
- Renting, EC2 Compute Unit, Platform and Storage, pricing, customers
- Eucalyptus
- Platform as aService(PaaS)
- Introduction to PaaS
- What is PaaS, Service Oriented Architecture(SOA)
- Cloud Platform andManagement
- Computation
- Storage
- Examples
- Google AppEngine
- MicrosoftAzure
- SalesForce.com
- Force.complatform
- Software as aService(PaaS)
- Introduction to SaaS
- Webservices
- Web2.0
- Web OS

Case Study on SaaS

- Service Management in CloudComputing
- Comparing Scaling Hardware: Traditional vs.Cloud
- Economics of scaling: Benefitting enormously
- ManagingData
- Looking at Data, Scalability &CloudServices
- Database & Data Stores inCloud
- Large Scale DataProcessing
- CloudSecurity
- InfrastructureSecurity
- Network level security, Host level security,Application level security
- Data security andStorage
- Data privacy and security Issues, Jurisdictional issues raised by Datalocation
- Identity &AccessManagement
- AccessControl
- Trust, Reputation, Risk
- Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and businessconsiderations
- Case Study on Open Source &CommercialClouds
- Eucalyptus
- Microsoft Azure
- AmazonEC2

Suggested Books:

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India. 2011
2. Block chain, blueprint for a new economy by Melanie Swan, 1st Ed., orielly publications. 2015.
3. James Broberg, Andrzej M. Goscinski, Wile.2013
4. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer.2012.
5. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India, 2010