Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum for

M.Sc. – I

Industrial Mathematics

with Computer Applications (IMCA)

With effect from June 2019

Programme Structure

Semester	Course Code	Course Title	Course	No. of
I	MTS4101	Real Analysis	T-Core	4
	MTS4102	Applied Linear Algebra	T-Core	4
	MTS4103	Discrete Mathematics I	T-Core	4
	MTS4104	Software Engineering	T-Core	4
	MTS4105	Experimental Training on C-Programming	P-Core	4
II	MTS4201	Advanced Calculus	T-Core	4
	MTS4202	Abstract Algebra	T-Core	4
	MTS4203	Discrete Mathematics II	T-Core	4
	MTS4204	Probability and Statistics	T-Core	4
	MTS4205	Experimental Training on C++	P-Core	4
	MTS4206	Experimental Training on DBMS	P-Core	4
III	MTS5301	Digital Image Processing	D Elect-1	4
	MTS5302	Statistical Inference	D Elect-2	4
	MTS5303	Complex Analysis	D Elect-3	4
	MTS5304	Financial Mathematics	D Elect-4	4
	MTS5305	Applied Field Theory	D Elect-5	4
	MTS5306	Operating Systems	T-Core	4
	MTS5307	Computer Networks	T-Core	4
	MTS5308	Experimental Training on Data Structures using C	P-Core	4
Note: Students need to opt any THREE courses from MTS5301 to MTS5305				
IV	MTS5401	DAA	D Elect-1	4
	MTS5402	Cryptography	D Elect-2	4
	MTS5403	Applied Geometry from Computer Graphics	D Elect-3	4
	MTS5404	Dynamical Systems	D Elect-4	4
	MTS5405	Machine Learning with AI	D Elect-5	4
	MTS5406	Theoretical Computer Science	D Elect-6	4
	MTS5407	UNIX Internals	D Elect-7	4
	MTS5408	Experimental Training on Java Programming	P-Core	4
	MTS5409	Experimental Training on R + Python	P Elect-1	4
	MTS5410	Experimental Training on Web UI and UX	P Elect-2	4
Note: Students need to opt **any THREE** courses from MTS5401 to MTS5405, **any ONE** from MTS5406 and MTS5407 and **any ONE** from MTS5409 and MTS5410.				
V	MTS5501	Numerical Analysis	D Elect-1	4
	MTS5502	Optimization Techniques	D Elect-2	4

	MTS5503	Compiler Construction	D Elect-3	4
	MTS5504	Data Mining	D Elect-4	4
	MTS5505	Introduction to UML and Design Patterns	D Elect-5	4
	MTS5506	Mobile Application Development	D Elect-6	4
	MTS5507	Experimental Training on Project Implementation	Project-1	4
Note: Students need to opt **any ONE** from MTS5501 and MTS5502 and **any THREE** from MTS5503 to MTS5506.				
VI	MTS5601	Industrial Training	Industrial Training	8

M.Sc. (Industrial Mathematics with Computer Applications)
Extra Credits

Semester	Name of the paper	Course Code	Title of the Course	No. of Credits
I	Extra Credit Course	MTS4121	Human Rights - I	1
	Extra Credit Course	MTS4122	Introduction to Cyber Security - I	1
	Extra Credit Course	MTS4123	Skill Development - I (LATEX)	1
II	Extra Credit Course	MTS4221	Human Rights - II	1
	Extra Credit Course	MTS4222	Introduction to Cyber Security - II	1
	Extra Credit Course	MTS4223	Skill Development - II (SCILAB)	1
III	Extra Credit Course	MTS4321	Introduction to Cyber Security - III	1
	Extra Credit Course	MTS4322	Emerging Trends - I	1
IV	Extra Credit Course	MTS5321	Introduction to Cyber Security – IV	1
	Extra Credit Course	MTS5322	Emerging Trends - II	1

Programme Outcomes:

PO1	A student should be able to recall basic facts about Mathematics and should be able to display knowledge of conventions such annotations, terminology and recognize basic geometrical figures and graphical displays, state important facts resulting from their studies.
PO2	A student should get a relational understanding of Mathematical and Statistical concepts and concerned structures and should be able to follow the patterns involved with Mathematical reasoning.
PO3	A student should get adequate exposure to global and local concerns to explore many aspects of Mathematical Sciences.
PO4	Students should be able to apply their skills and knowledge, that is, translate information presented verbally into Mathematical form, select and use appropriate Mathematical formulae or techniques in order to process the information and draw the relevant conclusion.
PO5	A student should be made aware of history of Mathematics, Statistics and hence of its past, present and future role as part of our culture.
PO6	A student should be able to write necessary algorithms and programs in different languages as per the need of the industry.
PO7	This course concentrates on areas where Mathematics and Computing are most relevant to each other, emphasizing the bridges between theory and practice. It offers opportunities for potential students both to develop a deeper understanding of Mathematical foundations of their subjects, and to acquire a familiarity with the Mathematics of Application areas where Computers can solve otherwise intractable problems. It also gives students access to both a practical understanding of the use of Computers and deeper understanding of the limits on the use of Computers in their own subject.

MTS4101 Real Analysis
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understanding the Fundamental Concepts related to the Theory of Real Analysis which include Topological aspects, Sequences, Series, Continuity, Differentiation and Riemann Integration, its related theorems and proofs with complete problem solving	Black Board Teaching and problem-solving assignments

Unit No.	Title of Unit and Contents
I	**Basic Topology** Finite, Countable and uncountable sets, Metric Spaces, Compact Sets, Perfect Sets, Connected Sets.
II	**Numerical Sequences and Series** Convergent Sequences, Subsequences, Cauchy Sequences, Some special Sequences Series , Series of Non-negative Terms, The number e, The Root and Ratio Tests, Power Series, Summation by parts, Absolute Convergence.
III	**Continuity** Limits of Functions, Continuous Functions, Continuity and Connectedness, Continuity and Compactness, Discontinuities, Monotonic Functions.
IV	**Differentiation** Derivatives and Mean Value Theorems, Taylor's Theorem, Convex Functions, Cauchy form of the remainder term, Differentiation of Vector Valued Functions.
V	**Riemann Stieltjes Integral** Definition and Existence of the Integral, Properties of the integral, Integration and Differentiation, Integration of Vector Valued Functions, Rectifiable Curves.

Learning Resources

- Walter Rudin, Principles of Mathematical Analysis, McGraw Hill India (3rd edition)
- Ajit Kumar and S. Kumerasan, A First Course on Real Analysis CRC Press

MTS4102 Applied Linear Algebra
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understanding the concept of Vector space, Inner Product spaces, Norms, Linear Transformations, Concept of Eigenvalues and Eigenvectors by means of Examples	Blackboard Teaching
Understanding various applications of vector and matrix algebra to solve problems in Numerical Analysis, Statistics, Data Analysis and Image Processing by means of the theory applicable to the examples	Various software like Scilab, Octave, Matlab and Mathematica can be used to demonstrate examples.

Unit No.	Title of Unit and Contents
I	**Vector Spaces and Basis** Real Vector Spaces**,** Subspaces, Intersection of Subspaces, Sum of Subspaces**,** Span and Linear Independence**,** Basis and Dimensions**,** The Fundamental Matrix Subspaces, Kernel and Image, Superposition Principle, Adjoint Systems, Cokernel and Coimage, Fundamental theorem of Linear Algebra
II	**Inner Products and Norms** Inner Products, Inner Product on Function Spaces, Inequalities: Cauchy Schwarz, Orthogonal Vectors, Triangle Inequality, Norms: Unit Vectors and Matrix Norms, Positive Definite Matrices : Gram Matrices, Completing the Square: Cholesky Factorization
III	**Orthogonality** Concepts of Orthogonal and Orthonormal Basis, Gram Schmidt Process, Orthogonal Projections and Orthogonal Subspaces, Orthogonality of Fundamental Matrix Subspaces and the Fredholm Alternative, Orthogonal Polynomials : Legendre Polynomials
IV	**Linearity** Linear Operators, Space of Linear Functions, Dual Spaces, Composition and Inverses**,** Linear Transformations, Change of Basis**,** Introduction to Affine Transformations and Isometry**,** Adjoints, Positive Definite Linear Functions and Minimization
V	**Eigen values and Eigenvectors** Introduction, Basic Properties and Gerschgorin Circle Theorem Eigenbasis, Diagonalization, Invariant Subspaces, Eigenvalues of Symmetric Matrices, Spectral theorem (Statement only) Introduction to Schur's Decomposition and Jordan Canonical Form Introduction to Singular values, The Pseudo Inverse, Euclidean Matrix Norm, Conditional number and rank, Variance Covariance and Introduction to Principal Components
VI	**Applications** Minimization of Quadratic Forms, Concept of the Closest Point Least Squares, Introduction to Discrete Fourier Transform, Compression and Denoising, Introduction to Haar Wavelets, Modern Wavelets, Haar Scaling Function.

Learning Resources:

- Peter Olver and ChehradShakiban, Applied Linear Algebra (Second Edition) Springer Publishing house
- Gilbert Strang, Linear Algebra and its applications (Fourth Edition)
- K.Hoffman and Ray Kunje , Linear Algebra (PHI India Private Ltd)
- David Lay, Linear Algebra with Applications

- M.L.Artin , Algebra (PHI private Limited)
- A.G.Hamilton ,Linear Algebra (Cambridge University House)
- Henry Helson, Linear Algebra (Hindustan Book Agency)
- I.N.Herstein ,Topics in Algebra (Second Edition)

MTS4103 Discrete Mathematics I
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understand the Logic and interpret mathematically.	Explanation of theorems / Theory part
Understand propositional equivalences, predicates and quantifiers, formulation of different types of proofs	Problem solving
Understand the basic Graph theory, types of graphs, operations on graphs.	Case studies / Programs on shortest path, spanning trees / small projects on topics based on graph theory.
Formulate Matrix representation of graphs and understand algorithms of fusion	
Demonstrate different algorithms of shortest paths and spanning trees minimum weighted algorithms, graph coloring algorithms	

Unit No.	Title of Unit and Contents
I	**Logic** Introduction, Proposition, Simple proposition, compound proposition, Truth value, Prepositional Calculus, operators, Conjunction, Disjunction, conditional statement, Biconditional statement, converse, contrapositive and Inverse, Precedence of logical operators, Translating in English sentences into symbolic form and logical implications. **Propositional Equivalences** Introduction, Logical equivalences, Tautology, Contradiction, Logic rules. **Predicates and Quantifiers** Introduction, Universal quantifier, existential quantifier, counter examples, negating quantifiers, translating sentences into logical expressions, nested quantifiers, truth value of quantifiers. **Methods of Proof** Theorem, Proof, rules of inference, argument, valid argument, invalid argument, direct method of proof, indirect method of proof, rules of reference for quantified statements.

II	**Graph Theory: [36 Lectures]** **Graph:** Definition, vertex, edge, Terminal vertices, self-loop, parallel edges, incidence, adjacent, degree of vertex, isolated vertex, pendent vertex, null graph, hand shaking lemma, regular graph, bipartite graph, complete graph, complete bipartite graph. **Matrix Representation:** Incidence matrix, adjacency matrix, properties. Subgraph, Isomorphism and examples of isomorphic graphs. **Operations on graphs:** Union, intersection, deletion of vertex, deletion of edge, ring sum, fusion. **Connected graphs:** Walk, paths, circuit, Theorems on connected graphs. **Euler graph:** Definition, examples, Chinese postman problem, Fleury's algorithm, Theorems on Eulerian graphs. **Trees:** Definition, pendent vertex in a tree, distance and centres in a tree, rooted and binary trees, spanning trees and rank nullity, fundamental circuits, fundamental cutset, vertex connectivity, edge connectivity, spanning trees, weighted graphs, Kruskal's algorithms, Prim's algorithm, Breadth first search algorithm, depth first search algorithm, Dijkstra's algorithm, Warshall Floyd algorithm, Theorems on trees. **Directed graphs:** Incident out of a vertex, incident into a vertex, indegree, out degree, isolated vertex, pendent vertex, types of digraphs, arborescence definition. **Networks** Flows and cuts, Max ow and min cut theorem, The Ford and Fulkerson Algorithm **Graph Coloring:** **Vertex Coloring:** K-coloring, K-colorable, Chromatic Number, K-Chromatic. Vertex coloring Algorithm: Simple Sequential Coloring, Largest–First Sequential Algorithm (Welsh and Powell) Smallest–Last Sequential Algorithm. **Edge Coloring:** Definition and Concept Only. **Planar Graphs:** Introduction Kuratowski's two graphs (K5, K3) Euler's theorem, Examples based on Euler's theorem. **Matching and Factors:** Matching in bipartite graphs, maximum matchings, Hall`s matching conditions, Min-Matching in bipartite graphs, sets, applications and algorithms, maximum bipartite matching, weighted bipartite matching, Tutte`s 1 factor theorem, factors of graphs.

Learning Resources

- Kenneth H. Rosen, Discrete Mathematics and its Applications (TATA McGraw – HILL), Edition 6
- Kolman, Busby, Ross and Rehman, Discrete Mathematical Structures, Pearson Edition Sixth Edition
- John Clark and Derek Allan Holton, A first look at Graph Theory
- N. Deo, Graph theory with Applications to Computer Science and Engineering, PHI publication.
- Douglas B. West, Introduction to Graph Theory, Pearson Education, Second Edition
- Purna Chandra Biswal, Discrete Mathematics and Graph Theory, Fourth Edition (PHI.).
- Alan Tucker, Applied Combinatorics, John Willey, Fourth Edition.

MTS4104 Software Engineering
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
An ability to design and conduct experiments, as well as to analyze and interpret data.	Board and presentations, case study discussion and solving examples
An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	Board and presentations, case study discussion and solving examples
An ability to identify, formulate, and solve engineering problems.	Board and presentations, case study discussion and solving examples
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	Board and presentations, case study discussion and solving examples
The ability to analyze, design, verify, validate, implement, apply, and maintain software systems.	Board and presentations, case study discussion and solving examples

Unit No.	Title of Unit and Contents
I	**Introduction to software engineering** What is software engineering, software engineering principles, Software characteristics, applications, Objectives of software engineering, Phases of software engineering
II	**Software Processes and Life Cycle models** Software process, project and product, process assessment, Software Process capability maturity model: CMM Model. Life cycle models: Waterfall model, Incremental model, spiral model, advantages and disadvantages, Prototyping Model, Object-oriented model, Agile model, Extreme programming (Latest models can be discussed), advantages and disadvantages.
III	**Software requirements and Software Requirement engineering process** Functional, non-functional requirements, User requirement, System requirements, Software requirements documentation, Feasibility studies, Requirements elicitation and analysis, requirement validation, software prototyping, requirement management.
IV	**Software Reliability** Software Reliability; Software Reliability Metrics; Programming for Reliability; Software Reuse.
V	**Software design** Basics of software design, Data design, Architectural design, component level design and user interface design ,Fundamental design concepts-module and modularization, Design techniques
VI	**Structure analysis and tools** Data flow diagrams, Structure charts, decision tables, decision trees
VII	**Software maintenance** Software re-engineering, Change management, configuration management, maintenance tools and techniques.
VIII	**Software testing strategies:** A strategic approach to software testing, test strategies for convention software, Black-box and white box testing, validation and system testing, and debugging.

Learning Resources

- Jessica Keyes. *Software Engineering Handbook*. Auerbach Publications (CRC Press), 2003. Contains complete examples of various SE documents.
- Roger S. Pressman. *Software Engineering: A Practitioner's Approach* (Sixth Edition, International Edition). McGraw-Hill, 2005.
- Ian Sommerville. *Software Engineering* (Seventh Edition). Addison-Wesley, 2004.
- Hans van Vliet. *Software Engineering: Principles and Practice* (Second Edition). Wiley, 1999.

MTS4105 Experimental Training on C - Programming
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Design, implement, test, debug, and document programs in C	Presenting learning concepts in a thoughtful and concrete way
Understand how to write and use functions, how the stack is used to implement function calls, and parameter passing options	Demonstration of each and every concept using appropriate example code
Inscribe programs that use pointers, perform pointer arithmetic	Provide tasks and classroom assignments
Inscribe C programs to allocate memory using dynamic memory management functions	Explore various IDEs to make development easy
Inscribe programs to use the pre-processor directives	Focus should be given on hands-on of programming
Exercise to create and process data in files using file I/O functions.	Mini projects based on C could be given to individuals or groups.
Use an integrated development environment	Fostering student's motivation and interest in developing small C Programming real world applications

Unit No.	Title of Unit and Contents
I	**Introduction to Programming** Program and Programming, Programming Languages, Types of Software, Operating Systems, Basic Linux Commands and vi Editor, Compiler, Interpreter, Loader and Linker
II	**Basics of C** History and Features of C, Importance of C, Backslash Characters, Character set, Constants, Format Specifiers, Identifiers, Keywords, Variables, Data Types, Comments, const Qualifier, The Structure of a C Program, Building an Executable Version of a C Program, Debugging a C Program, Programming Examples
III	**Applications of C Programming** Demonstration of an application developed using C Note: This unit will not be considered for an assessment of students.
IV	**Control Statements** Decision Making Statements: if, if-else, switch Loop Control Structures: while, do..while, for Keywords- break and continue, exit() Function, return Statement, Programming

	Examples
V	**Operators and Expressions** Arithmetic Operators, Increment and Decrement Operators, Relational Operators , Logical Operators, Bitwise Operators, Assignment Operators, Conditional Operator, size of Operator, Comma Operator, Type Casting Operator, Other Operators, Precedence and Order of Evaluation, Programming Examples
VI	**Input and Output** Unformatted I/O, Character I/O, String I/O, Formatted I/O, Programming Examples
VII	**Functions** Concept, Usage of a Function, Advantages, Function Prototype, Function example, Types of Function, Call by Value and Call by Address, Recursion, Library Functions, Local variable, Global Variable, Storage classes (automatic, static, register, external), Programming Examples
VIII	**Array** Array Declaration, Initialization, Types of Array (1-D, 2-D and Multidimensional), Passing Arrays to Functions, Programming Examples
IX	**Pointers** Pointer Declaration and Initialization, Dereferencing Pointers, void Pointer, Pointer Arithmetic, Pointer to Pointer, Arrays and Pointers, Functions and Pointers, Passing Pointers to Function, Function Returning Pointer, Pointer to Function, Dynamic Memory Allocation, Programming Examples
X	**String Handling** Declaration and Initialization, Reading and Writing Strings, Standard String Library Functions, Array of Pointers to String, Command Line Arguments, Programming Examples
XI	**Structures and Unions** Overview of Structures, Defining and Using a Structure, typedef Keyword, Nested Structures, Passing Structure to Function, Structure and Pointer, Union, Difference between Structure and Union, Programming Examples
XII	**Pre-Processor Directives** Pre-Processor Directives, #define Macro, Conditional Compilation, Pre-defined Macros, #include and Header Files, Programming Examples
XIII	**File Handling** What is a Stream? Opening and Closing of Files, File Opening Modes, Writing and Reading in Text Format, Writing and Reading in Binary Format, Programming Examples

Learning Resources

Include Reference Books/ e-resources / journals/any other learning material

1. Kernighan Brian W., Ritchie Dennis M., The C Programming Language, PHI Learning Pvt. Ltd., 2nd Edition, 2010
2. Schildt Herbert, C: The Complete Reference, Tata McGraw Hill, 4th Edition, 2006
3. KanetkarYashavant, Pointers in C, BPB Publications, 4th Edition, 2013
4. KanetkarYashavant, Test your C Skills, BPB Publications, Rev. Edition, 2008

MTS4201 Advanced Calculus
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understanding the advanced concepts in Real Analysis which include sequences and series of functions, Special Functions, Concepts in Multivariable and Vector Calculus and Integration on Differential Forms, various theorems and proofs related to it.	Black board Teaching and Problem solving related to the theory by means of assignments

Unit No.	Title of Unit and Contents
I	**Sequences and Series of Functions** Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and Differentiation, Uniform convergence and Integration, Equicontinuous Families of Functions, The Stone Weierstrass Theorem
II	**Special Functions** Power Series, The Exponential and Logarithmic Functions, The Trigonometric Functions, Fourier Series, Gamma Function.
III	**Functions of Several Variables** Linear Transformations, Differentiation, The Contraction Principle The Inverse Function Theorem, The Implicit Function Theorem, The Rank Theorem, Determinants, Derivatives of higher Order Differentiation of Integrals
IV	**Integration of Differential Forms** Integration, Primitive Mappings, Partitions of Unity, Change of Variables, Differential Forms, Simplexes and Chains, Stoke's Theorem, Closed and Exact Forms, Vector Analysis.

Learning Resources

- Walter Rudin, Principles of Mathematical Analysis, McGraw- Hill India (3^{rd} edition)
- Michael Spivak , Calculus of Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus, Benjamin Cummings
- James Munkres, Analysis of Manifolds, Mathematical Association of America

MTS4202 Abstract Algebra
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Demonstrate insight into abstract algebra with focus on axiomatic theories	Black board Teaching and Problem solving related to the theory by means of assignments
Demonstrate knowledge and understanding of fundamental concepts including groups, subgroups normal subgroups, homomorphisms and isomorphism	Applications of Groups/rings and fields.
Understand and acquire knowledge of many Mathematical concepts studied in abstract Mathematics such as permutation groups, factor groups and Abelian groups.	
Understand concept of rings, fields and their properties	

Unit No.	Title of Unit and Contents
I	**Groups** Definitions and Examples, Simple properties of Groups based on axioms, Order of an element, properties and example. Subgroups: Definition and examples, necessary and sufficient condition for non-empty subset to be a subgroup, properties of subgroup, cyclic subgroups, Definition and examples of cyclic subgroup, properties, counting principle, cosets- examples and properties, Lagrange's theorem and its corollaries. Permutation groups: Definition and Examples, Permutation as composition of function, Definition of $\mathbf{S_n}$and discussion of S_3 and S_4 in detail. Cycles, Transpositions, Every Permutation is a product of disjoint cycles, Even and odd permutations, order of a permutation, Alternating group $\mathbf{A_n}$. Homomorphism and Isomorphism: Definitions and Examples, Simple Properties Isomorphism - Definition and Examples Fundamental theorem of homomorphism and its applications, Cayley's theorem Normal Subgroups: Definition and Examples, Properties of Normal Subgroups, Simple Groups, $\mathbf{A_n}$is simple for n=5, Factor Group, Definition and Examples, Properties of Factor groups. Sylow's theorems: Class Equations, Conjugate of an element-Definition and Examples, Conjugacy relation is and equivalence relation, Conjugacy Class Normalizer, Centralizer, Centre of a group, Class equation, a belongs to Z(G) if and only if N(a) = G, Centre of a p-group is nontrivial, every group of order p-square is abelian. Cauchy's theorem, Sylow's theorems (without proofs) - only problems.
II	**Rings [18 Lectures]** Definitions and examples, simple properties of rings, Commutative rings, ring with unity, integral domain, field, skew field, definitions examples and interrelationship between them. Subring: Definition, Examples, Properties. Characteristic of an integral domain. Ideals and Factor Rings: Definitions & Examples, Properties of ideals, Prime Ideals, Maximal Ideals, Quotient rings Homomorphism and Isomorphism of rings: Definition and examples, properties of ring homomorphisms, fundamental theorem of ring homomorphisms and its applications. Euclidean rings: Polynomial rings F[X] over a field F,F[X] is Euclidean ring, irreducible polynomial over a field, polynomials over a field of rationals, Gauss lemma and Eisenstein's criterion for irreducibility, Construction of finite fields.

Learning Resources

- Contemporary Abstract Algebra by Joseph Gallian (Fourth Edition, Narosa Publication)
- J.B. Fraleigh, Abstract Algebra, 7th edition
- I.S. Luthar and I.B.S. Passi, Algebra (Volume 1) Groups (Narosa Publishing House)
- I.N. Herstein, Topics in Algebra (Wiley-Eastern Ltd)
- M. Artin, Algebra (Prentice Hall)
- N.S. Gopala Krishnan, University Algebra (Wiley-Eastern Ltd)
- David S. Dummit and Richard M. Foote, Abstract Algebra (Wiley-Eastern Ltd), Second edition.

MTS4203 Discrete Mathematics II
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understand different counting principles	Explanation of theorems / Theory part
Formulate recurrence relations and understand how to solve it.	Problem solving
Acquire knowledge of fundamental notions from lattice theory and properties of lattices	Case studies and / or small projects on topics based on Boolean algebra.
Develop ability to solve individually and creatively advanced problems of lattice theory and problems connected with its applications to Mathematics	
Understand useful basic theorems from Boolean axioms simplify and complement Boolean expressions, define the fundamental logic operations AND, OR, complement etc, relate Boolean expressions to truth tables and logic diagrams.	

Unit No.	Title of Unit and Contents
I	**Combinatorics** The basic counting principles, Permutations and Combinations, Pigeonhole principle, Inclusion-Exclusion principle and applications of inclusion-exclusion principle. Combination, Permutation, Generating function models, calculating generating functions, Ordinary and Exponential generating functions. Recurrence relation, Methods of solution of recurrence relation, substitution method, characteristic method.
II	**Introduction to Lattice:** Partial order, Hasse diagram, join and meet operation, chain, examples, product of lattices, laws of lattices, Idempotency, Commutativity, Associativity, Absorption. Principal of duality Types of lattices, Complete, distributive, bounded, Modular sublattices, complementary lattice, unique complement, relative complement. Quotient lattices

IV	**Boolean Algebra:** Introduction, Boolean expressions and Boolean function, Boolean identities, principle of duality, Literal, minterm, disjunctive normal form, conjunctive normal form, Logic Gates: Introduction, OR gate, AND gate, circuit diagram, full adder, half adder. Minimization of circuits: Introduction, Karnaugh map, (2 variables, 3 variables), Prime implicant, essential prime implicant, QuineMcCluskey Method, bit string, cover.

Learning Resources

- K.H. Rosen, Discrete Mathematics and its Applications (TATA McGraw – HILL), Sixth Edition
- Kolman, Busby, Ross and Rehman, Discrete Mathematical Structures, Pearson Edition Sixth Edition
- Alan Tucker, Applied Combinatorics, John Willey, Fourth Edition.
- V. Krishnamurthy, Combinatorial, Theory and Applications, East West Press, New Delhi (1989) Scientific, (1996)
- G. Gratzer, Birkhauser, General Lattice Theory Second Edition (Edition 1998)
- Vijay Khanna: Lattices and Boolean Algebra, Vikas Publications.

MTS4204 Probability and Statistics
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understanding the Fundamental concepts in Probability, Distributions, Correlation, various versions of Central Limit Theorems, Regression and Hypothesis Testing with some basic proofs	Blackboard Teaching
Problem solving with respect to the theory mentioned above	Use of R Programming Language to solve these Computational Examples

Unit No.	Title of Unit and Contents
I	**Introduction to Probability** Classical Definition of Probability, Mutually Exclusive and Independent Events, Inclusion Exclusion Principle, Conditional Probability, Bayes Theorem and related problems
II	**Random Variables and Distribution Functions** Introduction, Distribution Functions, Discrete Random Variable, Examples, Concept of Probability Mass Functions, Continuous Random Variables, Examples and Concept of Probability Density Functions. Introduction to Joint Probability Mass Functions and Marginal Distributions, Expected Value and Variance
III	**Introduction to Distributions** Introduction to Binomial, Poison, Geometric, Continuous Uniform, Normal, Exponential and problems related to these distributions.
IV	**Important Results and Theorem** Discussion on the Random Walk problem, Statements on various versions of Central Limit theorem. Statement of Chebychev's Inequality and Weak Law of Large Numbers.

V	**Correlation and Regression** Introduction, Scatter Diagrams, Karl Pearson Correlation Coefficient, properties and problems related to it, Introduction to Simple Linear Regression Model, Regression Equations, Examples, Assumptions of the Model, Introduction to Multiple Linear Regression Model, Regression Equations, Assumptions of the Model and Fitting of the Models.
VI	**Testing of Hypothesis** Introduction to Sampling, Basic Terms of hypothesis testing, Type I, Type II errors, Large Sample tests based on Means and Proportions, Introduction to chi-square, t and F distributions, Small sample tests based on t for means, difference of means, Paired t test, chi-square test for Independence of attributes, goodness of Fit, Introduction to Modeling of an One way ANNOVA and a problem related to it.

Learning Resources:

- Sheldon Ross, Probability and Statistics for Engineers and Scientists, Academic Press (Fourth Edition)
- George Casella, Roger Lee Berger, Statistical Inference, Wordpress
- S.C. Gupta , Fundamentals of Statistics, Himalaya Publishing House

MTS4205 Experimental Training on C++
Credits: 4C

Learning Outcomes	**Suggested Pedagogical Processes**
To implement the features of Object-Oriented Programming using C++	Presenting learning concepts in a thoughtful and concrete way
To develop C++ programs using concept of classes	Demonstration of each and every concept using appropriate example code
To handle File, I/O in C++	Provide tasks and classroom assignments
To implement exception handling in C++	Explore various IDEs to make development easy
To demonstrate the usage of Templates and STL in C++	Focus should be given on hands-on on programming
To develop object-oriented applications using C++	Mini projects based on C++ could be given to individuals or groups.
	Fostering student's motivation and interest in developing small C++ Programming real world applications

Unit No.	**Title of Unit and Contents**
I	**Introduction to C++** History, Features of C++, Structure of C++ program, Variables, Data Types, Keywords, Operators, Namespaces, using Keyword, I/O Stream, References in C++, C vs C++, Programming Examples
II	**Control Statements** Decision Making Statements: if, if-else, switch Loop Control Structures: while, do. While, for Keywords- break and continue, Comments, Programming Examples

III	**Functions** Concept, Usage of a Function, Types of Function, Call by Value, Call by Reference and Call by Address, References vs Pointers, Return by Reference, Inline Function, Default Arguments Concept, Recursion, Programming Examples
IV	**Arrays** Arrays, Passing Array to Function, Multidimensional Arrays, Programming Examples
V	**Strings** Concept, Operations on Strings, Standard Library String Functions, Programming Examples
VI	**Class and Objects** OOPs concepts: Encapsulation, Inheritance, Polymorphism, Abstraction Object, Class, Constructor, Types of Constructor (Default, Parameterised, Copy), Destructor, Virtual Destructor, this Pointer, static Members (Fields & Member Functions), Structs, Friend Function, Programming Examples
VII	**Inheritance & Aggregation** Concept, Advantages, Types of Inheritance, Aggregation, Programming Examples
VIII	**Polymorphism** Concept, Function overloading, Operator overloading, Function overriding, Virtual function, Virtual base class, Programming Examples
IX	**Abstract class** Concept, Pure Virtual Function, Interface, Programming Examples
X	**File & Stream** Concept, I/O Manipulators (endl, flush, setfill, setprecision, setw), fstream, ifstream, ofstream, File I/O, Programming Examples
XI	**Exception Handling** Concept, Exception Handling Keywords (try, catch, throw), Advantages, Standard Exception Classes in C++, User-defined Exceptions, Programming Examples
XII	**Templates** Concept, Function Template, Overloading of Function Template, Restrictions on Generic Functions, Class Template, Programming Examples
XIII	**Introduction to STL (Standard Template Library)** Concept, Containers (Stack, Queue, Vector, List), Algorithms (Sorting, Searching), Iterator, Programming Examples

Learning Resources

Include Reference Books / e-resources / journals / any other learning material

1. Herbert Schildt, The Complete Reference C++, Tata McGraw Hill, 4th Edition, 2003
2. Herbert Schildt, C++ Programming Cookbook, Tata McGraw Hill, 2008
3. Bjarne Stroustrup, The C++ Programming Language, Pearson, 4th Edition
4. Lafore Robert, Object-Oriented Programming with C++, Pearson, 4th Edition, 2010
5. Kanetkar Yashavant, Let us C++, BPB Publications, 2nd Edition, 2010

MTS4206 Experimental Training on DBMS
Credits: 4C

Learning Outcomes	Suggested Pedagogical Processes
Understanding of Basics of DBMS	Demonstration and discussion of concepts using board and projector.
Understand, analyze and apply common SQL statements including DDL, DML and DCL statements to perform different operations.	Practical demonstration with discussion of concepts.
Design different views of tables for different users and to apply embedded and nested queries.	
Understand and solve examples based on functions, procedures, cursors and triggers.	
Design and implement a database for a given problem according to well-known design principles that balance data retrieval performance with data consistency.	

Unit No.	Title of Unit and Contents
I	**Database Management System Concepts**: 1.1 Introduction 1.2 Significance of Database 1.3 Database System Applications 1.4 Data Independence 1.5 Entities and their Attributes 1.6 Relationships and Relationships Types 1.7 E R Diagram 1.8 Data types 1.9 Creating tables (without keys)
II	**An Introduction to RDBMS**: 2.1 Relational Database Management System 2.2 RDBMS Properties 2.3 Maintaining Integrity and Defining Data Integrity 2.5 Integrity Rules and Integrity Constraints 2.6 Relational Integrity Rules 2.7 Creating tables (with keys)
III	**SQL** 3.1 Types of SQL DCL- DML 3.2 Basic queries in SQL Single table 3.3 Deletion- Insertion- and Update in SQL 3.4 Simple queries (with insert, delete, and update)
IV	4.1 Multi table Retrievals 4.2 Nested queries (with foreign key and using multi tables)
V	**Stored Functions** 5.1 Function definition 5.2 How to write function and its execution 5.3 Solving some problems with function
VI	**Stored Procedures** 6.1 Procedure definition

	6.2 How to write procedure and its execution 6.3 Solving some problems with procedure
VII	**Cursors** 7.1 Cursor definition 7.2 How to write cursor and its execution 7.3 Solving some problems with cursor
VIII	**Triggers** 8.1 Trigger definition 8.2 How to write trigger and its execution 8.3 Solving some problems with trigger
IX	**Views** 9.1 View definition 9.2 How to write view and its execution 9.3 Solving some problems with view

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1. Henry F. Korth, Abraham Silberschatz, S. Sudarshan Database System Concepts, ISBN:9780071289597, Tata McGraw-Hill Education
2. KorryDouglas, PostgreSQL, , ISBN:9780672327568
3. John Worsley, Joshua Drake Practical PostgreSQL (B/CD), ISBN: 9788173663925 Shroff / O'reilly
4. Joshua D. Drake, John C Worsley Practical Postgresql, O'Reilly
5. Richard Stones, Neil Matthew Beginning Databases with PostgreSQL, From Novice to Professional, 2nd Edition