MATHS
Mathematics

(DEEMED TO BE UNIVERSITY)

NAAC ACCREDITED A++ GRADE

nirf
2019 Rankings
#50 in University
#52 in Engineering

Recognised as CATEGORY 1 UNIVERSITY By UGC, Statutory Body of MHRD

CURRICULUM

POST GRADUATE DEGREE IN
APPLIED MATHEMATICS
W.E.F. 2019-20 ADMITTED BATCH OF STUDENTS

DEPARTMENT OF MATHEMATICS
KLEF | GREEN FIELDS, VADDESWARAM - 522502

Table of Contents

Version Control

Version	Author	Date	Changes
0.1	Name of Professor Incharge		
0.2	Name of Professor Incharge		
0.3	Name of Professor Incharge		
1.0	Name of Professor Incharge		
2.0	Name of Professor Incharge		

List of tables

List of Acronyms

Acronym	Expansion of the Acronym
L-T-P/S	Lecture-Tutorial-Practical/Skilling
Cr	Credit
CH	Contact Hours
CO	Course Outcome
PO	Program Outcome
PSO	Program Specific Outcome
BTL	Bloom's Taxonomy Level

A. ProgramOutcomes

PO1. Ability to assimilate and understand a large body of complex concepts and their interrelationships.

PO2. Apply Advanced Mathematical Techniques to formulate, solve and analyze mathematical models of real life problems.

PO3. Identify and apply suitable computational mathematical tools and techniques to solve various complex Engineering problems

PO4. Ability to communicate, and work, with people of diverse backgrounds in individual and group settings, in an ethical and professional manner.

PO5. To maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for life long learning.

PO6. Ability to apply Mathematics as a language in a wide range of situations relevant to research and industry.

PO7. Promote interdisciplinary research among allied subjects related to applied mathematics

PO8. Use symbolic and numerical software as part of practical computation.

B. Program Specific Outcomes for M.Sc., Applied Mathematics

PSO1. An ability to identify, formulate, abstract, and solve mathematical problems that use tools from a variety of mathematical areas, including algebra, analysis, probability, numerical analysis and differential equations

PSO2. The program prepares students for a variety of mathematical careers. The current program has three identified tracks: Cryptography, Data analysis, Applied Mechanics, and Ph.D preparation. Students should be prepared for employment requiring mathematical skill and sophistication at the Master's level.

PSO3. Apply mathematics and technology tools (MATLAB, R, MINITAB) to solve problems.

PSO4. Ability to do research in a particular topic agreed with a Supervisor, on which the student publish a research paper in an indexed journal.

C. Outcomes -Competencies – Performance Indicators

PO 1: Ability to assimilate and understand a large body of complex concepts and their interrelationships		
Competency	**Indicators**	
1.1 To develop mathematical competency to visualize the problem for practical applications with a possible meaningful solution.	1.1.1	To identify the problem and understand the importance of participating parameters in the field equations, there by identifying the objectives of the problem.
	1.1.2	To identify the real life problems, variables and parameters to solve the problem. Further mathematical tools to be identified.
1.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering systems.	1.2.1	A suitable mathematical model need to be developed there by inter connecting various participating parameters and obtain their relationships and then to correlate the terms. Problems identified , assembled and evaluated based on the characteristic features of the vital terms involved.
	1.2.2	The solution applied with the better tested tools and with the experimental data wherever it is applicable.
PO 2: Apply Advanced Mathematical Techniques to formulate, solve and analyze mathematical models of real life problems		
Competency	**Indicators**	
2.1 Demonstrate an ability to identify and formulate complex analytical systems coupled with engineering real lifeapplications.	2.1.1 2.1.2 2.1.3	The course is basically aimed to train the students to pursue their career in several areas of cyber security and network analysis /protection. The cyber security and cryptology are mainly focused at big data analysis and transfer of files in the encrypted form and there by encoded to decryption by the end user. This makes the data transfer more secure and safe. The basic concepts of applied mathematics leads the students to pursue their higher studies in applied mechanics and Ph.D programs. The concepts learned by the students will enable them to design and develop aero dynamical and fuel efficient systems.

2.2 Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1 2.2.2	The study involves a comprehensive analysis and design of cyber security and full proof system security. The methods studied will enable the students to apply their knowledge for safe secured transfer of confidential files and more so in the financialsector. The procedures and techniques studied by the students will enable them to apply their knowledge in mathematical modeling of aerodynamic vehicles and structures in civil engineering with higher stability.
2.3 Demonstrate an ability to formulate and interpret a model	2.3.1	The concepts studied by the candidates enable them to apply engineering mathematics and complex computational techniques there by producing and validating results through contemporary engineering tools and models.

PO 3 Identify and apply suitable computational mathematical tools and techniques to solve various complex Engineering problems

Competency	Indicators	
3.1 Demonstrate an ability to define a complex / open-ended problem in engineering terms	3.1.1	The complex problems existing the hither to not been aerodynamically designed for better utilization and optimality. The mathematical tools studied by the students will enable the engineers to design a competitive and comprehensive designs viz. as theory of plates and shells and aerodynamic and fire resistance structure for better livingconditions.

PO 4 Ability to communicate, and work, with people of diverse backgrounds in individual and group settings, in an ethical and professional manner.

Competency	Indicators
4.1 The ability to demonstrate and conduct investigations of technical issues with the understand of technical importance.	The scope and importance of the project will be discussed in consultation with the qualified and competent technical man power available in the field further the relevant methods, tools, design and system calibration long with data acquisition will be implemented with the compitenent technical man power. A strong rapport with the local and non local people will be established for the successful implementation of the project.

4.2 Demonstrate an ability to design experiments to solve open ended problems	Design and develop experimental approach, specify appropriate equipment and procedures Understand the importance of statistical design of experiments and choose an appropriate experimental design plan based on the study objectives

PO 5: To maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for life long learning.

Competency	Indicators
5.1 Demonstrate an ability to identify / create modern engineering tools, techniques and resources	Apart from the class room teaching the candidates shall acquire the knowledge of modern tools and computer aided drafting and practical modeling analysis for the successful implementation of the undertakenjob. It is also expected that create/adopt modify understand implement and exhibit the latest techniques to understand engineeringproblems.

PO 6: Ability to apply Mathematics as a language in a wide range of situations relevant to research and industry.

Competency	Indicators
6.1 Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and locallevel
6.2 Demonstrate an understanding of professional ngineering regulations,legislation and standards	6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

PO 7 Promote interdisciplinary research among allied subjects related to applied mathematics

Competency	Indicators
7.1 Demonstrate an understanding of the impact of engineering and industrialpractices	Understand the risk/ impact the life cycle of an engineering/ financial project for the better utility of the social economic community. It is expected that the relation between technical and socio economicrelationcoupledwiththeenvironmentalbalancewillbe

on social, environmental and in economic contexts	the need of hour,

PO 8: Use symbolic and numerical software as part of practical computation.

Competency	Indicators
8.1 Demonstration of the latest software techniques and numerical methods for the real life situations.	8.1.1 A gap between the theoretical knowledge by appling the numerical methods and software techniques will be studied and the gap will be try to fill depending up on the naturalconsequences

MATHS
Mathematics

(DEEMED TO BE UNIVERSITY)

D. Program Articulation Matrix

S.No	Course Code	Course Name	Category	L	T	P/S	Credits	PO								PSO			
								1	2	3	4	5	6	7	8	1	2	3	4
1	19AM1101	Real Analysis		4	0	0	4	2	2										
2	19AM1102	Ordinary Differential Equations		3	0	2	4			2		3		2	2	1	4	1	4
3	19AM1103	Numerical Methods		3	0	2	4					3	3	2	2	1	4	1	4
4	19AM1104	Introduction to Computer Programming		3	0	2	4					3	3	2		2	2	2	2
5	19AM1105	Mathematical Statistics		4	0	0	4	2		2				2		2	1	2	2
6	19AM1106	Seminar-1		0	0	2	1						2						
7	19AM1201	Soft computing		4	0	0	4					3	3	2		2	2	2	2

S.No	Course Code	Course Name	Category	L	T	P/S	Credits	PSO											
								1	2	3	4	5	6	7	8	1	2	3	4
8	19AM1202	Data Structures		3	0	2	4	2	2							1	2	1	2
9	19AM1203	Statistical Inference		4	0	0	4		2					2		2	2	2	2
10	19AM1204	Discrete Mathematics		4	0	0	4		2							2	3	3	3
11	19AM1205	Complex Analysis		4	0	0	4					3	3			1	4	4	4
12	19AM1206	Seminar-2		0	0	2	1												
13	19AM2101	Partial Differential Equations		3	0	2	4					3	3			1	4	1	1
14	19AM2102	Data Base Management system		3	0	2	4		2	2				2		2	2	1	4
15	19AM2103	Abstract Algebra		4	0	0	4			2	2				2	2	1	1	2
16	19AM2104	Transform Techniques		3	0	2	4					3	3		2	3	3	3	3
17	19AM2105	Seminar-3		0	0	2	1												
18	19AM2106	Cryptanalysis and Cyber Defense		3	0	2	4					3	3	2	2	1	1	1	1
19	19AM2107	statistics with R Programming		3	0	2	4					3	3	2	2	3	3	2	2

S.No	Course Code	Course Name	Category	L	T	P/S	Credits	PSO											
								1	2	3	4	5	6	7	8	1	2	3	4
20	19AM2108	Continuum Mechanics-I		4	0	0	4					3	3		2	2	2	2	2
21	19AM2201	Topology		4	0	0	4				3	3				2	2	2	2
22	19AM2202	Mathematical Programming		4	0	0	4					3	3	2		1	1	1	1
23	19AM2203	Dissertation with research Publications		0	0	24	12					3	3	3					
24	19AM2204	Computer networks and Security		3	0	2	4					3	3	3	2	2	2	2	2
25	19AM2205	Crypto currencies & Block chain Technologies		3	0	2	4					3	3	2	2	2	2	2	2
26	19AM2206	Big Data Analytics		3	0	2	4				3	3		2	2	2	2	1	1
27	19AM2207	Cloud Computing		3	0	2	4					3	3	2	2				
28	19AM2208	Continuum Mechanics-II		4	0	0	4					3	3		2	3	3	4	3
29	19AM2209	Computational Fluid Dynamics		3	0	2	4					3	3		2	2	2	2	3

19AM1101 – **Real Analysis**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 1.2 Course Outcomes of 19AM1101

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

Real number system, Cauchy sequences, Darboux's theorem, Weierstrass approximation ,Reimann integrals

Syllabus

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.

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, 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.

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 convergence at a point infinity□, infinite Range Integration. Integral as a product of functions.

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1.	Royden. H.L. and Fitzpatrick. P.M., Real Analysis, Prentice Hall India Pvt. Ltd.	2010
2.	Apostol, T. M., Mathematical Analysis, Narosa PublishingHouse.	2002
3.	Lang. S., Real and Functional Analysis, Springer - Verlag.	1993
4.	Rudin. W., Principles of MathematicalAnalysis, McGraw-Hill Book Company.	1976
5.	Goldberg, R.R., Methods of Real Analysis, Oxford and IBH Publishing company Pvt. Ltd.	1970

19AM1102-Ordinary Differential Equations

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 1.3 Course Outcomes of 19AM1102

CO No:	Course Outcomes	PO's/PSO's	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 hypergeometric , 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

Existence, uniqueness of solutions of first order ODE, Power series, Boundary value problems, Oscillation theory, Eigen values and Eigen functions.

Syllabus

Existence, uniqueness and continuation of solutions of a differential equation and system of differential equations; Applications. Differential and integral inequalities. Fixed point methods. Linear systems, properties of homogeneous and non- homogeneous systems, behaviour of solutions of n^{th} order linear homogeneous equations.

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.

Boundary value problems for second order differential equations, Green's function and its applications. Eigen value problems, self adjoint form, Sturm –Liouvile 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.

List of lab Experiments:

Lab session No	Experiment	CO-Mapping
1	Introduction to MATLAB.	CO1
2	Solving first and second order ODE.	CO1
3	Determine solutions of homogeneous system of ODE.	CO1
4	Determine solutions of non-homogeneous system of ODE.	CO2
5	Determine the singular and regular points of second order ODE.	CO2
6	Determine Hermite and Chebyshev polynomials.	CO2
7	Solutions of BVP for second order ODE.	CO3
8	Solutions of Strum-Liouvile problem.	CO3
9	Solution of BVP using Green's function.	CO3
10	Oscillatory solutions of BVP.	CO4
11	Determine the Eigen values and Eigen functions.	CO4
12	Determine the solution of vibrating string.	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1.	Braun, M. "Differential Equations and Their Applications", 4th Ed., Springer	2011
2.	Brauer, F. and Nohel, J.A., "The Qualitative Theory of Ordinary Differential Equations", Dover Publications	1989
3.	Coddington E.A., "Ordinary Differential Equations", Tata McGraw Hill	2002
4.	Deo, S.G., Lakshmikantham, V., and Raghvendra, V.,"Text Book of Ordinary Differential Equations", 2nd Ed., Tata McGraw Hill	2010
5.	Simmons G.F., "Ordinary Differential Equations with Applications", Tata McGraw Hill	2003

19AM1103 –**Numerical Methods**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 1.4 Course Outcomes of 19AM1103

CO No:	Course Outcomes	PO's/PSO's	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.	PSO3	3

System of linear equations, Roots of non-linear equations, Eigen values and Eigen vectors, Interpolation Numerical differentiation, Numerical integration, Numerical solution of first and second order ordinary differential equations.

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 $1/3^{rd}$ and $3/8^{th}$ 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:

S.No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1	Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Ed., Wesley.	2002
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.	2000
3	Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw- Hill Publisher	1982
4	Krishnamurthy, E. V. & Sen, S. K., "Applied Numerical Analysis", East West Publication.	1998

19AM1104- **Introduction to Computer Programming**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 1.5 Course Outcomes of 19AM1104

CO No:	Course outcomes	PO/PSO	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**	

Computer Fundamentals, Computer Fundamentals, Programming through functional decomposition and Data hiding, Data structures. Dynamic binding and virtual functions, Polymorphism, Dynamic data in classes.

Syllabus

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. **Basic Programming in C++**: Input/output; Constants, variables, expressions and operators; Naming conventions and styles; C; 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.

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 defaultarguments;Library functions.

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.

List of Lab Experiments

Lab session No	List of Experiments	CO-Mapping
1	Write a program that enters a 10- digit telephone number (the first three digits refer to the area code, the next three digits refer to the exchange code, and the remaining four digits refer to number), prints the parts of the number and complete telephone number and addition of area code and exchange code in the following format.	CO1
2	The government of India passed a GO regarding tax payment and you have to develop a C program based on some conditions. If the income is less than 1,50,000 then no tax. If taxable income is in the range 1,50,001-3,00,000 then charge 10% of tax. If taxable income is in the range 3,00,001-5,00,000 then charge 20% of tax. If taxable income is in the range 5,00,001 above then charge 30% of tax. Calculate the amount of tax he/she has to pay.	CO1
3	https://www.hackerrank.com/challenges/staircase Consider value of n = 5: 1 2 3 4 5 2 3 4 5 6 3 4 5 6 7 4 5 6 7 8 5 6 7 8 9 Write a program that prints the above pattern for given n.	CO1
4	a) Write a C++ program to solve the second degree equation $aX^2 + bX + c = 0$ for any real a, b and c. b) Find the greatest and smallest of given 3 numbers	CO2
5	a). A company is having N no of employees. Calculate their net salary the with the following details of HRA,DA and TAX on basic salaryIf basic salary is in between 80000 to 60000 then HRA = 30% DA = 20% Tax= 10% If the basic is in between 59000 to 40000 HRA = 25% (on basic) DA = 12% Tax= 8% If basic is below 39000 DA = 12% Tax= 8% For basic more than 80000 HRA = 30% (on basic) DA = 30% Tax= 20% b) Create a file named "inventory.dat" that stores item name, quantity and price for a single item. Write a program to read the values from the file and calculate bill amount and re write the same into the same file.	CO2
6	a) Write a C++ program to read N values and get their mean and the standard deviation. b) Write a C++ program to perform binary search.	CO2
7	a). Write a C++ program to convert a given decimal number to binary using recursion b) Write an efficient function to return maximum occurring character in the input string e.g., if input string is "test" then function should return 't'.	CO3
8	a) Write a function *reverse(int n)* which reverses the digits of given number and returns the result. For Example, if n is 927 , it would return 729 b) Write a C++ program to perform different arithmetic operation such as addition, subtraction, and multiplication using inline function	CO3
9	a) Write a C++ program to swap two number by both call by value and call by reference mechanism, using two functions swap_value() and swap_reference respectively , by getting the choice from the user and executing the user's choice by switch-case.	CO3

	b). Create a class Student which has data members as name, branch, roll no, age ,sex ,marks in five subjects and display them.	
10	a) Write a program to print the names of students by creating a Student class. If no name is passed while creating an object of Student class, then the name should be "Unknown", otherwise the name should be equal to the String value passed while creating object of Student class. b) Write a Program to design a class complex to represent complex numbers. The complex class should use an external function (use it as a friend function) to add two complex numbers. The function should return an object of type complex representing the sum of two complex numbers.	CO4
11	Write a program to overload unary operator ++ and – (prefix)	CO4
12	Create a base class basic_info with data members name ,roll no, sex and two member functions getdata and display. Derive a class physical_fit from basic_info which has data members height and weight and member functions getdata and display. Display all the information using object of derived class.	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1.	H.M. Deitel and P.J. Deitel. C++ How to Program. 8th Ed., Prentice Hall.	2011
2.	B. Eckel. Thinking in C++ Volume 1 & 2. 2nd Ed., Prentice Hall.	2003
3.	I. Koren. Computer Arithmetic Algorithms. 2nd Ed., A.K. Peters Ltd.	2001
4.	S.B. Lippman, J. Lajoie, and B.E. Moo. The C++ Primer. Addison-5th Ed., Wesley Professional.	2012
5.	S. Oualline. Practical C++ Programming. 2nd Ed., O'ReillyMedia.	2003
6.	S. Prata. C++ Primer Plus. 5th Ed., Sams.	2004
7.	W. Stallings. Computer Organisation and Architecture: Designing for Performance. 7th Ed., Prentice-Hall.	2005
8.	B. Stroustrup. The C++ Programming Language. Addison-3rd Ed., Wesley.	1997
9.	R. Lafore. Object-Oriented Programming in C++.4th Ed., Sams Publishing.	2001

19AM1105 – **Mathematical Statistics**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 1.6 Course Outcomes of 19AM1105

CO No:	Course Outcomes	PO/PSO	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 distributions of random variables	PO3 ,PS02	3
CO 2	Explain the concepts of independence, jointly distributed random variables and conditional distributions, and use generating functions to establishthe distribution of linear combinations of independent randomvariables.	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

Conditional Probability, discrete distributions, Random variables, Simple random sampling with replacement and without replacement, Fundamental sampling distributions.

SYLLABUS

Concept of probability, Axioms of Probability, Conditional Probability, Addition, Multiplication and Baye's Theorems, Random variable and Distribution function of discrete and continuous distributions, Mathematical expectation, Moments and Moment generating function.

Some discrete distributions: Binomial, Poisson, Geometric and Hypergeometric; Some continuous distributions: Uniform, Exponential, Weibull, Gamma and Normal.

Bivariate Random variables: Joint, Marginal, Conditional distribution, Statistical independence, product moments, correlation, regression, transformation of random variables, Law of large numbers and Central limit theorem.

Simple random sampling with replacement and without replacement, Parameter and statistic, Mean and variance of sampling distributions, order statistics and distribution of order statistics, Fundamental sampling distributions from normal population viz. χ^2 , t, f and Z (central).

Suggested Books:

S.No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1.	Miller, I. and Miller, M., "Freund's Mathematical Statistics with Applications",7th Ed., Prentice Hall PTR .	2006
2.	Hogg, R. V. and Craig, A., "Introduction to Mathematical Statistics", 6th Ed., Pearson Education,	2006
3.	Rohatgi, V. K. and Md. Ehsanes Saleh, A. K., "An Introduction to Probability and Statistics", 2nd Ed., John Wiley and Sons.	2000
4.	Papoulis, A., Pillai, S.U., Probability, "Random Variables and Stochastic Processes", 4th Ed.,Tata McGraw-Hill.	2002
5.	Bhatt B.R., "Modern Probability Theory", 3rd Ed., New Age International Ltd.	1999

2. COURSE OFFERED IN FIRST YEAR SEMESTER-2

Table 2.2 Courses Offered in I Year, Semester2

19AM1201 –**Soft Computing**

.L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 2.2 Course Outcomes of19AM1201

CO#	CO	PO/PSO	BTL
CO1	Apply A*, AO*, Branch and Bound search techniques for problem solving.	PO1 PSO 2	2
CO2	Differentiate and classify traditional and non-additional optimization methods and Formulate an optimization problem to solve complex problems.	PO1, PO5 PSO 2	2
CO3	Apply Neural network methods for simple applications	PO1, PO5 PSO 2	3
CO4	Apply GA, PSO and ACO algorithms for various optimization problems	PO1, PO5 PSO 2	4

Problem Solving Methods, Evolutionary Methods, Artificial Neural Networks, Swarm Optimization swarm intelligence algorithms, Simple problems and applications.

Syllabus

Problem Solving Methods : Problem Space, Problem solving, State space, Algorithm's performance and Complexity, Search Algorithms, Depth first search method, Breadth first search method, Branch and Bound search method, Introduction to P type, NP complete and NP Hard problems. Classical methods versus Non-traditional methods.

Evolutionary Methods: Principles of Evolutionary Processes and genetics, Introduction to evolutionary algorithms, Evolutionary strategy, Evolutionary programming. Genetic Algorithm : Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Genetic programming, Simple applications.

Artificial Neural Networks: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, Simple applications.

Swarm Optimization: Introduction to Swarm intelligence, Ant colony optimization (ACO), Meta- heuristic, Algorithm for Travelling Salesman Problem, Particle swarm optimization (PSO), Other variants of swarm intelligence algorithms, Simple problems and applications.

Suggested books:

S.No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1	Kalyanmoy Deb, *Multi-objective Optimization using Evolutionary Algorithms* John Wiley and Sons	2012
2	Maurice Clerc, *Particle Swarm optimization*, ISTE, USA, South Asian Edn	2007
3	Marco D & Thomas S, *Ant Colony optimization*, MIT Press, London,	2004
4	Tettamanzi Andrea, Tomassini and Marco, *Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems*, Springer.	2001
5	S S Rao, *Engineering Optimization*, New Age, New Delhi,	2014

19AM1202-**Data Structures**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 2.3 Course Outcomes of 19AM1202

CO#	Course Outcome	PO/PSO	BTL
CO1	Analyze and compare stack ADT and queue ADT implementations using linked list andapplications.	PO1, PO4, PSO1, PSO2	4
CO2	Analyze the linked lists and types of Binary trees and their representations.	PO1, PO4, PSO1, PSO2	4
CO3	Apply measures of efficiency on algorithms and Analyze different Sorting Algorithms, Analyze the linked implementation of Binary,Balanced Trees and different Hashing techniques.	PO1, PO2, PSO1 PSO2	4
CO4	Analyze different representations, traversals, applications of Graphs and Heap organization.	PO2, PO4, PSO1, PSO2	4
CO5	Develop and Evaluate common practical applications for linear and non-linear data structures.	PO1, PO2, PSO1, PSO2	5

Data structures, Arrays, Binary trees, General lists: Representations, operations,dynamic storage management, garbage collection, compaction. minimum spanning tree, shortest path algorithm

Syllabus

Introduction to data structures. Arrays: One and two dimensional arrays, storage allocations. String representation. Implementation of abstract data types (ADT). Stacks: LIFO structure, push, pop, create, delete and empty stack. Queues: FIFO structure, operations on queues, priority queues, circular queues. Linear lists, list v/s array, internal pointer & external pointer, head, tail of a list, null list, length of a list. Linked Lists: nodes, linked list data structure, algorithms: insert, delete and retrieve node, create, search, print, append linked list, array of linked lists, header nodes, circularly-linked list, doubly linked list: insertion, deletion.

Binary trees: definition, array, linked and threaded representations, traversal, (Pre, Postand Symmetric order), expression trees (Infix, Prefix and Postfix). Sorting: Selection sort, bubble sort, exchange

sort, quick sort, heap sort and merge sort. Analysis of sorting techniques. Searching: sequential search, binary search, search trees AVL trees, M-way search trees, B trees, hash tables, hashing functions, collision resolution techniques.

General lists: Representations, operations, dynamic storage management, garbage collection, compaction.

Graphs: array and linked representation, operations: add, delete and find vertex, add, delete edge, traverse graph (depth-first, breadth-first). Networks: minimum spanning tree, shortest path algorithm (Dijkstra's algorithm and Kruskal'salgorithm).

List of Lab Experiments

Lab session No	Experiment	CO-Mapping
1	Traversal, insertion, deletion in a linear array.	CO1
2	Stacks using arrays.	CO1
3	Linear Queue using arrays.	CO1
4	Circular Queue using arrays	CO1
5	Stacks and Queues using linked list.	CO1
6	Singly Linked circular List.	CO1
7	Doubly Linked List.	CO1
8	Polynomial Arithmetic using linked list.	CO1
9	Insertion sort, Exchange sort, Selection sort	CO2
10	Quick sort	CO2
11	Heap Sort.	CO2
12	Binary Tree Traversal (pre, post and symmetric order)	CO4
13	Sequential Search and Binary Search.	CO4
14	Binary Search Tree	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
1	Langman, Y., Augenstein, M.; Tennenbaum A.M. Data Structure Using C and C++. Prentice Hall of India.	1998
2	Sahni S., Data Structures Algorithms and Applications in C++, McGraw Hill	2005
3	Dale N., C++ Plus Data Structures. Narosa Publications.	2000
4	Tenenbaum A. M., Data Structures Using C, Pearson Edn, India.	1990
5	Kruse Robert L., Ryba Alexander J., Data Structures and Program Design in C++	1998

19AM1203- **Statistical Inference**

L-T-P/S	4-0-0
Credits	4
Contact Hours	5

Table 2.4 Course Outcomes of 19AM1203

CO No	Course Outcome (CO)	POS/PSOs	Blooms Taxonomy Level (BTL)
CO1	Obtain estimates of parameters and identify the various methods to estimateit.	PO1, PS02	3
CO2	Apply various principles for the data reduction and draw conclusion about the population based upon samples drawn from it	PO2, PS02	3
CO3	Describe the tests of significance and draw conclusion about the population and sample using various tests.	PO3, PS02	3
CO4	Testing the hypothesis to analyze the variance and also predict the linear relationship between the two variables	PO3, PS02	3

Theory of Estimation, Principle of Data Reduction, Testing of Hypothesis and Analysis of Variance

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 UMVU Estimators. Interval Estimation, Some results 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:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
1	Miller, I. and Miller, M.,"Freund's Mathematical Statistics with Applications",7th Ed., Prentice Hall PTR.	2006
2	Lehman, E.L., "Testing of Statistical Hypothesis", Wiley Eastern Ltd	1959
3	G. Casella, R. L. Berger, "Statistical Inference", Duxbury Press	2002
4	Lehman, E.L., "Point Estimation", John Wiley & sons	1984
5	Rohatgi, V.K., "Statistical Inference", Dover Publications	2011

19AM1204- **Discrete Mathematics**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 2.5 Course Outcomes of 19AM1204

CO No:	Course out come	PO/PSO	BTL
CO1	Apply the rules of Propositional logic to establish valid results and apply rules of valid inference and hence understand how to construct correct mathematical arguments, Mathematical Induction	**PO3, PO6, PO7 PSO2**	**2**
CO2	Understand the concept of relations, functions and discrete structures , Count discrete event occurrences , lattices, to represent the Boolean functions by an expression	**PO2, PO3, PO6, PO7 PSO3**	**3**
CO3	Formulate and solve recurrence relations of homogeneous and non homogeneous relations, understand some recursive algorithms.	**PO2, PO3, PO6, PO7 PSO3**	**3**
CO4	Use graph theory for various techniques to study and analyze different problems associated with computer design, logic design, Formal languages, Artificial Intelligence etc, Analysis of different traversal methods for trees and graphs.	**PO2, PO3, PO5, PO6, PO7 PSO3**	**3**

Fundamentals of logic, Partially ordered sets, Lattices, Recurrence Relation, Graphs, colouring theorems, isomorphism of graphs.

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:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
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

19AM1205 –**Complex Analysis**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 2.6 Course Outcomes of 19AM1205

CO No:	Course out come	PO/ PSO	BTL
CO1	Explain the definition of continuity, differentiability, **apply** the concepts of analytic function and harmonic function to explain Cauchy-Riemann equations; Understganding Power Series.	**PO1, PSO1**	3
CO2	Apply the concept of conformal mapping, and describe the mapping properties of Möbius transformations and how to apply them for conformal mappings in Fluid Dynamics,etc.	**PO2, PO7, PSO4**	3
CO3	Explain complex contour integrals; Understand simple sequences and series **apply** the convergence properties of a power series, and to determine the Taylor series or the Laurent series of an analytic function.	**PO1, PO7 PSO1, PSO4**	3
CO4	Explain properties of singularities and poles of analytic functions and **apply** to compute residues integrals by **applying** residue techniques.	**PO1 PSO1, PSO4**	3

Analytic Functions, Cauchy-Reimann equations, Complex integration, Residue Calculus, Conformal Mapping:, Evaluation of real integrals.

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, Rouche'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:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1	Churchill, J. W. and Brown, R. V., "Complex Analysis", Mcgraw-Hill.	2009
2	Gamelin, T. W., "Complex Analysis", Springer-Verlag	2001
3	Greene R., and Krantz, S. G., "Function Theory of One Complex Variable", 3rd Ed., GSM, Vol. 40, American Mathematical Society.	2006
4	Kreyszig, E., "Advanced Engineering Mathematics", Wiley, New York	2009
5	Lang, S., "Complex Analysis", Springer –Verlag.	2003
6	Mathews, J. H. and Howell, R. W., "Complex Analysis for Mathematics and Engineering", Narosa	2009

19AM2101- **Partial Differential Equations**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 3.2 Course Outcomes of 19AM2101

CO No	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Model the relevant phenomena as a Partial differential equations and obtain the solutions	PO2, PSO1	3
CO2	Understand the Nature of the higher order Partial differential equation and obtain the solutions	PO3, PSO4	3
CO3	Express the Laplace equation in Various coordinate systems and solve by Fourier series method	PO1, PO5 PSO1	3
CO4	Solve the Hyperbolic and Parabolic differential equations by Separation of variable method	PO1, PO5 PSO1	3

Formation of PDE, Classification of second order equation, Hyperbolic, Parabolic and Elliptic equations of separation of variables, Solutions in cylindrical and spherical equation, The maximum principle for the heat equation.

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 dimensionaldiffusion 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:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1.	Zachmanoglou, E.C., Thoe, D.W., "Introduction to Partial Differential Equattions with Applications", Dover Publications.	1986
2.	Sneddon, I. N., "Elements of Partial Differential Equations", McGraw-Hill Book Company.	1988
3.	Amarnath, T., "An Elementary Course in Partial Differential Equations", 2nd Ed., Narosa Publishing House.	2012
4.	Rao, K. S., "Introduction to Partial Differential Equations", 2nd Ed., PHI Learning Pvt. Ltd.	2012
5.	Lawrence C. Evans, "Partial Differential Equations", American Mathematical Society	2010

19AM2102- **Data Base Management systems**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 3.3 Course Outcomes of 19AM2102

CO#	Course Outcome	PO/PSO	BTL
CO1	Illustrate the functional components of DBMS, importance of data modelling in design of a database.	PO1, PO5, PSO2	2
CO2	Build queries using SQL and concepts of PL/SQL	PO1, PSO2	3
CO3	Apply normalization techniques and indexing to construct and access decent database.	PO5, PSO1	3
CO4	Identify the importance of transaction processing, concurrency control and recovery techniques	PO1, PSO4	3
CO5	Develop a good database and define SQL queries for data analysis	PO3, PSO2	3

Database Fundamentals, Relational Algebra & SQL, Database Design and Transaction Management &Recovery Techniques

Syllabus

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types. **Data Modelling:** ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. Enhanced ER data Model, EER Diagram, Relational Model: concepts, constraints, schemas, ER to Relational Model.

Relational Algebra & SQL: Relational Algebra :Operators in relational algebra, Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, views, compound statements, user defined functions, user defined procedures, cursors, Triggers.

Database Design: Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4th and 5th normal forms. File and storage structures: File storage, Indexstructures,Indexing and hashing, query processing and optimization.

Transaction Management &Recovery Techniques: Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log and concurrency control techniques: Lock based techniques, and Timestamp based techniques, Multiversion based Techniques. Recovery concepts, shadow paging, ARIES.

SuggestedBooks:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
1	Ramez Elmasri and shamkant B Navathe, "Database Systems: Models, Languages, Design and Application Programming", 6th Ed., Pearson Education.	**2013**
2	. CONNOLLY,Database Systems : A Practical Approach to Design, Implementation and Management**,** 6thEd., Pearson Education	Latest Eddition
3	A.Silberschatz Henry F Korth,S.Sudarsan, " Database System Concepts", 6th Ed., Tata McGrawhHill	**2011**
4	Raghu RamaKrishnan , Johannes Gehrke, "Database Management Systems", 3rd Ed., Tata McGraw Hill.	**2014**
5	Ivan Bayross, "SQL, PL/SQL: The Programming Language of Oracle", 2nd Ed., BPB Publications.	Latest Eddition
6	C. J. Date, A. Kannan and S. Swamynathan, An Introduction to Database Systems, 8th Ed., PearsonEducation.	**2009**

List of Lab Experiments:

Experiment - 1:

Introduction to DBS lab, Tools used in the lab(TerraER2.23for ER diagrams, MYSQL5.7server and client)

Experiment - 2:

Draw an ER diagram that captures thisinformationabout university database by considering the followinginformation

- Professors have an SSN, a name, an age, a rank, and a researchspecialty.
- Projects have a project number, a sponsor name (e.g., NSF), a starting date, an ending date, and abudget.
- Graduate students have an SSN, a name, an age, and a degree program (e.g., M.S. or Ph.D.).
- Each project is managed by one professor (known as the project's principalinvestigator).
- Each project is worked on by one or more professors (known as the projects co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is worked on by one or more graduate students (known as the project's researchassistants).
- When graduate students work on a project, a professor must supervise their work on the project.
- Graduate students can work on multiple projects, in which case they will have a (potentially different) supervisor for eachone.
- Departments have a department number, a department name, and a mainoffice.
- Departments have a professor (known as the chairman) who runs thedepartment.
- Professors work in one or more departments, and for each department that they work in, a time percentage is associated with theirjob.

- Graduate students have one major department in which they are working on theirDegree.
- Each graduate student has another, more senior graduate student (known as a Student advisor) who advises him or her on what courses to take.
- Capture dependent details of the professor to offer medical insurance to theirfamily.
- Capture information regarding the clients who sponsored projects to theprofessors.
- Capture informationregardingthe expenditure and income and details of the project along with PIdetails.

19AM2103 – **Abstract Algebra**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 3.4 Course Outcomes of 19AM2103

CO No:	Course out come	PO/PSO	BTL
CO1	Define group, subgroup and quotient group with examples, and proving some preliminary lemmas.	**PO3, PSO2**	**2**
CO2	Define homomorphism and automorphisim of groups .Explain Cayley's and Sylow's theorems of finite groups and demonstrate the problems.	**PO1, PSO1**	**2**
CO3	Define a ring, homomorphismof rings, ideal, quotient rings with examples. Explain principal ideal domain, unique factorization domain, modules over PID theorems and demonstrate the problems.	**PO2, PSO1**	**2**
CO4	Define field and Polynomial ring with examples. Explain the field of Quotients of an integral domain and Euclidean and polynomial rings with problems.	**PO4, PSO2**	**2**

Group theory, Ring theory, Vector Spaces, Fields, Euclidean rings, polynomial rings.

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:

S.No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
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 Education	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., Cengage Learning	2013

19AM2104-**Transform Techniques**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 3.5 Course Outcomes of 19AM2104

CO No:	**CO**	**PO/PSO**	**BTL**
CO 1	Apply Laplace transform techniques to solve linear differential equations in system analysis where initial conditions can be easily included to give system response.	PO1, PO3, PO4, PS03	3
CO 2	Applying z- transform and Mellin transform to the analysis and characterization of Discrete Time systems.	PO1, PO3, PS03	3
CO 3	Apply Fourier series to analyze various signals.	PO4, PS03	3
CO 4	Apply Fourier transforms to analyze various signals.	PO6, PS03	3
CO 5	Verify the solution of the Transform techniques through MATLAB.	PSO3	3

Laplace transforms, Inverse Laplace transforms, Applications, Mellin Transform, Fourier Series, Fourier Transforms

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, Mellintransforms 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.

List of Lab Experiments:

Lab session No	List of Experiments	CO-Mapping
1	Introduction and Review of MATLAB.	CO1
2	Determine the Laplace transforms of the function using derivatives and integrals property.	CO1
3	Calculate the Inverse Laplace transforms of the given function.	CO1
4	Solving ODE by Laplace transforms.	CO2
5	Using the Shifting, Convolution, Initial and finalvalue theorems of Z-transforms to the function .	CO2
6	Using Z-transforms to solve the difference equations.	CO2
7	Determine the Mellin transforms of derivatives and integrals.	CO3
8	Obtain the Complex form of Fourier series of the function.	CO3
9	Determine the Fourier series of even and odd functions.	CO3
10	Solving ODE using Fourier series.	CO4
11	Expressing the Fourier sine and cosine integrals and Complex form of Fourier integral representation of the function.	CO4
12	Application of Fourier transforms to Boundary Value Problems (BVP).	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
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., Integal Tranforms and Their Applications, 2nd Ed., Taylor and Francis Group	2007

4. COURSE OFFERED IN SECOND YEARSEMESTER-2

19AM2201-**Topology**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 4.2 Course Outcomes of 19AM2201

CO No:	Course Outcome	PO/PSO	BTL
CO1	Explain the definition of Finite, countable, uncountable sets and **apply** the concepts of composite function and Axiom of choice to explain Zorn's Lemma.	**PO1 PSO1,2**	**3**
CO2	Explain the concept of open sets, closed sets and basis for a topology describe the properties of product space and **apply** the concept of topological space and continuous function.	PO1 PSO1, PSO2	**3**
CO3	Explain the definition of compact space and connected space and **apply** the concept of finite intersection property and Bolzano weierstrass property.	PO1 PSO1, PSO2	**3**
CO4	Explain the properties of Hausdorff's space and normal space and **apply** the Urysohn's lemma to determine the urysohn's metrization theorem, Tietze extension theorem, and tychonoff theorem.	PO1 PSO1, PSO2	**3**

Countable, uncountable sets, functions, relations, Topological Spaces and Continuous functions Connectedness and Compactness, Countability and Separation axiom.

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 NormalSpaces, Urysohn's Lemma, Urysohn metrization Theorem. Tietze Extension Theorem, Tychonoff Theorem

Suggested Books:

S.No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication
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

19AM2202-**Mathematical Programming**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

L-T-P/S :4-0-0
Credits 4
ContactHours 4

Table 4.3 Course Outcomes of 19AM2202

CO No:	CO	PO/PSO	BTL
CO 1	Apply different methods to find the optimal solution of linear programming problems and analyze the sensitivity of the solution.	PO3, PSO1	3
CO 2	Different methods to find the optimal solution of Transportation and Assignment problems.	PO3, PSO1	3
CO 3	Apply non-linear optimization methods to solve non- linear programming problems	PO3, PSO1,	3
CO 4	Apply Search methods tosolvenon-linearprogramming problems	PO3, PSO1,	3

linear programming, Simplex Method, Non-linear optimization, Quadratic Programing

Syllabus

Introduction to linear programming: Convex Sets, Graphical Method, Simplex Method, Big – M 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, Lagrange's multipliers, Khun-Tucker theory, Quadratic Programing-Wolfes Method

Search Methods- Unconstrained search:Fibanocci Search Method, Constrainedsearch: Penalty function method(Interior and exterior search)

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
1	Taha, H.A., "Operations Research: An Introduction", MacMillan Pub Co., NY, 9th Ed. (Reprint).	2013
2	Mohan, C. and Deep, K., "Optimization Techniques", New Age India Pvt. 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", Jain Brothers, New Delhi, 2nd Ed.	2012

19AM2106-Crypto Analysis And Cyberdefense

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 5.2 Course Outcomes of 19AM2106

CO #	CO Description	PO/PSO	BTL
CO1	Understand the principles of cryptography by analyzing Various attacks and apply different classic encryption techniques.	PO1 PSO2	3
CO2	Understand the principles of block cipher and analyze algorithms like DES, AES.	PO5 PSO2	3
CO3	Understand and apply different algorithms of public key crypto system for ensuring secured communication.	PO5 PSO2	3
CO4	Apply Security engineering principles and respective algorithms to achieve authentication, integrity and digital certification.	PO5 PSO2	3
CO5	Implement various cryptographic algorithms so as to analyze the achievability of security goals like Confidentiality, integrity, authentication and also Justify the possibility of Cryptanalysis attack with each algorithm.	PO5 PSO2	4

Security Concepts, Encryption Techniques, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Applications of Cryptographic Hash functions.

Syllabus

Introduction to Security: Security Concepts, Security Attacks, Security Services and Mechanisms, A Security Model, Classical Encryption Techniques: Symmetric Cipher Model,Substitution Techniques, Transposition Techniques.
Block Ciphers and DES: Traditional Block Cipher Structure, DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles. AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example, AES Implementation. Block Cipher Operation: Multiple Encryption and Triple DES, Modes of Operation, Pseudorandom Number Generation and Stream Ciphers: Principles and Pseudorandom Number Generation,
Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream, Ciphers, RC4
Public-key Cryptography and RSA: Principles of Public-Key Cryptosystems, the RSA algorithm. Other Public-key Cryptosystems: Diffie-Hellman Key Exchange,ElGamal Cryptosystem, Elliptic Curve Arithmetic Elliptic Curve Cryptography.
Cryptographic Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, Hash Functions based on Cipher Block Chaining, SHA. Message Authentication,Digital Signatures:
Digital Signatures, ElGamal Digital Signature Scheme

List of Lab Experiments

Lab session No	List of Experiments	CO-Mapping
1	Write a C program to implement Multiplicative Inverse	CO1
2	Write a C program to implement encryption and decryption usingCeaser ciphersubstitution.	CO1
3	Write a C program to implement encryption and decryption using Substitution technique like Playfair	CO1
4	Write a C program to implement encryption using Hill Cipher assuming a 2x2 matrix key.	CO2
5	Write a C program to implement encryption and decryption using Transposition technique like railfence	CO2
6	Write a C program to implement encryption and decryption using Transposition technique like Columnar.	CO2
7	Write a C program to implement DES Key Generation by taking 10 bit key.	CO2
8	Write a C program to implement AESMix Column operation.	CO2
9	Write a C program to generate hash code using simple hash function	CO3
10	Implement RSA algorithm using Cryp Tool	CO3
11	Implement Diffie-Hellman Key Exchange algorithm using Crypt tool.	CO3
12	Implement Elgamal digital signature algorithm using Crypt tool.	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of ublication/ Reprint
1	Cryptography and Network Security Principles and Practice, by William stallings, 5th Ed., Pearson.	Latest Eddition
2	Applied Cryptography: Protocols, Algorthms, and Source Code in C , by Bruce Schneier, Second Edition , John Wiley & Sons, Inc.,2015	**2015**
3	Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, by Hamid R. Nemati and Li Yang, IGI Global.	**2011**
4	Forouzon B, "Cryptography and Network Security," Indian Edition, TMH	**2010**

19AM2204- COMPUTER NETWORKS AND **SECURITY**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 5.3 Course Outcomes of 19AM2204

CO#	CO Description	PO/PSO	BTL (1to6)
CO1	Understand network security issues and apply key distribution techniques.	PO1, PO5, PSO2	2
CO2	Apply user authentication and Transport layer Security techniques.	PO1, PO5, PSO2	3
CO3	Understanding Wireless Network Security	PO1, PO5, PSO2	2
CO4	Applying Email and IP Security concepts	PO1, PO5, PSO2	3
CO5	Implementing the various Network Security concepts and analyse their performance using various networking tools	PO1, PO5, PSO2	4

Networking using the Internet, Distribution Using Symmetric Encryption Kerberos, Wireless Network Security, : IP Security Overview. IP Security Policy

Syllabus

Overview of networking using the Internet as an example, Introduction, Symmetric Encryption and Message Confidentiality: Public-Key Cryptography and Message Authentication. Key Distribution, Message authentication: HAMAC, User Authentication: Symmetric Key Distribution Using Symmetric Encryption Kerberos, Key Distribution Using Asymmetric Encryption, X.509 Certificates, Public-Key Infrastructure.

User Authentication: Remote User Authentication Principles, Remote User Authentication using Symmetric Encryption, Remote User Authentication Using Asymmetric Encryption, Transport-Level Security: Web Security Considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH).

Wireless Network Security: IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP, End-to-End Security. Electronic Mail Security: Pretty Good Privacy, S/MIME, Domain Keys Identified Mail IP Security: IP Security Overview. IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
1	William Stallings, "Network Security Essentials",6th Ed.,Pearson Education.	**2017**
2	Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", 2nd Ed., Prentice Hall.	**2017**
3	Eric Cole, Ronald L. Krutz, James Conley 2005, Network Security Bible, Wiley.	Latest Eddition

List of lab Experiments

Lab session No	Experiments	CO-Mapping
1	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather informationabout networks and domain registrars.	CO1
2	Study of packet sniffer tools like wire shark, ethereal, tcpdump etc. Use the tools todo the following (i) Observer performance in promiscuous as well as non-promiscousmode.	CO1
3	Study of packet sniffer tools like wireshark, ethereal, tcpdump etc. Use the tools todo the following (ii) Show that packets can be traced based on different filters.	CO1
4	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc.	CO2
5	Use the Nessus tool to scan the network for vulnerabilities.	CO2
6	Install IDS (e.g. SNORT) and study the logs.	CO3
7	Attacking Web Application: SQL injection	CO3
8	Practical approach to study Wireshark	CO4
9	Practical approach to study SNORT(Intrusion Detection System)	CO4
10	Practical approach to study Web Application Vulnerability.	CO4

19AM2205-**Crypto currencies & Block chainTechnologies**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 5.4 Course Outcomes of 19AM2205

CO#	CO Description	PO/PSO	BTL(1 to6)
CO1	Understand crypto currencies and Markets, Mining and Crypto currencies	PO1, PO 3 PSO 2	2
CO2	Understand block chain technology,Transactions, Blocks and Hashes	PO2, PO 3 PSO 2	2
CO3	Applying Hash cryptography, Encryption vs hashing. Analyzing Transactions , Digital signature, Information technology programs	PO 2, PO 7PSO2	3
CO4	Analyzing Security and safeguards: protecting block chain fromattackers.	PO 2, PO12 PSO 2	4
CO5	Creation of Merkle trees, block chain, Wallet structure, address structure	PO 5 PSO 2	3

Cryptography & crypto currencies, block chain technology, The Double-Spend and Byzantine Generals' Computing Problems, Information technology program.

Syllabus

Introduction to cryptography & crypto currencies , Crypto currency and Markets, Mining and Crypto currencies, Bitcoin applications & security overview of block chain technology, what is block chain: Transactions, Blocks, Hashes, Distributed consensus.

The Double-Spend and Byzantine Generals' Computing Problems, Crowd funding, Bit coin Prediction Markets, Hash cryptography, Encryption vs hashing. Transactions: Recording transactions, Digital signature, Information technology program, verifying and confirming transactions. Security and safeguards: protecting block chain from attackers, Forks soft andhard.

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	
1.	Bitcoin and Cryptocurrency Technologies : A comprehensive Introduction by Joseph Bonneau, Aravind Narayanan, Edward Felten, 2016 Ed., Prince Town university press, ISBN:9780691171692.	2016
2.	Block chain, blueprint for a new economy by Melanie Swan, 1st Ed., orielly publications.	2015
3.	Cryptocurrency Investing Bible: The Ultimate Guide About Blockchain, Mining, Trading, ICO, Ethereum Platform, Exchanges, Top Cryptocurrencies for Investing and Perfect Strategies to Make Money,Kindle Edition By Alan T.Norman, Kindle Edition	2017
4.	A Short Introduction to the World of Cryptocurrencies, Aleksander Berentsen and FabianSchär	Latest Eddition
5.	Blockchain: A Step-By-Step Guide For Beginners to Implement Block chain Technology And Leveraging Blockchain Programming By Tailor Jacobs, volume-1,2017,ISBN: 1548009598	Latest Eddition

List of Lab Experiments:

Lab session No	Experiment	CO-Mapping
1	Write a program to create block chain	CO1
2	Write a program for implementation of block chain	CO1
3	Implement Merkle trees	CO1
4	Implement Proof of Stake protocol	
5	Write a program to implement Proof of Work protocol	
6	Write a program for Mining Proof of Work	
7	Write a program for validate the second signature with second key	
8	Write a program to**generate Hash from File**	
9	Write a program on RPC handles or delegates network communication for all RPC requests.	
10	Write a program for adding transactions in block chain	
11	Implement Wallet structure	
12	Write a program to create address structure	

6. COURSES OFFERED IN ELECTIVE STREAM – DATA ANALYTICS

19AM2107- **STATISTICS WITH RPROGRAMMING**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 6. 2 Course Outcomes of 19AM2107

CO No	Course Outcome (CO)	POS/PSOs	Blooms Taxonomy Level (BTL)
CO1	Understand the basic functions in R programming and identify the operators using in it.	PO8, PS03	2
CO2	Simulating data using R	PO8, PS03	2
CO3	Apply various probability distributions to the real world problems using R	PO3, PS02	2
CO4	Analyze the data using various linear and nonlinear lines using R	PO3, PS02	2

R Sessions and Functions, R Programming Structures, Control Statements, Graphics, Creating Graphs, Probability Distributions, Normal Distribution, Linear Models and Nonlinear Models.

Syllabus

Introduction, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes. R Programming Structures, Control Statements, Loops, - Looping Over Non vector Sets,- If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quick sort Implementation- Extended Example: A Binary Search Tree. Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability- Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /out put, Accessing the Keyboard and Monitor, Reading and writer Files,

Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot () Function Customizing Graphs, Saving Graphs to Files. Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA.

Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression- other Generalized Linear Models-Survival Analysis, Nonlinear Models, Splines- Decision- Random Forests,

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	Year of Publication/ Reprint
1	The Art of R Programming, Norman Matloff, Cengage Learning	
2	R for Everyone, Lander, Pearson	
3	R Cookbook, PaulTeetor, Oreilly	
4	R in Action,Rob Kabacoff, Manning	

LAB EXPERIMENTS:

Tutorial session No	Topics	CO-Mapping
1	Lab on Basic functions and data types using R	CO5
2	Lab on Data Frames, Lists, Matrices, Arrays, Classes	CO5
3	Lab on control statements, loops, Arithmetic and Boolean Operators	CO5
4	Lab on Math and Simulation in R	CO5
5	Lab on Calculating Probability- Cumulative Sums and Products-	CO5

	Minima and Maxima	
6	Lab on Linear Algebra Operation on Vectors and Matrices	CO5
7	Lab on Creating Graphs, the plot () Function, Customizing Graphs	CO5
8	Lab on Normal Distribution, Binomial Distribution,Poisson Distributions	CO5
9	Lab on correlation, covariance, t-test and ANOVA	CO5
10	Lab on Simple Linear Regression, Multiple Regression and Logistic regression	CO5

19AM2206- **Big DataAnalytics**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 6.3 Course Outcomes of 19AM2206

CO#	Course Outcome	PO/PSO	BTL
CO1	Illustrate the concepts of big data, Initial exploration of analysis of data and Data visualization.	PO1, PO5, PSO2	1
CO2	Demonstrate Initial exploration of data and advanced data analytics by using R	PO2, PO3, PSO2	2
CO3	Examine advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	PO2, PO4, PSO1	2
CO4	Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	PO2, PO4, PSO1	2
CO5	To implement Lab experiments using Hadoop		

Big Data Analytics, Advanced Analytics and Statistical Modeling for Big Data, Use MADlib to solve analytics problems in-database. Endgame ,concepts to a big data analytics problem in the final lab.using R.

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

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 model screated Use Randin-database 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 Greenplum extensions for in-database analytics.

Use MADlib to solve analytics problems in-database. Endgame - Operationalizing an Analytics Project: Tasks needed to operationalize an analytics project. Four common deliverables of an analytics lifecycle project meet the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate data visualization and identify ways to improve it. Apply these concepts to a big data analytics problem in the final lab. using R.

List of Lab Experiments:

Lab session No	List of Experiments	CO-Mapping
1	To draw and explain Hadoop Architecture and Ecosystem with the help of a case study using WorkCount example to define and install Hadoop.	CO1
2	To implement the following file management tasks in Hadoop Sysem (HDFS) : Adding files and directories, retrieving files, deleting files	CO1
3	To run a basic word count Mapreduce program to understand Mapreduce Paradigm: To count words in a given file, To view the output file and to calculate execution time.	CO1
4	To perform NoSQL database using mongodb to create, update and insert.	CO2
5	To study and implement basic functions and commands in R Programming.	CO2
6	To build wordcloud, a text mining method using R for easy to understand and visualization than a table data.	CO3
7	To implement Bloom filters for filter on stream data in C++/Java.	CO3
8	To implement clustering program using R programming.	CO4
9	To finding similar documents with cosine similarity in R.	CO4

Suggested Books:

S.No	Author(s) / Title/ Edition No./ Publisher	Year of Publication
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/	
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	2012
6.	Agile data science: building data analytics applications with Hadoop-Russell Journey- O'Reilly Media	2013
7	An Introduction to Applied Multivariate Analysis with R -Brian Everitt, Torsten Hothorn-Springer-2011	2011
8	Statistical Modeling and Analysis for Database Marketing: Effective Techniques for Mining Big Data-Bruce Ratner-Chapman and Hall/CRC-2003	2013
9	Big Data Analytics with R and Hadoop-Vignesh Prajapati-Packt Publishing-2013	2013

19AM2207-**CLOUD COMPUTING**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 6.4 Course Outcomes of 19AM2207

CO#	Course Outcome	PO/PSO	BTL
CO1	Identify the appropriate cloud services for a given application	PO2	2
CO2	Understand authentication, confidentiality and privacy issues in Cloud computing environment.	PO3	2
CO3	Justify financial and technological implications for selecting cloud computing platforms	PO2	3
CO4	Analyze Cloud infrastructure including Google Cloud and Amazon Cloud.	PO5	4
CO5	Develop applications using VariousCloud Platforms	PO5	5

Cloud Computing, Resource Virtualization, Virtual Machine, Implementation of cloud services

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)

ResourceVirtualization

- 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: Benefittingenormously
- 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

- Access Control
- Trust, Reputation, Risk
- Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations
- Case Study on Open Source & Commercial Clouds
- Eucalyptus
- Microsoft Azure

- AmazonEC2

List of lab Experiments

Lab session No	Experiments	CO-Mapping
1	Create a spreadsheet by using Google forms.	CO1
2	Create and Store a fine using Amazon S3 .	CO1
3	Create and deploy a cloud-based application using Amazon EC2.	CO1
4	Create and deploy a cloud-based application using IBM Blue Mix.	CO2
5	Use Yahoo! Pipes to create a mashup.	CO2
6	Create and deploy a cloud-based application using Google App Engine.	CO2
7	Find procedure to do Desktop virtualization that allows a computer to run two or more operating systems at the same time and allows user to switch between the systems.	CO3
8	Install a virtual machine and execute a sample C program.	CO4
9	Execute a sample C or C++ Program using Server Virtualization.	CO4

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	
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	2010

7. COURSES OFFERED IN ELECTIVE STREAM - FLUIDMECHANICS

19AM2108- **ContinuumMechanics-1**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 7.2 Course Outcomes of 19AM2108

CO #	CO Description	PO/PSO	BTL
CO1	Apply the basic concepts of generalized co-ordinates, unilateral and bilateral constraints; principle of virtual work, D'Alemberts principle.	PO3 PSO2	3
CO2	Apply the methods of variational principle, problems of calculus of variations, shortest distance, minimum surface of revolution, Brachistochrone problem iso-perimetric problem, geodesic.	PO3 PSO2	3
CO3	Analyze Lagranges equation of first kind and of second kind, uniqueness of solution, Energy equation of conservative fields, generalized equations	PO4 PSO2	4
CO4	Analyze the principle of least action, Routh's equation, Hamilton-canonical equation of Motion.	PO4 PSO2	4

Physical Properties of Fluids, Thermodynamics of Fluids, Eulerian and Lagranges methods of Description of Fluids.

Syllabus

Physical Properties of Fluids:Concept of fluids, Continum Hypothesis, Density, Specific Weight and Specific Volume, Pressure, Viscosity and Surface tension. Thermodynamics of Fluids:Introduction to thermodynamics, Equation of State, First Law of thermodynamics, Second Law of Thermodynamics and Clausius Inequality Kinematics of Fluids:Eulerian and Lagranges methods of Description of Fluids, Equvalence of Lagrangian and Eulerian Methods, Translation, Rotation and Deformation of Fluid Elements, Analytical Approach to Deformation, Stress - strain relations, Steady and unsteady flows, Stream Lines, Path Lines and Streak Lines Stress in Fluids and Constitutive Equations:Stress tensor, Normal Stresses, Shear Stresses, Symmetry of Shear of Stress tensor, newtonian Fluids, Non Newtonian Fluids, Purely viscous fluids, Reiner Rivlin Fluids, Power Law Fluids, Visco elastic fluids

Suggested Books:

S. No.	Name of Authors / Books / Publishers Year of Publication
1.	D.N.Berghese and A.M.Downs, Classical mechanics and Control, John Willey
2.	Goldstein, Classical Mechanics, Narosa Publications
3.	Rana and Jong, Classical Mechanics, Narosa Publications
4.	E.T.Whittecker, Treatise on the Analytical Dynamics and Rigid Bodies
5.	I.S.Sokolnikoff : Mathematical Theory of Elasticity , Tata Mc. Grawhill 1997
6.	S.Valliappan : Continuum Mechanics , Oxford & IBH Publishing Company

19AM2208- **ContinuumMechanics-2**

L-T-P/S	4-0-0
Credits	4
Contact Hours	4

Table 7.3 Course Outcomes of 19AM2208

CO #	**CO Description**	**PO/PSO**	**BTL**
1	Apply various parameters such as Body force, Surface force, Cauchy's stress principle. Stress vector, State of stress at a point, relationship. These basics are essential for firther analysis and to know the composition of fluidstructure	PO1 PSO3	3
2	Analyze force and moment equilibrium, Stress tensor symmetry, Stress quadric of Cauchy, Stress transformation laws, Principal stress, Stress invariant, Stress ellipsoid.	PO2 PSO3	4
3	Analyze the concepts of deformation Gradients, Displacement Gradient, Deformation tensor, Finite strain tensors, Small deformation theory—	PO3 PSO4	4
4	Analyze finite strain interpretation, principal strains, strain invariant, cubical dilatation, Compatibility equation for linear strain, Strain energy function. Hook's Law. Methods and Solutions of Navier-Stocks Equations.	PO5 PSO3	4

Conservation Laws, Equation for the conservation of momentum, D' Alemberts paradox, Incompressible Viscous Fluid Flows:

Syllabus

Conservation Laws:Equation of conservation of Mass, Equation for the conservation of momentum, Equation for energy, Basic equations in different coordinate systems, Boundary conditions,Irrotational and Rotational Flows: Kelvins minimum energy theorem, Gauss theorem, Bernoullis equation and its application, 2D irrotational incompressible flows, D' Alemberts paradox, Flow due to a moving cylinder with circulation, Flow over an aerofoil, Voretex motion, velocity potential due to a vortex, velocity potential due to a vortex, Incompressible Viscous Fluid Flows:Flow between two parallel plates, Plane ciutte flow, Plane poiseuille flow, Flow over an inclined plane, Flow of two immissible fluids, Flow through circular pipe. Flow through an annulus, Flow between two porous plates,Plane couette flow, Flow through convergent and divergent channels, Stagnent point, Unsteady flows. Unsteady flow over a flat plate, Unsteady flow between two parallel plates.

Suggested Books:

S. No.	**Author(s) / Title/ Edition No./ Publisher**
1.	D.N.Berghese and A.M.Downs, Classical mechanics and Control, John Willey
2.	Goldstein, Classical Mechanics, Narosa Publications
3.	Rana and Jong, Classical Mechanics, Narosa Publications
4.	E.T.Whittecker, Treatise on the Analytical Dynamics and Rigid Bodies
5.	I.S.Sokolnikoff : Mathematical Theory of Elasticity , Tata Mc. Grawhill 1997
6.	S.Valliappan : Continuum Mechanics , Oxford & IBH Publishing Company

19AM2209- **Computational FluidDynamics**

L-T-P/S	3-0-2
Credits	4
Contact Hours	5

Table 7.4 Course Outcomes of 19AM2209

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the concepts of Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation. and General Structure of ConservationEquations, Approximate Solutions of Differential Equations:	PO1 PSO2	1
CO2	Apply the concepts of steady state Diffusion Problems,Boundary Condition Implementation. Discretization of Unsteady State Problems, FTCS (Forward time central space) scheme,	PO2 PSO2	3
CO3	Apply the basic features of Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Methods, Iterative Methods, -Diffusion Equations:	PO3 PSO2	3
CO4	Analyze the nature of Navier Stokes Equations:Stream FunctionVorticity approach and Primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm,	PO5 PSO3	4
CO5	To analyze the analytical solution and compare with that of numerical solution for a meaningful interpretation	PO8 PSO4	4

Continuity Equation, Navier Stokes Equation, Energy Equation, Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, A Finite Volume Approach.

Syllabus

Introduction to Computational Fluid Dynamics and Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations: Error Minimization Principles: Finite Element Method, Finite Difference and Finite Volume Method, Finite VolumeMethod:

Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems,Boundary Condition Implementation and Discretization of Unsteady State Problems, FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, FTFS, FTBS and CTCSSchemes,

Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods, - Diffusion Equations:

A Finite Volume Approach, Discretization of Navier Stokes Equations:Stream FunctionVorticity approach and Primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm,

Suggested Books:

S. No.	Author(s) / Title/ Edition No./ Publisher	
1.	K. Muralidhar, T. Sundararajan, Computational Fluid Flow and Heat Transfer, 2nd Ed., Narosa.	2011
2.	Fluid Mechanics by Jenkins and White	
3.	Chung T. J., Computational Fluid Dynamics, Cambridge University Press.	2003
4.	Tapan K. Sengupta, Computational Fluid Dynamics by University Press.	2005
5.	Hirch C., Numerical Computation of Internal and External Flows, Elesvier.	2007
6	S. V. Patankar, Numerical Heat Transfer and Fluid Flow (Hemisphere Series on Computational Methods in Mechanics and	Latest Eddition

	Thermal Science)	
7	Zikanov. O., Essential Computational Fluid Dynamics, Wiley.	2010
8	P. S. Ghoshdastidar, Computer Simulation of Flow and Heat Transfer, 4th Ed., Tata McGraw-Hill.	1998