arise. awake. achieve

VIVEKANANDA
GLOBAL UNIVERSITY

(Established by Rajasthan State Legislature and covered u/s 2(f) of the UGC Act, 1956)

FACULTY OF BASIC AND APPLIED SCIENCES

SCHEME & SYLLABUS
FOR
MASTER OF SCIENCE
MATHEMATICS
(Department of Mathematics)

Version	2.3
Applicable for Back Examination (Session)	Session 2016-17 , 2017-2018, 2018-2019,2019-2020
Date of BOS/BOF/AC	BOS-05/05/2020/BOF-05/05/2020/AC-18/07/2020
Page No. Where Major/Minor Changes have been done	Page No 1- 58
Implemented from (Session)	Session 2020-21
Scheme and Syllabus Page Number	Scheme-4 to 6, Syllabus - 7 to 40

Total Credit of the Program

Semester	I	II	III	IV	Total
Credits	22	22	22	22	88

SESSION: 2020-2021

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Master of Science (Mathematics)
Contents

Programme Objectives

The M.Sc. Mathematics programme's main objectives are

PO1: To inculcate and develop mathematical aptitude and the ability to think abstractly in the student.

PO2: To develop computational abilities and programming skills.

PO3: To develop in the student the ability to read, follow and appreciate mathematical text.

PO4: Train students to communicate mathematical ideas in a lucid and effective manner.

PO5: To train students to apply their theoretical knowledge to solve problems.

PO6: To encourage the use of relevant software such as MATLAB and MATHEMATICA.

Programme Specific Outcomes

On successful completion of the M.Sc. Mathematics programme a student will

PSO1: Have a strong foundation in core areas of Mathematics, both pure and applied.

PSO2: Be able to apply mathematical skills and logical reasoning for problem solving.

PSO3: Communicate mathematical ideas effectively, in writing as well as orally.

PSO4: Have sound knowledge of mathematical modeling, programming and computational techniques as required for employment in industry.

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21						
SEMESTER I						
Course Code	University Course Type	Course Name	Teaching Scheme			
			L	T	P	C
MAT158	Core Theory	Advanced Abstract Algebra	4	1	0	5
MAT160	Core Theory	Integral Transforms	4	1	0	5
MAT161	Core Theory	Differential Geometry	4	1	0	5
	Department Specific Elective 1	**(Choose any one)**				
MAT159 BCS 305		Topology Object Oriented Programming Lab with C++	4 0	1 0	0 4	5 2
BCSAI 102 BCSAI 104 BCSAI 105		Elements of Computing System Computing Systems Lab Programming in C Language Lab	3 0 0	0 0 0	0 4 4	3 2 2
Total			**16**	**4**	**4**	**22**

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21						
SEMESTER II						
Course Code	University Course Type	Course Name	Teaching Load			
			L	T	P	C
MAT 163	Core Theory	Mathematical Programming	4	1	0	5
MAT 164	Core Theory	Combinatorics and Graph Theory	4	1	0	5
	Department Specific Elective 2	**(Choose any one)**				
MAT 162		Functional Analysis	4	1	0	5
BCSAI 205 BCSAI 206		Digital Electronics Digital Electronics Lab	3 0	0 0	0 4	3 2
DSE 3	Department Specific Elective 3	Choose any one from list of DSE Courses	4	1	0	5
MAT 180	Core Practical	Numerical Analysis Lab – I	0	0	4	2
Total			**16**	**4**	**4**	**22**

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21						
SEMESTER III						
Course Code	University Course Type	Course Name	Teaching Scheme			
			L	T	P	C
MAT 168	Core Theory	Advanced Linear Algebra	4	1	0	5
MAT 169	Core Theory	Operations Research	4	1	0	5
MAT 170	Core Theory	Advanced Graph Theory-I	4	1	0	5
DSE 4	Department Specific Elective 4	Choose any one from list of DSE Courses	4	1	0	5
MAT 181 BCSAI309	Department Specific Elective Lab 5	**(Choose any one)**				
		Numerical Analysis Lab – II	0	0	4	2
		Object Oriented Programming With Java Lab	0	0	4	2
Total			**16**	**4**	**4**	**22**

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21						
SEMESTER IV						
Course Code	**University Course Type**	**Course Name**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT 182	Core Practical	MATLAB Lab	0	0	4	2
MAT 193	Core Practical	Seminar	0	0	4	2
MAT 184	Core Practical	Project	0	0	16	8
DSE 6	Department Specific Elective 6	Choose any one from list of DSE Courses	4	1	0	5
DSE 7	Department Specific Elective 7	Choose any one from list of DSE Courses	4	1	0	5
Total			**8**	**2**	**24**	**22**

Theory – **2 Midterm Exams and Course Work* (40%)** **End Term Exam (60%)**

Practical- **2 Midterm Exams and Course Work* (60%)** **End Term Exam (40%)**

*Class work shall include: Quiz, Assignment, Seminars, Presentations, Attendance, Case study, Surprise class test, Lab. record, Viva, Projects, and Observation

LIST OF DEPARTMENT SPECIFIC ELECTIVE COURSES (FOR DSE 3, 4,6,7)

S. No.	Course Code	Department Specific Elective
1.	MAT 165	Integral Equations
2.	MAT 167	Calculus of Variations & Special Functions
3.	MAT 171	Fluid Mechanics
4.	MAT 172	Mathematics in Multimedia
5.	MAT 173	Mathematical Modeling
6.	MAT 174	Wavelet Analysis
7.	MAT 175	Fuzzy Sets and Applications
8.	MAT 176	Cryptography
9.	MAT 178	Algorithm Design Techniques
10.	MAT 179	Mathematical Statistics
11.	MAT 202	Tensor Analysis & Number Theory
12.	MAT 203	Differential Equation and Finite Element Analysis
13.	MAT 204	Advanced Numerical Analysis
14.	BCSAI 303 BCSAI 308	Data Structures & Algorithms Data Structures & Algorithms Lab
15.	BCSAI 401 BCSAI 405	Design and Analysis of Algorithms AI and Intelligent Agents
16.	BCSAI 504 BCSAI 509	Data Mining And ML Data Mining And ML Using Python Lab
17.	BCSAI 603 BCSAI 610	Advanced Machine Learning Advanced Machine Learning with Python Lab

Evaluation Scheme

Maximum Marks for all the courses

	Theory	**Practical**
Maximum Marks	100	100
Internal Marks	40%	60%
External Marks	60%	40%

- Practical and Theory courses are mention in the format as L-T-P where

  L- Lecture

  T- Tutorial

  P- Practical

- Class work shall include: Quiz, Assignment, Seminars, Presentations, Attendance, Case study, Surprise class test, Lab record, Viva, Projects, and Observation Book.
- All elective courses are clearly mention as "**Department specific elective (DSE)"**
- No zero credit course is there in the scheme.

Semester I

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21		
Course Code	University Course Type	Course Name
MAT158	Core Theory	Advanced Abstract Algebra
MAT 159	Core Theory (Group A)	Topology
BCS 305	Core Practical (Group A)	Object Oriented Programming Lab with C++
BCSAI 102	Core Theory (Group B)	Elements of Computing System
BCSAI 104	Core Theory (Group B)	Computing Systems Lab
BCSAI 105	Core Theory (Group B)	Programming in C Language Lab
MAT 160	Core Theory	Integral Transforms
MAT 161	Core Theory	Differential Geometry

MAT 158

ADVANCED ABSTRACT ALGEBRA

L - T - P – C : 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: In this course a new algebraic structure, namely, solvable groups and modules are introduced and studied in detail. Fields forms one of the important and fundamental algebraic structures and has an extensive theory dealing mainly with field extensions which arise in the study of roots of polynomials. In this course we study fields in detail with a focus on Galois theory which provides a link between group theory and roots of polynomials.

Course Outcomes: After studying this course the student will be able to

CO1: Identify and construct example of modules and solvable groups, and apply homomorphism theorems on the same. identify and construct examples of fields, distinguish between algebraic and transcendental extensions, characterize normal extensions in terms of splitting fields and prove the existence of algebraic closure of a field.
CO2: perfect fields using separable extensions, construct characterize examples of automorphism group of a field and Galois extensions and the fundamental theorem of Galois theory.
CO3: classify finite fields using roots of unity and Galois theory and prove that every finite separable extension is simple.
CO4: use Galois theory of equations to prove that a polynomial equation over a field of characteristic is solvable by radicals iff its group (Galois) is a solvable group and hence deduce that a general quintic equation is not solvable by radicals.

Module-I

Quotient groups- Fundamental theorem of homomorphism. Structure theory of groups- free abelian groups, finitely generated abelian groups, group actions on a set, Sylow's Theorem.

Module-II

Solvable groups, Jordan-Holder Theorem, Normal series, Quotient rings, Maximal and prime ideal. Fundamental Theorem of ring isomorphism. Field of Quotients and embedding of rings.

Module-III

Polynomial rings, Factorization theory of Integral domains, Prime fields, Extension of fields.

Module-IV

Modules- Definition and examples, Sub modules and Direct sums, Ring homomorphism and Quotient modules, Completely reducible modules, Free modules over polynomial rings.

Module-V

Galois theory - Automorphism, Groups and fixed field, Normal extension and Fundamental theorem of Galois theory, Application Galois theory to classical problems such as root of unity and cyclotomic polynomial, cubic equations, cyclic extensions, symmetric functions, Construction with Ruler and Compass.

Text Books:

1. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
2. E. Artin, Galois theory, Notre Dame, Indiana (1959).

Reference Books:

1. K.G. Ramanathan, Lectures in Abstract Algebra,TIFR(1954).
2. N. Jacobson, Lectures in Abstract Algebra, Vol. III, Van Nostrand,Princeton(1964).
3. T. W. Hungerford, Algebra.
4. G. Birkhoff and S. MacLane, Algebra.
5. K. M. Hoffman and R. Kunze, Linear Algebra.

MAT 160
INTEGRAL TRANSFORMS

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: The goals for the course are to gain a facility with using the transform, both specific techniques and general principles, and learning to recognize when, why, and how it is used. Together with a great variety, the subject also has a great coherence, and the hope is students come to appreciate both.

Course Outcomes: Students will be able to-
CO1. know the use of Laplace transform in system modeling, digital signal processing, process control, solving Boundary Value Problems.
CO2. use Fourier transform in communication theory and signal analysis, image processing and filters, data processing and analysis, solving partial differential equations for problems on gravity

Module 1

Laplace transform– Definition and its properties, Rules of manipulation, Laplace transform of derivatives and integrals, Properties of inverse Laplace transform, Convolution theorem.

Module 2

Fourier transform – Definition and properties of Fourier sine, cosine and complex transforms, Convolution theorem, Inversion theorems, Fourier transform of derivatives.

Module 3

Applications of Laplace transform and Fourier transform-Solution of ordinary and partial differential equations.

Module 4

Mellin transform– Definition and elementary properties, Mellin transforms of derivatives and Integrals, Inversion theorem, Convolution theorem.

Module 5

Complex inversion formula, Infinite Hankel transform– Definition and elementary properties, Hankel transform of derivatives, Inversion theorem, Parseval Theorem.

Text Books:

1. Integral Transforms, Schaum Series.

Reference Books:

1. A First course in integral equations –A.M. Wazwaz (1997) (world Scientific)
2. Introduction to Integral Equation with Applications –A.J. Jerri (1999) Second edition Wiley Interscience.

MAT 161
DIFFERENTIAL GEOMETRY

L - T - P – C: 4 – 1 – 0- 5 **Course Type - Core Theory**

Course Objectives: The primary objective of this course is to understand the notion of level sets, surfaces as solutions of equations, geometry of orientable surfaces, vector fields, Weingarten maps, line integrals, areas, volumes and Gauss-Bonnet theorem.

Course Outcomes: After studying this course the student will be able to-

CO1. Understand the concepts of graphs, level sets as solutions of smooth real valued functions vector fields and tangent space.

CO2. Know line integrals, be able to deal with differential forms and calculate arc length and curvature of surfaces.

CO3. Learn about linear self-adjoint, Weingarten map and curvature of a plane curve with applications in geometry and physics.

CO4. Study surfaces with boundary and be able to solve various problems and the Gauss - Bonnet theorem.

Module-I

Space curves, Tangent, Contact of curve and surface, Osculating plane, Principal normal and Binormal, Curvature, Torsion, Serret-Frenet's formulae, Osculating circle and Osculating sphere, Existence and Uniqueness theorem for space curves, Bertrand curves, Involute and Evolutes.

Module-II

Conoids, Inflexional tangents, Singular points, Indicatrix. Ruled surface, Developable surface, Tangent plane to a ruled surface, Necessary and sufficient condition that a surface $\zeta = f(\xi, \eta)$ should represent a developable surface.

Module-III

Metric of a surface, first and second fundamental forms, Fundamental magnitudes of some important surfaces, orthogonal trajectories.

Module-IV

Normal curvature, Principal directions and Principal curvatures, First curvature, Mean curvature, Gaussion curvature, Radius of curvature of a given section through any point on z = f(x,y). Lines of curvature, Third Fundamental Form, Relation between fundamental forms.

Module-V

Asymptotic lines, Differential equation of an asymptotic line, Curvature and Torsion of an asymptotic line, Gauss's formulae, Gauss's characteristic equation, Weingarten equations, Mainardi-Codazzi equations, Fundamental existence theorem for surfaces, Parallel surfaces, Gaussian and mean curvature for a parallel surface.

Text Books:

1. J.A. Thorpe : Elementary Topics in Differential Geometry (Springer Verlag)

Reference Books:

1. B Oneill : Elementary Differential Geometry (Academic - New York)
2. M. do Carmo: Differential Geometry of curves and surfaces. (Englewood Cliffs, N.J., Prentice Hall, 1976).
3. R. Millman and G. Parker : Elements of differential Geometry. (Englewood Cliffs, N.J., Prentice Hall, 1977)

MAT 159
TOPOLOGY

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory(Group A)**

Course Objectives: To introduce basic concepts of point set topology, basis and sub basis for a topology and order topology. Further, to study continuity, homeomorphisms, open and closed maps, product and box topologies and introduce notions of connectedness, path connectedness, local connectedness, local path connectedness, convergence, nets, countability axioms and compactness of spaces.

Course Outcomes: After studying this course the student will be able to

CO1. Determine interior, closure, boundary, limit points of subsets and basis and sub basis of topological spaces.

CO2. Check whether a collection of subsets is a basis for a given topological spaces or not, and determine the topology generated by a given basis.

CO3. Identify the continuous maps between two spaces and maps from a space into product space and determine common topological property of given two spaces.

CO4. Determine the connectedness and path connectedness of the product of an arbitrary family of spaces.

Module-I

Definition and examples of topological spaces. Closed sets, Closure, Neighborhoods, interior, exterior, and boundary, Accumulation points and derived sets and related sets.

Module-II

Bases and sub-bases, Subspaces and relative topology, Alternative methods of defining a topology in terms of Kuratowski closure operator and neighborhood systems, Continuous functions and homeomorphism.

Module-III

The separation axioms T_0, T_1, T_2, T_3, T_4; their characterizations and basic properties, Urysohn's lemma, Tietze extension theorem.

Module-IV

Compactness-Basic properties of compactness, Compactness and finite intersection property, Sequential, Compact space, and B-W compactness. Local compactness.

Module-V

Product space, Connected spaces and their basic properties. Connectedness of the real line. Components. Locally connected spaces.

Text Books:

1. J. L. Kelley, General Topology, Van Nostrand, 1995.
2. James R. Munkres, Topology, 2nd Edition, Pearson International, 2000.

Reference Books:

1. G.E. Bredon, Topology and Geometry, Springer, 2014.
2. K. D. Joshi, Introduction to General Topology, Wiley Eastern, 1983.
3. J. Dugundji, Topology, Prentice-Hall of India, 1966.
4. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
5. N. Bourbaki, General Topology, Part I, Addison-Wesley, 1966.
6. S. Willard, General Topology, Addison-Wesley, 1970.

7. S.W. Davis Topology, Tata McGraw Hill, 2006

Semester I **M.Sc.Mathematics / B.Sc.**

BCS 305

OBJECT ORIENTED PROGRAMMING LAB WITH C++ Lab

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

Objective: To understand the advance aspect of computer programming and object oriented concepts like concept of class, invoking methods, inheritance etc. using C and C++.

1. Create a user defined function (any) and use it inside the program.
2. Implement "call by value" & "call by reference " function call techniques by using any user defined functions.
3. Implement the working of classes and objects by using any real world object.
4. Create a Stack object model in C++ & also make use of default and parameterized constructor to make the class more flexible in use.
5. Make all the member functions, including constructors, non-inline in the above class.
6. Create any user defined class using the concept of static data and member functions.
7. Create a Class or program implementing the concept of passing and returning object to/from member functions.
8. WAP to implement polymorphism through function overloading (Area of different shapes).
9. Create a user defined type Complex and do all the Complex number arithmetic. And also make use of operator overloading.
10. Implement single level inheritance by using Student and Marks class.
11. Implement multilevel inheritance by using the Stack class.
12. Demonstrate the calling mechanism of constructors and destructors in Multilevel Inheritance.
13. Create generic Stack model for storing different types of data.
14. Create a user defined type Matrix and perform all matrix operations. Also make use of operator overloading.
15. Implement the concept of Abstract classes and virtual functions by using Shape, Rectangle and Triangle class.

Text Books :

1. Problem solving with C++, The OOP, 4th Edition, Walter Savitch, Pearson Education.
2. Object Oriented Programming in C++, 3rd Edition, R.Lafore, Galigotia Publications pvt ltd.

Reference Books:

1. C++, The Complete Reference, 4th Edition, Herbert Schildt, TMH.
2. The C++ Programming Language, 3rd Edition, B.Stroutstrup, Pearson Education

Semester I **M.Sc. Mathematics/B.Tech CSE (AI)**

BCSAI 102: ELEMENTS OF COMPUTING SYSTEM

3L + 0T + 0P + 3C **Course Type- Core Theory(Group B)**

Unit 1: Register Transfer and Micro-operation

Register Transfer Language, Register Transfer, Bus and Memory Transfer: Three state bus buffers, Memory Transfer. Arithmetic Micro-operations: Binary Adder, Binary Adder-Subtractor, Binary Incrementor, Logic Micro-operations.

Unit 2: Basic Computer Organization and Control Unit

Instruction Codes, Computer Registers: Common bus system, Computer Instructions: Instruction formats, Instruction Cycle: Fetch and Decode. Control Memory, Address Sequencing, Conditional branching, Mapping of instruction, Subroutines, Design of Control Unit, Central Processing Unit: Introduction, General Register Organization, Stack Organization stack; Instruction Formats, Addressing Modes

Unit 3: Computer Arithmetic

Introduction, Addition and Subtraction, Multiplication Algorithms (Booth algorithm), Division Algorithms, Input – Output Organization: Peripheral devices, Input – Output interface, Introduction of Multiprocessors: Characteristics of multi-processors

Unit 4: Modes of Data Transfer and Memory Organization

Modes of Data Transfer: Priority Interrupt, Direct Memory Access, Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory

Unit 5: Introduction to Information Storage: Information Storage, Evolution of Storage Architecture

Data Center Environment: Application, Host (Computer), Connectivity, Storage, Host Access to Data, Direct-Attached Storage, Storage Design Based on Application

Data Protection (RAID): RAID Implementation Methods, RAID Array Components, RAID Techniques, RAID Levels, RAID Impact on Disk Performance, RAID Comparison

Text /Reference Books:

1. Computer System Architecture by Morris Mano, PHI
2. Computer Organization and Architecture by William Stallings, PHI
3. Information Storage and Management (Storing Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments) 2nd Edition by Somasundaram Gnanasundaram Alok Shrivastava.
4. Digital Computer Electronics: An Introduction to Microcomputers by Malvino, TMH
5. PC Hardware in a Nutshell by Barbara Fritchman Thompson, Robert Bruce Thompson, O'Reilly, 2nd Edition , 2010
6. Fundamentals of Computer Organization and Architecture by Mostafa AB-EL-BARR and Hesham EL-REWNI, John Wiley and Sons
7. Storage Management in Data Centers: Understanding, Exploiting, Tuning, and Troubleshooting Veritas Storage Foundation by Volker Herminghaus and Albrecht Scriba.

Semester I **M.Sc. Mathematics/B. Tech CSE (AI)**

BCSAI 104: COMPUTING SYSTEM LAB

0L + 0T + 4P + 2C **Course Type- Core Practical(Group B)**

List of Experiments:

1. Given a PC, name its various components and list their functions
2. Identification of various parts of a computer and peripherals
3. DOS Basic Commands
4. Exercises on entering text and data (Typing Practice)
5. Installation of Windows Operating System using pen- drive, CD & Virtual Machine
6. Configuring the Directly Attached Disks for Basic and Dynamic Disks
7. Creating and configuring the disk partitions and volumes for the disk in Windows/Linux System
8. Creating and Configuring the RAID 0, 1 and RAID5 in windows server 2012 R2
9. Configuring the Network Share using Windows Server 2012 R2
10. Configuring the File Server in Windows Server 2012 R2
11. Configuring NFS in Linux Server
12. Configuring the iSCSI in Windows Server 2012 R2
13. Configuring FCOE in Windows Server 2012 R2
14. Creating a System Backup and Restoring in Windows Server and Linux System
15. Creating and Restoring the Snapshot for Virtual Machines in Hyper-V

M.Sc. Mathematics /B. Tech CSE (AI)

BCSAI 105: PROGRAMMING IN C LANGUAGE LAB

0L + 0T + 4P + 2C **Course Type- Core Practical(Group B)**

Basic Calculation:

1. Write a c program to display your Name, address and city in different lines.
2. Write a c program to perform all arithmetic operations.
3. Write a c program to convert the Fahrenheit into centigrade. Formula c= (F-32)/1.8
4. Write a c program to calculate the simple interest.
5. Write a c program to calculate the compound interest.
6. Write a program in C to display sum of first N natural numbers.
7. Write a c program to find the roots of the quadratic equation.

Conditional Statements

1. Write a C – program which used to determine type of triangle based on sides. Measure of sides input by the user. To check whether the triangle is isosceles, scalene or equilateral triangle. Hint: If all the sides are equal than equilateral, If any two sides are equal than isosceles otherwise scalene.
2. Write a program in C to which allow user to enter any arithmetic operator (+ - * /) and two integer values and display result according to selection of operator.
3. Write a program in C to calculate gross salary of employee using : 1. Gross Salary = Basic Pay + DA + HRA – PF. 2. DA = 30% If Basic Pay < 5000 otherwise DA = 45% of the Basic Pay. 3. HRA = 15% of Basic Pay. 4. PF = 12% of Basic Pay. Only basic pay will input by the user. Display Gross salary – DA – HRA – PF and basic salary
4. Student should fulfill the following criteria for admission: Mathematics >= 50 Physics >= 45 Chemistry >= 60 Total of all subject >= 170 OR Total of Mathematics + Physics >= 120 Accept the marks of all the three subjects from the user and check if the student is eligible for admission.
5. Write a program in C for grade calculation using if…else if ladder and switch Statement. Accept marks of 3 subjects calculate total and based on it calculate Grade.

Loop Programs

1. Program to display first N prime numbers. N is input by the user.
2. Program to display A to Z in upper case or lower case according to user selection.
3. Program which used to print A to Z and Z to A.
4. Program which ask for party to user until the user say yes
5. Program which ask for party to user until the user say yes
6. Program which check that whether the given number is palindrome or not.
7. Program to check that the given number is Armstrong or not.
8. Program which will display next nearest prime number of given integer number. For example next nearest prime of 5 is 7, for 8 is 11, for 7 is 11 (Using Do while)

Semester II

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21		
Course Code	University Course Type	Course Name
MAT 162	Core Theory (Group A)	Functional Analysis
BCSAI 205	Core Theory (Group B)	Digital Electronics
BCSAI 206	Core Theory (Group B)	Digital Electronics Lab
MAT 163	Core Theory	Mathematical Programming
MAT 164	Core Theory	Combinatorics and Graph Theory
DSE 1	Department Specific Elective 1	Choose any one from list of DSE Courses
MAT 180	Core Practical	Numerical Analysis Lab – I

MAT 162
FUNCTIONAL ANALYSIS

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: To familiarize with the basic tools of Functional Analysis involving normed spaces, Banach spaces and Hilbert spaces, their properties dependent on the dimension and the bounded linear operators from one space to another.

Course Outcomes: After studying this course the student will be able to

CO1. verify the requirements of a norm, completeness with respect to a norm, relation between compactness and dimension of a space, check boundedness of a linear operator and relate to continuity, convergence of operators by using a suitable norm, compute the dual spaces.

CO2. distinguish between Banach spaces and Hilbert spaces, decompose a Hilbert space in terms of orthogonal complements, check totality of orthonormal sets and sequences, represent a bounded linear functional in terms of inner product, classify operators into self-adjoint, unitary and normal operators.

Module-I

Normed linear spaces, Quotient space of normed linear spaces and its completeness, Banach spaces and examples, bounded linear transformations, Normed linear space of bounded linear transformations.

Module-II

Equivalent norms, Basic properties of finite dimensional normed linear spaces and compactness,Reisz Lemma, Multilinear mapping, Open mapping theorem, Closed graph theorem, Uniform boundness theorem.

Module-III

Continuous linear functional, Hahn-Banach theorem and its consequences, Embedding and Reflexivity of normed spaces, Dual spaces with examples, Inner product spaces, Hilbert space and its properties.

Module-IV

Orthogonality and Functionals in Hilbert Spaces. Pythagorean theorem, Projection theorem,Orthonormal sets, Bessel's inequality, complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.

Module-V

Adjoint of an operator on a Hilbert space, Self-adjoint, Positive, Normal and Unitary operators and their properties. Projection on a Hilbert space. Invariance, Reducibility, Orthogonal projections. Derivatives of a continuous map from an open subset of Banach space to a Banach space.Rules of derivation, Derivative of a composite, Directional derivative, Mean value theorem and its applications.

Text Books:

1. E. Taylor, Introduction to Functional Analysis, John Wiley, 1958.
2. B. V. Limaye, Functional Analysis, Wiley Eastern.

Reference Books:

1. N. Dunford and J. T. Schwartz, Linear Operators, Part-I, Interscience, 1958.
2. R. E. Edwards, Functional Analysis, Holt Rinehart and Winston, 1965.
3. C. Goffman and G. Pedrick, First Course in Functional Analysis, Prentice- Hall of India, 1987.
4. K. K. Jha, Functional Analysis and Its Applications, Students' Friend, 1986

Semester II **M.Sc. Mathematics/B.Tech CSE (AI)**

BCSAI 205: DIGITAL ELECTRONICS

3L+0T+0P+3C **Course Type- Core Theory(Group B)**

Unit 1: Number Systems And Codes: Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic
Introduction to Boolean algebra: Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems

Unit 2:Logic Gates: Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic

Unit 3: Simplification Of Boolean Functions: K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method
Combinational Logic: Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers

Unit 4:Sequential Circuits: Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters

Unit 5: Logic Families: Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, DTL, TTL, ECL, MOS), tri-state devices
Programmable Logic: Introduction to programmable logic array (PLA) & programmable array logic (PAL

Text/Reference Books:

1. Digital Design, Moris Mano, Pearson Education
2. Digital Fundamental, Floyd and Jain, Pearson Education
3. Digital System: Principles and Applications, Tocci, Pearson Education
4. Digital Electronics, B. P. Singh, DhanpatRai& Sons
5. Modern Digital Electronics, R. P. Jain, Tata McGraw-Hill

Semester II **M.Sc. Mathematics/B.Tech CSE (AI)**

BCSAI 206: DIGITAL ELECTRONICS LAB

0L+0T+4P+2C **Course Type- Core Practical(Group B)**

List of Experiments:

1. To study and perform the following experiments:
(a) Operation of digital multiplexer and demultiplexer.
(b) Binary to decimal encoder.
(c) Characteristics of CMOS integrated circuits.
2. To study and perform experiment - Compound logic functions and various combinational circuits based on AND/NAND and OR/NOR Logic blocks.
3. To study and perform experiment - Digital to analog and analog to digital converters.
4. To study and perform experiment - Various types of counters and shift registers.
5. To study and perform experiment - Interfacing of CMOS to TTL and TTL to CMOS ICs.
6. To study and perform experiment- BCD to binary conversion on digital IC trainer.
7. To study and perform experiment -
(a) Astable (b) Monostable (c) Bistable Multivibrators and the frequency variation with different parameters, observe voltage waveforms at different points of transistor.
8. To study and perform experiment -Voltage comparator circuit using IC-710.
9. To study and perform experiment- Schmitt transistor binary circuit.
10. Design 2 bit binary up/down binary counter on bread board.

MAT 163

MATHEMATICAL PROGRAMMING

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: The objective of this course is to study optimality conditions, Lagrangian duality and numerical methods of mathematical programming problems with nonlinear objective and nonlinear constraints.

Course Outcomes: After studying this course the student will be able to

CO1. derive first and second order optimality conditions for a nonlinear programming problem and consider convex functions for deriving sufficient optimality conditions.

CO2. understand duality theory in terms of Lagrangian function and investigate saddle point theory.

CO3. understand numerical methods like Wolfe's method, convex simplex method and penalty function methods for solving different types of nonlinear programming problems.

Module-I

Introduction- Separating plane, supporting hyper plane and related theorems, convex function, local and global maxima and minima, theorem based on convexity and concavity of quadratic forms, simplex method and revised simplex method for solving L.P.P, bounded variable problems.

Module-II

Integer programming- Pure and mixed integer programming problems, Gomory's-cutting plane method, Branch and bound algorithm.

Module-III

Quadratic forms and Lagrangian function, Saddle points-Necessary and sufficient conditions for saddle points, Classical optimization –Nonlinear programming problem, Kuhn-Tucker Theory and Kuhn-Tucker necessary and sufficient condition for NLPP.

Module-IV

Quadratic programming problem Wolfe's method and Beale's method for solving quadratic programming problems.

Module-V

Dynamic programming-Introduction Bellman's principle of optimality, solution of problem with finite number of stages. Solution of LLP by Dynamic Programming.

Text Books:

1. F. S. Hiller and G. J. Leiberman, Introduction to Operations Research (6th Edition), McGraw-Hill International Edition, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison Wesley.

Reference Books:

1. H. A. Taha, Operations Research –An Introduction, Macmillan.
2. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
3. S. S. Rao, Optimization Theory and Applications, Wiley Eastern.
4. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi.

WEF.A.Y.2018-2019

MAT 164
COMBINATORICS AND GRAPH THEORY

L - T - P – C : 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: This course introduces topics in three key areas of discrete mathematics: graph theory, combinatorics, and extremal set theory. Students will have to reason abstractly, provide proofs of mathematical statements, and work with precise definitions.

Course Outcomes: After studying this course the student will be able to

CO1: State all of the technical definitions covered in the course (such as a graph, tree, planar graph, colouring, digraph, generating function, linear extension, and other terms).

CO2: State all of the relevant theorems covered in the course. Use these definitions and theorems from memory to construct solutions to problems and/or proofs.

CO3: . Formulate graph theoretic models to solve real world problems (e.g., scheduling problems).

CO4: Analyze combinatorial objects satisfying certain properties and answer questions related to existence (proving the existence or non-existence of such objects), construction (describing how to create such objects in the case they exist), enumeration (computing the number of such objects), and optimization (determining which objects satisfy a certain extremal property).

Module 1: Combinatorics– Counting of sets and multisets. Binomial and multinomial numbers. Unordered selection with repetitions, Selection without repetition. Counting objects and functions. Functions and the Pigeonhole principle. Inclusion and exclusion principle.

Module 2: Discrete numeric functions and combinatorial problems, Generating functions and recursions, Power series and their algebraic properties, Homogeneous and non-homogeneous linear recursions.

Module 3: Graphs– Basic terminology, Simple graphs, Multi graphs and Weighted graphs, Isomorphism, complementary graphs, self-complementary graphs, Adjacency matrix & Incidence Matrix of a graph.

Module 4: Walk and Connectedness, Paths and circuits, Shortest path in weighted graphs, Eulerian paths and circuits, Hamiltonian paths and circuits.

Module 5: Traveling salesman problem, operations on graphs. Trees– Trees, Rooted trees, Paths lengths in rooted trees, spanning trees, minimum spanning trees.

Text Books:

1. R. Diestel, Graph Theory, Springer.

Reference Books:

1. Harary, Graph Theory Narosa Publishers, New Delhi.
2. Douglas B West, Introduction to Graph Theory, Prentice- Hall, New Delhi.

WEF.A.Y.2019-2020

MAT 180
NUMERICAL ANALYSIS LAB – I

L - T - P – C: 0 - 0 – 4 - 2 **Course Type-** Core Practical

Course Objectives: The aim of this course is to enable students to design and analyze numerical methods to approximate solutions to differential equationsand to acquaint students with the latest typesetting skills. This course is devoted to learning basic scientific computing for solving differential equations. The concept and techniques included in this course enable the student to construct and use elementary MATLAB, MATHEMATICA programs for differential equations.

Course Outcomes: After studying this course the student will be able to

CO1.understand the key ideas, concepts and definitions of the computational algorithms, origins of errors, convergence theorems.

CO2.decide the best numerical method to apply to solve a given differential equation and quantify the error in the numerical (approximate) solution.

CO3.analyze an algorithm's accuracy, efficiency and convergence properties.

CO4: Typeset mathematical formulas, use nested list, tabular & array environments.

List of Practicals (Any eight using any software)

1. Solution of quadratic equation.
2. Solution of algebraic and transcendental equations.
3. Solve the system of equations by Gauss-Seidel method.
4. Solve the system of equations by Matrix inversion method.
5. Solution of the system of equations by Gaussian elimination method.
6. Solve the 1st order ordinary differential equation by Euler's method.
7. Solve the 1st order ordinary differential equation by Euler's modified method.
8. Solution of 1st order ordinary differential equation by Runge-Kutta methods.
9. Solution of numerical integration by Trapezoidal method.
10. Solution of numerical integration by Simpson's 1/3 method.
11. Solution of numerical integration by Simpson's 3/8 method.
12. Introduction to LaTeX and typesetting a simple document.
13. Adding basic information to a document, Environments by LaTeX.

Text books:

1. Robert J. Schilling & Sandra L. Harris, "Applied Numerical Methods for Engineers using SCILAB & C", Thomson Brooks / Cole.

2. P. N. Wartikar and J. N. Wartikar, "Elements of Applied Mathematics", Volume 1 and 2, VidyarthiPrakashan, 1978.

Reference Books:

1. S. S. Shastri, "Engineering Mathematics", Vol-2, PHI, 2nd Edition, 1994.
2. S.S. Shastri, "Introductory Methods of Numerical Methods" Vol-2, PHI, 2ndEdition, 1994.
3. S. C. Gupta,V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 1971.
4. Erwin Kreyszing, "Advanced Engineering Mathematics", John Wiley & Sons, 2010.
5. John H. Mathews, "Numerical Methods for Mathematics, Science & Engineering", Prentice Hall, 1992.

Semester III

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21		
Course Code	University Course Type	Course Name
MAT 168	Core Theory	Advanced Linear Algebra
MAT 169	Core Theory	Operations Research
MAT 170	Core Theory	Advanced Graph Theory-I
DSE2	Department Specific Elective 2	Choose any one from list of DSE Courses
MAT 181	Core Practical (Any One)	Numerical Analysis Lab - II
BCSAI 309		Object Oriented Programming With Java Lab

MAT 168

ADVANCED LINEAR ALGEBRA

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objective: The primary objective of this course is to introduce the tools of Linear algebra. This course emphasizes the application of techniques using the vector spaces, basis and dimension, rank of matrix, change of basis, linear transformations, dual space, inner product space (real and complex), adjoint of a linear operator, bilinear forms and their properties**.**

Courses Outcomes: On completion of this course, the student will be able to:

CO1. Appreciate the significance of vector spaces, basis and dimension.

CO2. Compute with the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.

CO3. Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain orthonormal basis.

Module-I

Vector spaces, Basis and dimension, rank of matrix, change of basis.

Module-II

Linear transformations -Algebra of linear transformation, linear functional, dual space, dual basis, linear transformation of direct sum.

Module-III

Elementary canonical form introductive, Characteristic values , annihilator polynomial. Invariant subspace, direct sum deco potion, invariant direct sum, primary decomposition theorem.

Module-IV

Inner product space- inner product(real and complex), adjoint operator hermition form, linear functional and adjoint unitary operator , normal operator .

Module-V

Bilinear form : Bilinear form , symmetric bilinear form , skew symmetric bilinear form, graphs preserving bilinear form.

Text Books:

1. K. Hoffman and Ray Kunje : Linear Algebra (Prentice - Hall of India private Ltd.)
2. J.S. Golan : Foundations of linear algebra (Kluwer Academic publisher (1995))

Reference Books:

1. M. Artin : Algebra (Prentice - Hall of India private Ltd.)
2. A.G. Hamilton : Linear Algebra (Cambridge University Press (1989))
3. N.S. Gopalkrishanan : University algebra (Wiley Eastern Ltd.)
4. J.S. Golan : Foundations of linear algebra (Kluwer Academic publisher (1995))
5. Henry Helson : Linear Algebra (Hindustan Book Agency (1994))
6. I.N. Herstein : Topics in Algebra, Second edition (Wiley Eastern Ltd.)

MAT 169
OPERATIONS RESEARCH

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: One of the objective of the course is to develop the conjugate duality theory and deal with some numerical techniques to solve a nonlinear problem. Further, the course aims to study dynamic programming approach to solve different types of problems and to study optimal control problems.

Course Outcomes: After studying this course the student will be able to

CO1. have studied notions of sub-gradients and directional derivative for nondifferentiable functions.

CO2. understand the use of conjugate functions to develop the theory of conjugate duality.

CO3. know numerical methods like gradient descent method, gradient projection method, Newton's method and conjugate gradient method.

CO4. deal with dynamic programming approach to solve some problems including stage coach problem, allocation problem and linear programming problem. CO5. know both classical and modern approaches in the study of optimal control problems.

Module-I

Nonlinear Programming, Quadratic Programming, Duality in Quadratic Programming Problems, Unconstrained Optimization, Direct search methods, Gradient Method, Constrained Optimization, Separable Programming.

Module-II

Inventory Models-Deterministic and Probabilistic Models.

Module-III

Queuing Theory-Characteristics of queuing systems, Birth and death process, Steady state solutions, Single server model (finite and infinite capacities), Single server model (with SIRO), Models with state dependent arrival and service rates, Waiting time distributions.

Module-IV

Replacement Theory-Replacement of assets that deteriorate with time, Replacement of items that deteriorate suddenly.

Module-V

Project Scheduling by PERT, CPM.

Text Books:

1. F. S. Hiller and G. J. Leiberman, Introduction to Operations Research (6th Edition), McGraw-Hill International Edition, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison Wesley.

Reference Books:

1. H. A. Taha, Operations Research –An Introduction, Macmillan.
2. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
3. S. S. Rao, Optimization Theory and Applications, Wiley Eastern.
4. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., NewDelhi.

MAT170
ADVANCED GRAPH THEORY-I

L - T - P – C: 4 – 1 – 0- 5 **Course Type- Core Theory**

Course Objectives: This course is aimed to cover a variety of different problems in Graph Theory. In this coursestudents will come across a number of theorems and proofs. Theorems will be stated and proved formally using various techniques. Various graphs algorithms will also be taught along with its analysis

Course Outcomes: After the course the student will able to
CO1. Understand graph theory which has diverse applications in the areas of computer science, biology, chemistry, physics, sociology, and engineering.
CO2. To make difference between various graphs with the help of many theorems.

Module-I

Cut sets– Cut-sets, Cut vertices, Fundamental cut sets, Connectivity and seperativity, Net work flows, Max-flow min-cut theorem.

Module-II

Plannar Graphs– Combinatorial and geometric graphs, Kuratowski's graphs, Euler's formula, Detection of planarity, Geometric dual, Thickness and Crossing number.

Module-III

Graph Colouring, Vertex colouring, Edge colouring and Map colouring, Chromatic number, Chromatic polynomials, The four and five colour theorems.

Module-IV

Digraphs– Binary relations, Directed graphs and Directed trees, Arborescence, Polish notation Method.

Module-V

Enumeration of graphs, Counting of labeled trees and unlabeled trees, Cayley's theorem, counting methods, Polya's theory, Graph enumeration with Polya's theory.

Text Books:

1. D.B.West, Graph Theory, Pearson Publ. 2002.
2. 2. F.Harary, Graph Theory. Narosa Publ. ND.

Reference Books:

1. R. Diestel, Graph Theory, Springer, 2000.
2. Douglas B. West, Introduction to Graph Theory Prentice- Hall, New Delhi (1999)
3. John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991)
4. Nora Harsfield and Gerhard Ringel , Pearls Theory, Academic Press (1990)
5. Harary, Graph Theory, Narosa Publishers, New Delhi (1989)

WEF.A.Y.2019-2020

MAT 181

NUMERICAL ANALYSIS LAB- II

L - T - P – C: 0 - 0 – 4 - 2 **Course Type- Core Practical**

Course Objectives: The aim of this course is to enable students to design and analyze numerical methods to approximate solutions to differential equations and to acquaint students with the latest typesetting skills. This course is devoted to learning basic scientific computing for solving differential equations. The concept and techniques included in this course enable the student to construct and use elementary MATLAB, MATHEMATICA programs for differential equations.

Course Outcomes: After studying this course the student will be able to

CO1.understand the key ideas, concepts and definitions of the computational algorithms, origins of errors, convergence theorems.

CO2.decide the best numerical method to apply to solve a given differential equation and quantify the error in the numerical (approximate) solution.

CO3.analyze an algorithm's accuracy, efficiency and convergence properties.

CO4: Typeset mathematical formulas, use nested list, tabular & array environments.

Solve (using any software):

1. Solution of Transportation problem by North-West Corner Method.
2. Solution of Transportation problem by Lowest cost entry method.
3. Solve Assignment problem
4. Solve Dual Simplex method
5. Solve mixed integer programming problem.
6. Solution of L.P.P. with one constraint.
7. Solution of L.P.P. with multiple constraints.
8. Local and Global optimization involving one variable.
9. Numerical non-linear local optimization of functions.
10. Numerical non-linear global optimization of functions.
11. Introduction of Footnotes, Sectioning and displayed material in LaTeX.
12. Accents and symbols, Mathematical Typesetting (Elementary and Advanced) in LaTeX.

Text Books:

1. Hamdy A. Taha, "Operations Research an Introduction", 8th Edition, Pearson Education, 2004.
2. F.S.Hillier& G.J. Lieberman, "Introduction to Mathematical programming",McGraw-Hill International Edition, 2010.

Reference Books:

1. S.S. Rao, "Optimization: Theory and Applications", 2nd Edition, Wiley EasternCompany, 2010.
2. Bazaara, Shetty and Sherali, "Non-linear Programming: Theory and Algorithms",Wiley Eastern Company, 2006.
3. Robert E. Larson and John L.Casti, "Principles of Dynamic Programming", reprint, 2011.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 309: OBJECT ORIENTED PROGRAMMING WITH JAVA LAB

0L + 0T + 4P +2C **MM 100**

List of Experiments:

Part A

1. Write a program to check whether two strings are equal or not.
2. Write a program to display reverse string.
3. Write a program to find the sum of digits of a given number.
4. Write a program to display a multiplication table.
5. Write a program to display all prime numbers between 1 to 1000.
6. Write a program to insert element in existing array.
7. Write a program to sort existing array.
8. Write a program to create object for Tree Set and Stack and use all methods.
9. Write a program to check all math class functions.
10. Write a program to execute any Windows 95 application (Like notepad, calculator etc)
11. Write a program to find out total memory, free memory and free memory after executing garbage Collector (gc).

Part B

1. Write a program to copy a file to another file using Java to package classes. Get the file names at run time and if the target file is existed then ask confirmation to overwrite and take necessary actions.
2. Write a program to get file name at runtime and display number f lines and words in that file.
3. Write a program to list files in the current working directory depending upon a given pattern.
4. Create a text field that allows only numeric value and in specified length.

Semester IV

M.Sc. MATHEMATICS SCHEME EFFECTIVE FROM 2020-21		
Course Code	University Course Type	Course Name
DSE 3	Department Specific Elective 3	Choose any one from list of DSE Courses
DSE 4	Department Specific Elective 4	Choose any one from list of DSE Courses
MAT 182	Core Practical	MATLAB Lab
MAT 193	Core Practical	Seminar
MAT 184	Core Practical	Project

MAT 182
MATLAB LAB

L - T - P – C: 0 – 0 –4 – 2 **Course Type- Core Practical**

Course Objectives: The objective of the course is to familiarize the student to make computer program with the help of MATLAB software. Also, to carry out the hand on sessions in computer lab to have a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

Course Outcomes: At the end of the course, students will be able to-
CO1. Creating, saving and executing the script file and function file.
CO2. Solve the linear equation and the system of linear equations.
CO3. Fit a polynomial curves, linear curves and non linear curves.
CO4. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.

MATLAB PROGRAMMING: Input output of data from MATLAB command. File types. Creating, saving and executing the script file. Creating and executing functions file. Working with files and directories. Matrix manipulation. Creating vectors. Arithmetic operations. Relational operations. Logical operations. Matrix functions. Determinant of matrix. Eigen values and Eigen vectors.

Programming in MATLAB: Function files, sub functions, global variations, loops, branches and control flow. Interactive input. Recursion. Publishing a report. Controlling command windows. Command line editing.

Linear Algebra and interpolation: Solving the linear equation. Gaussian elimination, matrix factorization, curve fitting, polynomial curve fitting, least squares curve fitting. General non linear fits. Interpolation.

Differential equations and graphics: First order and second order ODE. Double integration. Roots of polynomial. Two and three dimensional plots. MATLAB plotting tools. Mesh and surface plots.

Text Books:

1. Getting Started with MATLAB 7: Rudra Pratap; Oxford Press.

Reference Books:

1. Applied numerical Methods using MATLAB: Won Young Yang, Tae-Sang-Chung, John Morris: John Wiley and Sons.
2. Solving ODE's with MATLAB: L.F. Shampine, I Gladwell, S. Thompson; Cambridge University Press.

MAT193
SEMINAR

L - T - P – C: 0 – 0 –4 – 2 **Course Type: Core Practical**

To enhance communication skill of the M. Sc students seminars have been incorporated in the syllabi in Semester IV .The candidates will have to choose a topic from the syllabi for seminar preparation. They will be expected to submit a write up pertaining to that topic and at the end of semester, a presentation will have to be made in presence of panel of experts from different fields of Mathematics.

PROJECT 1

L - T - P – C: 0 – 0 –16 – 8 **Course Type- Core Practical**

Objective: To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

There would be two reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

Syllabus of Discipline Elective Courses

S. No.	Course Code	Department Specific Elective
Group A & B		
1.	MAT 165	Integral Equations
2.	MAT 167	Calculus of Variations & Special Functions
3.	MAT 171	Fluid Mechanics
4.	MAT 172	Mathematics in Multimedia
5.	MAT 173	Mathematical Modeling
6.	MAT 174	Wavelet Analysis
7.	MAT 175	Fuzzy Sets and Applications
8.	MAT 176	Cryptography
9.	MAT 178	Algorithm Design Techniques
10.	MAT 179	Mathematical Statistics
11.	MAT 202	Tensor Analysis & Number Theory
12.	MAT 203	Differential Equation and Finite Element Analysis
13.	MAT 204	Advanced Numerical Analysis
Group B		
14.	BCSAI 303 BCSAI 308	Data Structures & Algorithms Data Structures & Algorithms Lab
15.	BCSAI 401 BCSAI 405	Design and Analysis of Algorithms AI and Intelligent Agents
16.	BCSAI 504 BCSAI 509	Data Mining And Ml Data Mining And Ml Using Python Lab
17.	BCSAI 603 BCSAI 610	Advanced Machine Learning Advanced Machine Learning with Python Lab

MAT 165

INTEGRAL EQUATIONS

L - T - P – C: 4 – 1 – 0- 5 **Course Type- DSE**

Course Objectives: The main objectives of the course are to familiarize the learner with Dimensional Analysis, Scaling, Perturbation methods,

Course Outcomes: After studying this course the student will be able to

CO1. know the concept of dimensional analysis and learn the main applications of dimensional analysis.

CO2. determine the solutions of Fredholm integral equations and Volterra integral equations by method of resolvent kernel, method of successive approximations, method of Laplace transform, system of Volterra integral equations and integro-differential equation.

Module 1: Linear integral equations– Definition and classification. Conversion of initial and boundary value problems to an integral equation. Eigen values and Eigen functions. Solution of homogeneous and general Fredholm integral equations of second kind with separable kernels.

Module 2: Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations. Resolvent kernel and its results. Conditions of uniform convergence and uniqueness of series solution.

Module 3: Integral equations with symmetric kernels– Orthogonal system of functions. Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen functions and bilinear form. Hilbert-Schmidt theorem. Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem.

Module 4: Solution of Volterra integral equations of second kind with convolution type kernels by Laplace transform. Solution of singular integral equations by Fourier transforms.

Module 5: Classical Fredholm theory– Fredholm theorems. Solution of Fredholm integral equation of second kind by using Fredholm first theorem.

Text Books:

1. Harry Hochsdedt, Integral Equations.
2. Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill.

Reference Books:

1. Abdul J. Jerry, Introduction to Integral Equations with applications, Marcel Dekkar Inc. NY.
2. L.G.Chambers, Integral Equations: A short Course, Int. Text Book Company Ltd. 1976,
3. R. P. Kanwal, Linear Integral Equations.

WEF. A.Y.2018-2019

MAT 167

CALCULUS OF VARIATIONS & SPECIAL FUNCTIONS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: The main objectives of the course are to familiarize the learner with Special functions, their different types of presentations, recurrence relations, orthogonaliyty conditions, generating functions. In this course student and variational problems.

Course Outcomes: After studying this course the student will be able to
CO1. know the concept of solution of differential equations as special functions.
CO2. understand the formulation of variational problems, the variation of a functional and its properties, extremum of functional, necessary condition for an extremum.

Module-I

Functional, The fundamental lemma, Euler's equations minimum surface of revolution, Brachistochrone problem, Problems on geodesics, isoperimetric problems.

Module-II

Several dependent variables, Functional dependent on higher order derivative, Functionals dependent variables, variational problems, parametric form.

Module-III

Gauss hypergeometric function and its properties, Integral representation, Linear transformation formulas, Contiguous function relations, Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its propertries, Integral representation, Kummer's first transformation.

Module-IV

Legendre Polynomials and functions - Recurrence formula, Rodrigue's formula, properties , Bessel functions– recurrence formula, generating function, properties of Bessel functions.

Module-V

Hermite, Laguerre, Associated Laguerre polynomials, chebyshev functions and polynomials.

Text Books:

1. Differential equations with Special Functions, Sharma and Gupta, Krishna Prakasan Mandir.
2. Differential equations and calculus of variations by L. Elsgolts, Mir publishers.

Reference Books:

1. Differential equations with applications and historical notes, G.F.Simmons, Tata McGRAW Hill.
2. J.L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.
3. E.D. Rainville, Special Functions, Chelsea Publishing Company, 1960.

MAT 171

FLUID MECHANICS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: Prepare a foundation to understand the motion of fluid and develop concept, models and techniques which enables to solve the problems of fluid flow and help in advanced studies and research in the broad area of fluid motion.

Course Outcomes: After studying this course the student will be able to

CO1. understand the concept of fluid and their classification, models and approaches to study the fluid flow. formulate mass and momentum conservation principle and obtain solution for nonviscous flow.

CO2. Understand the concept of stress and strain in viscous flow and to derive Navier-Stokes equation of motion and solve some exactly solvable problems.

CO3. know Eulerian and Lagrangian methods.

CO4. Understand Conservation Laws, Equation of energy, Irrotational and Rotational Flows, Bernoulli's equation,

Module-I

Physical Properties of fluids, Concept of fluids, Continuum Hypothesis, density, specific weight, specific volume.

Module-II

Kinematics of Fluids- Eulerian and Lagrangian methods of description of fluids, Equivalence of Eulerian and Lagrangian method, General motion of fluid element, integrability and compatibility conditions, strain rate tensor, stream line, path line, streak lines, stream function¸ vortex lines, circulation.

Module-III

Stresses in Fluids- Stress tensor, symmetry of stress tensor, transformation of stress components from one co-ordinate system to another, principle axes and principle values of stress tensor.

Module-IV

Conservation Laws- Equation of conservation of mass, equation of conservation of momentum, Navier Stokes equation, equation of moments of momentum, Equation of energy, Basic equations in different co-ordinate systems, boundary conditions.

Module-V

Irrotational and Rotational Flows- Bernoulli's equation, Bernoulli's equation for irrotational flows, Two dimensional irrotational incompressible flows, Blasius theorm, Circle theorem, sources and sinks, sources sinks and doublets in two dimensional flows, methods of images.

Text Books:

1. Textbook of fluid dynamics, F. Chorlton, CBS Publishers, Delhi.

Reference Books:

1. An Introduction to fluid dynamics, R.K. Rathy, Oxford and IBH Publishing Co.1976.
2. Theoretical Hydrodynamics, L. N. Milne Thomson, Macmillan and Co. Ltd.
3. Fluid Mechanics, L. D. Landau and E.N. Lipschitz, Pergamon Press, London.
4. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall..

MAT 172
MATHEMATICS IN MULTIMEDIA

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: The objective of this course is to provide students with a basic understanding of multimedia systems. This course focuses on topics in multimedia information representation and relevant signal processing aspects, multimedia networking and communications, and multimedia standards especially on the audio, image and video compression. All of these topics are important in multimedia industries.

Course Outcomes: After studying this course the student will be able to

CO 1: Students are expected to achieve a basic understanding of multimedia systems.

CO 2: Students would be able to evaluate more advanced or future multimedia systems.

CO 3: This course will also arouse students' interest in the course and further motivate them towards developing their career in the area of multimedia and internet applications.

Module 1: Multimedia: Introduction to Multimedia: Concepts, uses of multimedia, hypertext and hypermedia.; Image, video and audio standards.

Module 2: Audio: digital audio, MIDI, processing sound, sampling, compression.

Module 3: Video: MPEG compression standards, compression through spatial and temporal redundancy, inter-frame and intra-frame compression.

Module 4: Animation: types, techniques, key frame animation, utility, morphing.

Module 5: Virtual Reality concepts.

Text Books:

1. Mukherjee, Fundamentals of Computer graphics & Multimedia, PHI.

2. Elsom Cook – "Principles of Interactive Multimedia" – McGraw Hill

Reference Books:

1. Sanhker, Multimedia –A Practical Approach, Jaico.

2. Buford J. K. – "Multimedia Systems" – Pearson Education.

MAT 173

MATHEMATICAL MODELING

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: The objective of the course is to familiarize the students to understand the concepts to relate the differential equations with mathematical models in the manner of daily life problem, and geometrical and physical meaning of solutions of differential equations.

Course Outcomes: At the end of the course, students will be able to-
CO1. know about the concepts, uses and techniques of differentiation equations
CO2. Solve and use the differential equations in mathematical modeling,
CO3. Relate the biological, medicinal, physical, economical, environmental problems with mathematics and solve them by differential equation methods.

Module-I

Introduction To Mathematical Modeling using Differential Equations: Principles of Mathematical Modeling, Compartment Model, Population Models, Framing of Population Model, Growth and Decay, Drug absorption (Case of single cold pill, Case of a course of cold pills).

Module-II

Applications Of First Order Differential Equations : Reaction To Stimulus, Alcohol Absorption (Accident Risk), Artificial Kidney Machine, The Spread of Technological Innovations, Rocket flight.

Module-III

Applications of first Order Linear Differential Equations: Sales Response to Advertising, Art Forgeries, Electric Circuits, Pollution of the Great Lakes, Exploited Fish Populations, Neoclassical Economic Growth.

Module-IV

Applications of Second Order Linear Differential Equations: Mechanical Oscillations, Consumer Buying Behavior, Electrical Networks and Testing for Diabetes.

Module-V

Applications of Systems of Differential Equations to Models: Spring-Mass System, The Dynamics of Arms Races, Epidemics, Interacting Species, Competing Species (The Struggle for Existence).

Text Books:

1. D. N. Burghes, Modelling with Difference Equations, Ellis Harwood and John Wiley.
2. J. N. Kapur, Mathematical Modelling, Willey Eastern Limited, Reprint, 2000.

Reference Books:

1. D. J. G. James and J. J. Macdonald, Case studies in Mathematical Modelling, Stanly Thames, Cheltonham.
2. . M. Crossand and A. O. Moscrcadini, The art of Mathematical Modelling, Ellis Harwood and John Wiley.
3. C. Dyson, Elvery, Principles of Mathematical Modelling, Academic Press, New York.

MAT 174

WAVELET ANALYSIS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objective: To expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing. The student should reach good comprehension in the fields of Fourier series and the Fourier transform , theory of distributions Multi resolution analysis (MRA) Some commonly used wavelet systems.

Course Outcomes: Students are able to

CO1: understand about Fourier transform and difference between Fourier transform and wavelet transform.

CO2: understand wavelet basis and characterize continuous and discrete wavelet transforms

CO3: understand multi resolution analysis and identify various wavelets and evaluate their time - frequency resolution properties

CO4: implement discrete wavelet transforms with multirate digital filters

Module 1: Fourier analysis: Fourier and inverse Fourier transforms, Convolution and delta function, Fourier transform of Square integrable functions. Fourier series, Basic Convergence Theory and Poisson's Summation formula.

Module 2: Wavelet Transforms and Time Frequency Analysis: The Gabor Transform. Short-time Fourier transforms and the uncertainity principle. The integral wavelet transforms Dyadic wavelets and inversions. Frames.

Module 3. Wavelet Series. Scaling Functions and Wavelets: Multi resolution analysis, scaling functions with finite two scale relations. Direct sum decomposition of L2(R). Linear phase filtering.

Module 4: Compactly supported wavelets, Wavelets and their duals, Orthogonal Wavelets and Wavelet packets, Example of orthogonal Wavelets. Identification of orthogonal two-scale symbols,

Module 5: Construction of Compactly supported orthogonal wavelets, Orthogonal wavelet packets,orthogonal decomposition of wavelet series.

Text Books

1. E.Hernandez & G.Weiss, A First Course on Wavelets, CRC Press, 1996.

2. L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

Reference Books:

1. C. K. Chui, A First Course in Wavelets, Academic press NY 1996.

2. I. Daubechies, Ten Lectures in Wavelets, Society for Industrial and Applied Maths, 1992.

MAT 175

FUZZY SETS AND APPLICATIONS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: The main objective of the course is to familiarize the students with the basic concepts of set theory and fuzzy set theory. The course will develop a depth understanding of fuzzy sets and its applications into real life problems. which in turn help in life-long self-learning.

Course Outcomes: At the end of the course, students will be able to-
CO1. Understand the role of membership and fuzzy sets in decision making problems.
CO2. apply knowledge of fuzzy sets to minimize uncertainty in real life scenario.

Module 1

Fuzzy sets – Basic definitions, level sets, convex fuzzy sets – Basic operations on fuzzy sets – Types of fuzzy sets – Cartesian products – Algebraic products bounded sum and difference.

Module 2

Extension principle and application – Zadeh extension principle, image and inverse image of fuzzy sets – Fuzzy numbers – Elements of fuzzy arithmetic.

Module 3

Fuzzy relations on fuzzy sets, The union and intersection of fuzzy relation -Composition of fuzzy relations – Min-max composition and its properties – Fuzzy equivalence relation.

Module 4

Fuzzy decision-Fuzzy linear programming problem- Symmetric fuzzy linear programming problem-Fuzzy linear programming with crisp objective function-Fuzzy graph.

Module 5

Fuzzy logic: An overview of classic logic, its connectives – Tautologies – Contradiction fuzzy logic – Fuzzy quantities – Logical connectives for fuzzy logic – Applications to control theory.

Text Books:

1. G. J. Klir & B. Yuan, “Fuzzy sets and Fuzzy logic; Theory and Applications”, Prentice Hall of India 1995.
2. K. H. Lee, First Course on Fuzzy theory and Applications”, Springer, 2004

Reference Books:

1. Didier Dubois, Henri M. Prade, “Fuzzy Sets and Systems: Theory and Applications”, Academic Press, 1994.
2. H. J. Zimmermann, Fuzzy set theory and its applications, Allied publishers Ltd., New Delhi, 2001.

MAT 176

CRYPTOGRAPHY

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives : This course aims at familiarizing the students to cryptography. Classical ciphers and their cryptanalysis have been discussed. Linear feedback shift registers have been studied. RSA and Diffie Hellman key exchange have been described.

Course Outcomes: After studying this course the student will
CO1. have been introduced to the concept of secure communication and fundamentals of cryptography.
CO2. know classical ciphers such as Vigenere Cipher and Hill Cipher.
CO3. have insight into DES and AES.
CO4. be familiar with secure random bit generator and linear feedback shift register sequences.
CO5. know of RSA, attacks on RSA, DiffieHellman key exchange and ElGamal, public key cryptosystem.

Module-I

Time estimates for doing arithmetic - Divisibility and the Euclidean algorithm –Congruences - Modular exponentiation - Some applications to factoring.

Module-II

Finite Fields - Multiplicative generators – Uniqueness of fields with prime power elements - Quadratic residues and reciprocity.

Module-III

Some simple crypto systems - Digraph transformations - Enciphering Matrices – Affine enchipering transformations RSA - Discrete Log - Diffie-Hellman key exchange – The Massey – Omura cryptosystem - Digital Signature standard - Computation of discrete log.

Module-IV

Pseudo primes - Strong pseudo primes - Solovay-Strassen Primality test – Miller - Rabin test - Rho method - Fermat factoring and factor bases - Quadratic sieve method.

Module-V

Elliptic Curves - Elliptic curve primality test - Elliptic Curve factoring - Pollard's p – 1 method -Elliptic curve reduction modulo n - Lenstras Method.

Text Books:

1. J.A. Buchmann, Introduction to Cryptography, Second Edition, Springer 2003.

Reference Books:

1. Neal Koblitz, "A course in Number Theory and Cryptography", 2nd Edition, Springer-Verlag, 2010.

2. Menezes A, Van Oorschot and Vanstone S.A, "Hand book of Applied Cryptography",Taylor & Francis, 1996.

MAT 178
ALGORITHM DESIGN TECHNIQUES

L - T - P – C: 4 – 1 – 0 – 5 **Course Type- DSE**

Course Objective: The aim is to teach the student various topics in Analyzing the asymptotic performance of algorithms, Selection Sort and Bubble Sort, Transform and conquer, Warshall’s and Floyd’s Algorithm, Optimal Binary Search trees, Greedy Techniques, Prim’s Algorithm, Kruskal’s Algorithm, Dijkstra’s Algorithm, Huffman trees, Hamiltonian Circuit problem , Assignment problem , Knapsack problem , Traveling salesman problem.

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:

CO1: Argue the correctness of algorithms using inductive proofs and invariants.

CO2: Analyze worst-case running times of algorithms using asymptotic analysis.

CO3: Describe the transform and explain when an algorithmic design situation calls for it.

CO4: Explain the major graph algorithms and their analyses. Employ graphs to model problems, when appropriate.

Module 1: Introduction – Notion of Algorithm – Fundamentals of Algorithmic Solving – Important Problem types – Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes. Mathematical Analysis of Non-recursive Algorithm –Mathematical Analysis of Recursive AFlgorithm – Example: Fibonacci Numbers –Empirical Analysis of Algorithms – Algorithm visualization.

Module 2: Brute Force – Selection Sort and Bubble Sort – Sequential Search and Brute – force string matching – Divide and conquer – Merge sort – Quick Sort – Binary Search –Binary tree- Traversal and Related Properties – Decrease and Conquer – Insertion Sort – Depth first Search and Breadth First Search.

Module 3: Tree Vertex Splitting– Multistage Graphs – All pairs shortest paths– Single – Source Shortest paths – Flow shop scheduling.

Module 4: Transform and conquer – Presorting – Balanced Search trees – AVL Trees – Heaps and Heap sort – Dynamic Programming – Warshall’s and Floyd’s Algorithm – Optimal Binary Search trees – Greedy Techniques – Prim’s Algorithm – Kruskal’s Algorithm – Dijkstra’s Algorithm – Huffman trees.

Module 5: Backtracking – n-Queen’s Problem – Hamiltonian Circuit problem – Subset - Sumproblem – Branch and bound – Assignment problem – Knapsack problem – Traveling salesman problem.

Text Book: Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press, McGraw-Hill Book Company, 2001.

Reference Books:

1. Michael T Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, John Wiley & Sons, 2006.

2. Sara Baase and Allen Van Gelder, “Computer Algorithms - Introduction to Design and Analysis”, 3 rd edition,Pearson Education Asia, 2003.

MAT 179
MATHEMATICAL STATISTICS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course objectives : The objective of this course is to provide an understanding for the graduate business student on statistical concepts to include measurements of location and dispersion, probability, probability distributions, sampling, estimation, hypothesis testing, regression, and correlation analysis, multiple regression

Learning Outcomes:

CO1: Demonstrate knowledge of, and properties of, statistical models in common use,

CO2:. Understand the basic principles underlying statistical inference (estimation and hypothesis testing).

CO3: Be able to construct tests and estimators, and derive their properties,

CO4: Demonstrate knowledge of applicable large sample theory of estimators and tests.

Module 1

Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions.

Module 2

Uniform, Binomial, Poisson, Geometric and Negative Binomial distributions and their properties. **Continuous distributions:** Uniform, Normal and Exponential distributions and their properties.

Module 3

Types of Sampling, errors in sampling, Parameter and Statistic, Tests of Significance: Null Hypothesis, Alternative Hypothesis, One-tailed, Two-tailed tests. Sampling Attributes: Tests of Significance for single proportion and difference of proportions. Sampling of Variables.

Module 4

Sampling Distributions: Chi-Square Distribution, Moment generating function of Chi-Square and its applications. Student's - ***t*** distribution. ***F*** and ***Z*** distributions.

Module 5

Estimation Theory: Characteristics of Estimators, Efficient estimator, Most Efficient estimator, Minimum variance unbiased estimators. Methods of estimation.

Text Books: S.C. Gupta ,Huber,Ross, Stapleton, Durrett , Adams , Schinazi

Reference Books:

1. Gupta, S. C., and Kapoor , V. K. *Fundamentals of Mathematical Statistics*, New Delhi: Sultan Chand & Sons, 2002.
2. E.J. Dudewicz and S.N.Mishra , Modern Mathematical Statistics, John Wiley and Sons, New York, 1988.
3. V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern New Delhi, 1988(3rd Edn)
4. G.G.Roussas, A First Course in Mathematical Statistics, Addison Wesley Publishing Company, 1973
5. B.L.Vander Waerden, Mathematical Statistics, G.Allen & Unwin Ltd., London, 1968.
6. M. Fisz , Probability Theory and Mathematical Statistics, John Wiley and sons.
7. Baisnab, and Jas, M. *Element of Probability and Statistics*, New Delhi: Tata McGraw Hill, 2001.

WEF.A.Y.2018-2019

MAT 202
TENSOR ANALYSIS & NUMBER THEORY

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: The objective of this course to motivate students to develop curiosity in students by numbers and create interest in number theory. The course will also develop an understanding of Tensors, their types, algebra and applications. The course will develop mental ability to solve problems based on real life.

Course Outcomes: At the end of the course, students will be able to-
CO1: Understand the basic knowledge of numbers and its uses to solve calendar problems, year problems etc.
CO2: Find the solutions of liner Diophantine equation and liner congruence
CO3: Understand the use of number theory in Cryptography, Public key encryption and decryption etc.
CO4: Understand the algebra, types and applications of tensors including some transformations and basic theorems.

Module1: Kronecker delta, Contravariant and Covariant tensors, Symmetric tensors, Quotient law of tensors, Relative tensor. Riemannian space. Metric tensor, Indicator, Permutation symbols and Permutation tensors.

Module2 : Christoffel symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Field of parallel vectors.

Module 3: Riemann-Christoffel tensor and its properties. Covariant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flate space, Isotropic point, Schur's theorem.

Module 4: Congruences: Some elementary properties and theorems, linear and systems of linear congruences. Chinese Remainder Theorem. Quadratic congruences, Quadratic Reciprocity Law, Primitive roots.
Module5: Some elementary arithmetical functions and their average order, Mobius Inversion formula, integer partitions, simple continued fractions, definite and indefinite binary quadratic forms ,some diophantine equations.

Text Books:
1. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications, 2003.
2. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007

Reference Books:
1.U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.
2. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
3. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge Univ. Press, 2008.
4. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.
5. Niven, H.S. Zuckerman & H.L. Montgomery, Introduction to the Theory of Numbers, Wiley, 2000.

WEF.A.Y.2018-2019

MAT 203

DIFFERENTIAL EQUATION AND FINITE ELEMENT ANALYSIS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: This course provides methods to solve non-linear differential equations, Riccati's equation, Monge's method to solve special type of second order partial differential equations,solution of Strum Liouville boundary value problems and an introduction to finite elements method with a focus on one dimensional problems in structures, heat transfer, static and dynamics.

Course Learning outcomes: Upon completion of this course student should be able to:

1. Solve non-linear differential equations, partial differential equations of order two with variable coefficients by different methods.
2. Understand the solutions of linear homogeneous boundary value problems.
3. Acquire the concept and purpose of Finite element methods.
4. Apply suitable boundary conditions to a global equation for axis symmetric and dynamic problems and solve them displacements, stress and strains induced.

Module 1: Non Linear differential equations of particular form. Riccati's equation - General solution and the solution when one ,two or three particular solutions are known. Total differential equations – necessary and sufficient equations, method of solution, geometric meaning of total differential equations.

Module 2 : Partial differential equations of second order with variable coefficients- Monge's method,Classification of Second order Partial differential equations with variable coefficients ,Canonical forms, Cauchy's problem for first order partial differential equations, method of separation of variables, Laplace wave and diffusion equations.

Module 3 : linear homogeneous boundary value problems. Eigen values and eigen functions, Strum Liouville boundary value problems. Orthogonality of eigen functions, Reality of eigen values.

Module 4: General theory of finite element methods, Difference between finite element and finite difference, Review of some integral formulae, Concept of discretization, Convergence requirements, Different coordinates, One dimensional finite elements, shape functions, stiffness matrix, connectivity, boundary conditions, equilibrium equation, FEM procedure.

Module 5: Generalization of the finite element concepts-weighted residual and variational approaches (Ritz method, Galerkin method, collocation method etc.) Numerical integration, Interpolation formulas and shape functions, Axis symmetric formulations, solving one-dimensional problems.

Text Books:

1. Ross S. L., *Differential Equations*, New Delhi: John Wiley and Sons (2004).
2. Raisinghania, M.D. *Advanced Differential Equations*, New Delhi: S.Chand & Company Ltd. 2001

Reference Books:

1. George, F Simmons, *Differential equations with applications and historical notes*, New Delhi: Tata McGraw Hill, 1974.).
2. Sneddon I. N., *Elements of Partial Differential Equations*, New Delhi: Tata McGraw Hill (1957).
3. Piaggio H. T. H., *Differential Equations*,New Delhi: CBS Publisher (2004).
4. Braess, D., Schumaker and Larry L. *Finite Elements: Theory, Fast Solvers, and Applications in Solid Mechanics*, New York: Cambridge University Press, 2001.
5. Desai C. S. *Introductory Finite Element Method*, Boca Raton: CRC Press, 2001.
6. Smith, G. D. *Numerical solution of Partial Differential Equations*, Oxford: Clarendon Press, 1986.
7. Bradie, B. *A friendly introduction to Numerical Analysis*, Delhi: Pearson, 2005.
8. Reddy, J. N. *An introduction to Finite Element Methods*, Delhi: McGraw-Hill Higher Education, 2005.

MAT 204
ADVANCED NUMERICAL ANALYSIS

L - T - P – C: 4 – 1 –0 – 5 **Course Type- DSE**

Course Objectives: Use the divided difference to interpolate and approximate functions by polynomials.

Course Outcomes:

CO1: Use the iterative methods with algorithms to implement several numerical methods.

CO2: Apply the midpoint rule for finding numerical integration.

CO3: Apply the trapezoidal rule for finding numerical integration.

CO4: Use the divided difference formula to proof the approximation part and error part in the basic quadrature rules.

CO5: The ability to use computer software such as Maple to apply several numerical methods and approximations.

Module 1

Iterative methods- Theory of iteration method, acceleration of the convergence, Chebyshev method, Muler's method, Methods of multiple and complex roots, Newton Raphson's method for simultaneous equations, Convergence of iteration process in the case of several unknowns.

Module 2

Solution of polynomial equations- Polynomial equation, Real and complex roots, Synthetic Division, the Birge- Vieta, Bairstow and Graeffe's root square method.

Module 3

system of simultaneous equations(linear)- Direct Method , Method of determinant, GaussJordan, Lui –Factorization- Dolittle's , Crout's and Cholesky's Partion method. Method of successive Approximation- Conjugate gradient and relaxation methods.

Module 4

Curve fitting and function Approximation- Least square error criteria, linear regression, polynomial fitting and other curve fittings, approximation of functions by Taylor series and Chebyshev polynomials

Module 5

Numerical Solution of ordinary differential equations- Taylor's series method, Runge-Kutta methodof fourth order, Multistep method, Predictor-Correctorstrategies, Stability Analysis- single and multistep methods. BVP's of ordinary differential equations- shooting methods, finite difference methods.

Text Book: Fritz John , G.S. MIiller , S.D. Conte.

Reference Books:

1. Shastry, S. S. Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd., 2005.
2. Xavier, C. C Language and Numerical Methods, New Age Int. Ltd., 2007.
3. Gerald, C.F. and Wheatley, P.O. Applied Numerical Analysis, 7th Edition, Pearson Education Asia.2003
4. Bradie, B. A friendly introduction to Numerical Analysis. Delhi: Pearson Education, 2007
5. S. D. Conte, C de Boor, Elementary Numerical Analysis, McGraw-Hill, 1980.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 303: DATA STRUCTURES & ALGORITHMS

3L + 0T + 0P + 3C **Course Type- DSE**

Unit 1: Introduction to Data structures

Definition, Classification of data structures: primitive and non-primitive, Elementary data organization, Time and space complexity of an algorithm (Examples), String processing. Dynamic memory allocation and pointers: Definition of dynamic memory allocation, Accessing the address of a variable, Declaring and initializing pointers, Accessing a variable through its pointer, Meaning of static and dynamic memory allocation, Memory allocation functions: Malloc(), Calloc(), free() and realloc(). Recursion: Definition, Recursion in C (advantages), Writing Recursive programs – Binomial coefficient, Fibonacci, GCD.

Unit 2: Searching and Sorting

Basic Search Techniques: Sequential search: Iterative and Recursive methods, Binary search: Iterative and Recursive methods, Comparison between sequential and binary search. Sort: General background and definition, Bubble sort, Selection sort, Insertion sort, Merge sort, Quick sort.

Unit 3: Stack and Queue

Stack – Definition, Array representation of stack, Operations on stack: Infix, prefix and postfix notations, Conversion of an arithmetic expression from Infix to postfix, Applications of stacks. Queue: Definition, Array representation of queue, Types of queue: Simple queue, Circular queue, Double ended queue (deque), Priority queue, Operations on all types of Queues.

Unit 4: Linked List

Definition, Components of linked list, Representation of linked list, Advantages and Disadvantages of linked list. Types of linked list: Singly linked list, doubly linked list, Circular linked list, Operations on singly linked list: creation, insertion, deletion, search and display.

Unit 5: Tree Graphs and their Applications:

Definition: Tree, Binary tree, Complete binary tree, Binary search tree, Heap Tree terminology: Root, Node, Degree of a node and tree, Terminal nodes, Non-terminal nodes, Siblings, Level, Edge, Path, depth, Parent node, ancestors of a node. Binary tree: Array representation of tree, Creation of binary tree. Traversal of Binary Tree: Preorder, Inorder and postorder. Graphs, Application of Graphs, Depth First search, Breadth First search.

Text /Reference Books:

1. Weiss, Data Structures and Algorithm Analysis in C, II Edition, Pearson Education, 2001
2. Lipschutz: Schaum's outline series Data structures Tata McGraw-Hill
3. Robert Kruse Data Structures and program designing using 'C'
4. E. Balaguruswamy Programming in ANSI C.
5. Bandyopadhyay, Data Structures Using C Pearson Education, 1999
6. Tenenbaum, Data Structures Using C. Pearson Education, 200
7. Kamthane: Introduction to Data Structures in C. Pearson Education 2005.
8. Hanumanthappa M., Practical approach to Data Structures, Laxmi Publications, Fire Wall media 2006.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 308: DATA STRUCTURES AND ALGORITHMS LAB

0L + 0T + 4P + 2C **Course Type- DSE**

List of Experiments:

Part A

1. Use a recursive function to find GCD of two numbers.
2. Use a recursive function to find the Fibonacci series.
3. Use pointers to find the length of a string and to concatenate two strings.
4. Use pointers to copy a string and to extract a substring from a given a string.
5. Use a recursive function for the towers of Hanoi with three discs.
6. Insert an integer into a given position in an array.
7. Deleting an integer from an array.
8. Write a program to create a linked list and to display it.
9. Write a program to sort N numbers using insertion sort.
10. Write a program to sort N numbers using selection sort.

Part B

1. Inserting a node into a singly linked list.
2. Deleting a node from a singly linked list.
3. Pointer implementation of stacks.
4. Pointer implementation of queues.
5. Creating a binary search tree and traversing it using in order, preorder and post order.
6. Sort N numbers using merge sort.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 309: OBJECT ORIENTED PROGRAMMING WITH JAVA LAB

0L + 0T + 4P +2C **Course Type- DSE**

List of Experiments:

Part A

12. Write a program to check whether two strings are equal or not.
13. Write a program to display reverse string.
14. Write a program to find the sum of digits of a given number.
15. Write a program to display a multiplication table.
16. Write a program to display all prime numbers between 1 to 1000.
17. Write a program to insert element in existing array.
18. Write a program to sort existing array.
19. Write a program to create object for Tree Set and Stack and use all methods.
20. Write a program to check all math class functions.
21. Write a program to execute any Windows 95 application (Like notepad, calculator etc)
22. Write a program to find out total memory, free memory and free memory after executing garbage Collector (gc).

Part B

5. Write a program to copy a file to another file using Java to package classes. Get the file names at run time and if the target file is existed then ask confirmation to overwrite and take necessary actions.
6. Write a program to get file name at runtime and display number f lines and words in that file.
7. Write a program to list files in the current working directory depending upon a given pattern.
8. Create a textfield that allows only numeric value and in specified length.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 401: DESIGN AND ANALYSIS OF ALGORITHMS

2L + 0T + 0P + 2C **Course Type- DSE**

Unit 1:

Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem.

Unit 2:

Fundamental Algorithmic Strategies: Brute-Force, Greedy,Dynamic Programming, Branch- and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving , Bin Packing, Knap Sack TSP. Heuristics – characteristics and their application domains.

Unit 3:

Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm.

Unit 4:

Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques.

Unit 5:

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE

Text/Reference books:

1. Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Fundamentals of Algorithms – E. Horowitz et al.algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
3. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
4. Algorithms—A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 405: AI AND INTELLIGENT AGENTS

3L + 0T + 0P + 3C **Course Type- DSE**

Unit 1: Introduction - What is intelligence? Foundations of artificial intelligence (AI). History of AI; Problem Solving- Formulating problems, problem types, states and operators, state space, search strategies.

Unit 2: Informed Search Strategies - Best first search, A* algorithm, heuristic functions, Iterative deepening A*(IDA), small memory A*(SMA); Game playing - Perfect decision game, imperfect decision game, evaluation function, alpha-beta pruning

Unit 3: Uncertainty - Basic probability, Bayes rule, Belief networks, Default reasoning, Fuzzy sets and fuzzy logic; Decision making**-** Utility theory, utility functions, Decision- theoretic expert systems.

Unit 4: Learning Forms of Learning, Inductive Learning: - Learning Decision Trees, Statistical learning methods: - Naïve Bayes models, Bayesian network, EM algorithm, HMM, Instance based learning:-nearest neighbour models.

Unit 5 : Intelligent Systems

Expert System- Stages in the Development of an Expert System, Difficulties in Developing Expert System, Application of Expert System, Introduction to Evolutionary Programming, Swarm Intelligent Systems.

Text / Reference Books:

1. Stuart Russell and Peter Norvig. Artificial Intelligence – A Modern Approach, Pearson Education Press, 2001.
2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, McGraw Hill, 2008.
3. George F. Luger, Artificial Intelligence, Pearson Education, 2001.
4. Mils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kauffman, 2002.

BCSAI 504: DATA MINING AND ML

3L + 0T + 0P + 3C **Course Type- DSE**

Unit 1: Introduction to Machine Learning and Data Mining

Introduction to modern data analysis, Machine Learning, supervised and unsupervised learning, Data mining definition and motivation, data mining functionalities Concept of interesting patterns, Data mining tasks, current trends, major issues and ethics in data mining, Data Mining and Knowledge Discovery in Databases.

Unit 2: Statistical Concepts & Linear Regression:

Probability Distributions, Statistical Inferences, Level of Significance, Type I and Type II Error, One Sample, Paired Samples, Independent Samples T Tests, One Way ANOVA, Chi-Square Test. Linear Regression, Scatter Plot, Correlations, R Square and Adjusted R Square, Testing of Slope, Standard Error of Estimate.

Unit 3: Logistic Regression & Decision Trees

Logit Function, Odds versus Probabilities, Nagelkerke R Square, Classification Matrix, Cut-Offs, ROC Curve. Classification & Regression Trees, Information Gain, Gain Ratio, Gini Index, Mean Squared Error, Pruning of Tree, Bagging, Random Forest, Adaptive Boosting, XG Boosting, Model Overfitting.

Unit 4: kNN& Naïve Bayes Classifiers, Association Rules Mining and Cluster Analysis

kNN as a lazy learner, Similarity Quantification, Appropriate k, Rescaling Data. Probabilistic Learning, Joint Probability, Conditional Probability, Laplace Estimator. Market Basket Analysis, Support, Confidence, Lift, Association Rules. Clustering Methods, Dendogram, Profiling of Cluster, Cluster Evaluation.

Unit 5: Dimensionality Reduction, Support Vector Machines and Text Mining

Principal Component Analysis, Eigen Values & Eigen Vectors, Singular Value Decomposition. Decision Boundaries for Support Vector Machine, Hyperplanes, Linear & Non-Linear Cases, Kernel Function, Kernel Trick, Kernel Hilbert Space, Model Evaluation. Text Data, Sentiment Analysis, Word Clouds, Term Frequency, Tokeniing.

Text Books:

1. Mitchell (2013). Machine Learning. McGraw Hill.
2. Han, Jiawei and Kamber, Micheline. (2012). Data Mining: Concepts and Techniques. Morgan Kaufman Publishers.
3. Tang, P.N., Steinback, M. and Kumar, V. (2014). Introduction to Data Mining. Pearson.

Reference Books:

1. Myatt, Glenn and Johnson, Wayne. (2009). Making Sense of Data II. Wiley.
2. Kassambara. (2017). Practical Guide to Cluster Analysis in R. STHDA
3. Silge& Robinson. (2017). Text Mining With R. SPD.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 509: DATA MINING AND ML USING PYTHON LAB

0L + 0T + 4P + 2C **Course Type- DSE**

List of Experiments:

1. Perform data preprocessing tasks and Demonstrate performing association rule mining on data sets
2. Demonstrate performing classification on data sets
3. Demonstrate performing clustering on data sets
4. Demonstrate performing Regression on data sets
5. Write a program to implement the naïve Bayesian classifier for a sample data set.
6. Write a program to construct a Bayesian network considering any data set.
7. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.
8. Implement K-means on .CSV file using python.
9. Implementing Logistic Regression in Python for classification

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 511: PROLOG PROGRAMMING LAB

0L + 0T + 4P + 2C **Course Type- DSE**

List of Experiments:

1. Write a prolog program to calculate the sum of two numbers.

2. Write a prolog program to find the maximum of two numbers.

3. Write a prolog program to calculate the factorial of a given number.

4. Write a prolog program to calculate the nth Fibonacci number.

5. Write a prolog program, insert_nth(item, n, into_list, result) that asserts that result is the list into_list with item inserted as the n'th element into every list at all levels.

6. Write a Prolog program to remove the Nth item from a list.

8. Write a Prolog program to implement append for two lists.

9. Write a Prolog program to implement palindrome(List).

10. Write a Prolog program to implement max(X,Y,Max) so that Max is the greater of two numbers X and Y.

11. Write a Prolog program to implement maxlist (List,Max) so that Max is the greatest number in the list of numbers List.

12. Write a Prolog program to implement sumlist (List,Sum) so that Sum is the sum of a given list of numbers List.

13. Write a Prolog program to implement two predicates evenlength(List) and oddlength(List) so that they are true if their argument is a list of even or odd length respectively.

14. Write a Prolog program to implement reverse(List,ReversedList) that reverses lists.

15. Write a Prolog program to implement maxlist(List,Max) so that Max is the greatest number in the list of numbers List using cut predicate.

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 603: ADVANCED MACHINE LEARNING

3L + 0T + 0P + 3C **Course Type- DSE**

Unit 1: Introduction

Bayesian Machine Learning: Machine Learning Paradigms, types of machine learning approaches, delineating between supervised and unsupervised learning, and between discriminative and generative approaches.

Unit 2: Bayesian Modelling

Bayesian Modelling: assumptions and processes of constructing a Bayesian model, dependency relationships in Bayesian models,graphical models and probabilistic programming.

Unit 3: Bayesian Inference

Bayesian Inference: approaches for estimating Bayesian posteriors, marginal likelihoods, and expectations. Monte Carlo sampling, Markov chain Monte Carlo (MCMC) sampling and variational inference.

Unit 4: Natural Language Processing:

Challenge of Natural Language Processing (NLP), Embeddings : methods to create embeddings, disadvantages and advantages, Classification and neural networks: classification task, tasks arises in NLP problems, Language models.

Unit 5: Deep Learning

Motivation for deep learning, basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.

Text and Reference Books:

1. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.
2. Ethem Alpaydin, Introduction to Machine Learning, Second Edition
3. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
4. Tom Mitchell, Machine Learning

M.Sc. Mathematics/B.Tech CSE (AI)

BCSAI 610: ADVANCED MACHINE LEARNING LAB

0L + 0T + 4P + 2C **Course Type- DSE**

List of Experiments

1. Implement and demonstrate the FIND-S Algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.