Department of Applied Mathematics
Delhi Technological University,
(Formerly Delhi College of Engg.)
Bawana Road, Delhi – 42.

B.Tech Mathematics and Computing

I Year: First Semester

Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	AM101	Mathematics-I	BSC	4	3	1	0	3	0	25	-	25	50	-
2	AP101	Physics	BSC	4	3	0	2	3	0	15	25	20	40	-
3	EC101	Basic Electronics & Communication Engineering	ESC	4	3	0	2	3	0	15	25	20	40	-
4	ME105	Computer Aided Engineering Graphics-II	ESC	4	3	0	2	3	0	15	25	20	40	-
5	MC103	Python Programming	SEC	2	0	0	4	0	3	-	50	-	-	50
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**20**										
I Year: Second Semester														
1	AM102	Mathematics-II	BSC	4	3	1	0	3	0	25	-	25	50	-
2	CO102	Programming Fundamentals	ESC	4	3	0	2	3	0	15	25	20	40	-
3	MC102	Discrete Mathematics	ESC	4	3	1	0	3	0	25	-	25	50	-
4	MC104	Complex Analysis	DCC	4	3	1	0	3	0	25	-	25	50	-
5	MC106	MATLAB Programming	SEC	2	0	0	4	0	3	0	50	-	-	50
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**20**										

Additional 02 credits are to be earned from mandatory community engagement course in first year to fulfil the requirement of award of the four year B.Tech Degree.

Department of Applied Mathematics
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B.Tech Mathematics and Computing

II Year: Third Semester

Teaching Scheme					Contact Hours/Week			Exam Duration (h)		Relative Weights (%)				
S. No.	**Subject Code**	**Course Title**	**Subject Area**	**Credit**	**L**	**T**	**P**	**Theory**	**Practical**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
1	MC201	Data Structure	ESC	4	3	0	2	3	0	15	25	20	40	-
2	MC203	Real Analysis	DCC	4	3	1	0	3	0	25	0	25	50	-
3	MC205	Probability and Statistics	DCC	4	3	0	2	3	0	15	25	20	40	-
4	MC207	Modern Algebra	DCC	4	3	1	0	3	0	25	0	25	50	-
5	MC209	Database Management Systems	DCC	4	3	0	2	3	0	15	25	20	40	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
7	MS299	Community Engagement Course	Mandatory	2										
Total				**24**										
II Year: Fourth Semester														
1	MC202	Operating Systems	ESC	4	3	0	2	3	0	15	25	20	40	-
2	MC204	Scientific Computing	DCC	4	3	0	2	3	0	15	25	20	40	-
3	MC206	Analysis and Design of Algorithms	DCC	4	3	1	0	3	0	25	-	25	50	-
4	MC208	Linear Algebra	DCC	4	3	1	0	3	0	25	-	25	50	-
5	MC210	Differential Equations	DCC	4	3	0	2	3	0	15	25	20	40	-
6	AEC/VAC	AEC/VAC	AEC/VAC	2	2/1/0	0	0/2/4	3/3/0	0/2/3	25/15/0	0/25/50	25/20/0	50/40/0	0/0/50
Total				**22**										

Details of Course:

Course Title	Course Structure			Pre-Requisite
AM 101 : Mathematics I	**L**	**T**	**P**	NIL
	3	**1**	**0**	

Course Objective: To acquaint the students with the knowledge of series & sequence, single & multiple variable calculus, knowledge of vector calculus and their applications.

Course Outcome (CO):

CO1	Analyse an infinite series of positive terms for convergence or divergence, and distinguish between absolute and conditional convergence.
CO2	Apply differential calculus to obtain Maclaurin's and Taylor's expansions, find the radius of curvature, sketch some standard curves, and calculate arc length and surface area using definite integrals.
CO3	Explain the various concepts of calculus and the properties of functions of several variables, find the maxima-minima, and estimate the error.
CO4	Explain the concept of multiple integrals, and apply multiple integration techniques for solving problems related to area and volume.
CO5	Interpret various concepts of differential and integral calculus of vector point functions and apply them to evaluate work done by a force or in other applications, and understand the concepts underlying Green's, Stoke's, and Gauss divergence theorems.

S. No.	Contents	Contact hours
1.	Infinite series: Tests for convergence of positive term series (Comparison, Ratio, nth Root, integral, Raabe's, Logarithmic), Alternating series, series, Absolute convergence, Conditional convergence.	8
2.	Differential & Integral Calculus of single variable: Maclaurin's and Taylor's Expansions, Radius of curvature, Tracing of some standard curves, Applications of definite integral to arc length and surface area (Cartesian and polar coordinates) .	8
3.	Calculus of several variables: Partial differentiation, Euler's theorem, Total derivative, Taylor's Expansion, Maxima-Minima, Lagrange's method of multipliers, Applications in estimation of error and approximation.	8
4.	Multiple Integrals: Double integral (Cartesian and polar co-ordinates), change of order of integration, triple integrals (Cartesian, cylindrical and spherical co-ordinates), Applications to area and volume.	9
5.	Vector Calculus: Scalar and vector point functions, gradient, directional derivative, divergence, curl and their interpretations. Line integral, surface integral and volume integral, Applications to work done by the force, Green's, Stoke's and Gauss divergence theorems.	9
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Advanced Engineering Mathematics: kreyszig; Wiley-India, 10th edition ISBN-978-1-119-45592-9	2020
2.	Advanced Engineering Mathematics: Jain and lyenger; Narosa, 5th Edition ISBN-978-81-8487-560-7	2019
3.	Advanced Engineering Mathematics: Alan Jeffery; Academic Press ISBN-978-93-80501-50-5	2010
4.	Calculus and Analytic Geometry: Thomas and Finney; Narosa. ISBN-978-81-85015-52-1	2013
5.	Advanced Engineering Mathematics: Dennis G. Zill, Jones and Bartee Publications 6th ed. ISBN-978-12844105902.	2016

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 103 : Python Programming	**L**	**T**	**P**	**Basic computer knowledge**
	0	**0**	**4**	

Course Objective: To introduce fundamentals of programming using Python and understand the concepts of program.

Course Outcome (CO):

CO1	Summarize how control flow works in Python and Interpret code snippets and predict their output.
CO2	Utilize libraries and modules to accomplish tasks efficiently and Identify errors and debug Python code effectively.
CO3	Design and develop Python applications.
CO4	Assess the efficiency and effectiveness of Python code and Critique solutions and propose improvements.
CO5	Innovate and create novel solutions using Python programming principles.

S. No.	Contents	Contact hours
1.	**Introduction to Python:** Arithmetic Operators, Variables, Expressions and Statements in Python, Function Calls, Parameters and Arguments, Infinite Recursion and Stack Diagrams, Logical Operators, Conditional and Alternative Execution, Iterations in Python.	7
2.	**Strings and Dictionaries in Python**: Immutable Strings, String Methods and Comparison, Mutable Lists, List Operations and Methods, Concept of Dictionary and Looping, Reverse Lookup, Immutable Tuples, Tuples as Return Values, Concepts of Namespaces and scope.	7
3.	**Error handling and Files in Python:**. Error handling using try and except, Create your own exceptions, Filenames and Paths, Persistence, Reading and Writing, Catching Exceptions, Attributes, Mutable Objects, Classes and Functions, Pure Functions, Modifiers, Classes and Methods, Inheritance	7
	Total	21

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Intro to Python for Computer Science and Data Science, Paul Deitel, Harvey Deitel, Pearson Education, 1st Edition, ISBN – 978-9353949518	2022
2.	Python Crash Course A Hands-On, Project-Based Introduction to Programming, Eric Matthes, No Starch Press, 3rd Edition, ISBN- 978-1718502703.	2023
3.	Python: The Complete Reference, Martin C. Brown, McGraw Hill Education, 4th Edition, ISBN- 978-9387572942.	2018

List of Experiments:

1. WAP that creates variables of numeric data types and perform arithmetic operations on them in Python. [CO 1]
2. WAP to declare variables of string datatype and perform different operations on them. [CO1, CO 2]
3. WAP to create, insert and delete Lists in Python. [CO 2]
4. WAP to create, insert and delete Dictionaries in Python. [CO 2, CO3]
5. WAP to create, insert and delete Sets and Tuples in Python. [CO 2]
6. WAP to print Fibonacci series using for loop in Python. [CO 1, CO3]
7. Create a function search_list which takes a list of values as arguments and search a particular number in the list. [CO 1, CO 3]
8. WAP for division of two numbers where denominator is 0. This will throw an exception. Now handle the exception using try and except. [CO 5]
9. WAP in Python that can create your own exceptions. [CO 4]
10. WAP to explain file handling in Python. [CO 4]
11. WAP to demonstrate objects and classes in Python. [CO 5]

Details of Course:

Course Title	Course Structure			Pre-Requisite
AM 102 : Mathematics II	**L**	**T**	**P**	NIL
	3	**1**	**0**	

Course Objective: To impart knowledge of matrices, Differential equations, Laplace transform, Fourier series & their applications.

Course Outcome (CO):

CO1	Solve the system of linear equations, interpret the eigenvalues and eigenvectors of a matrix.
CO2	Explain the concept of differential equations and evaluate various methods to solve ordinary differential equations.
CO3	Find the series solutions of differential equations using Power series and Frobenius methods.
CO4	Implement the integral transformation using the concept of Laplace transformation and apply it to solve differential equations.
CO5	Find Fourier series of a periodic function and apply it in harmonic analysis.

S. No.	Contents	Contact hours
1.	Matrices: Rank of a matrix, inverse of a matrix using elementary row transformations, solutions of system of linear equations, eigen values and eigen vectors of a matrix.	8
2.	Ordinary differential equations: Second and higher order linear differential equations with constant coefficients, General solution of homogenous and non-homogenous equations, method of variation of parameters, simultaneous linear differential equations.	9
3.	Special Functions: Power series method, Frobenious method, Legendre equation, Legendre Polynomials, Bessel equation, Bessel function of first kind and their Orthogonal property.	9
4.	Laplace Transforms: Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, Unit step function, periodic function. Applications of Laplace transform to initial and boundary value problems.	8
5.	Fourier series: Fourier series of 2π period, Fourier series of arbitrary period, Fourier series of Even and odd functions, half range Fourier series, Harmonic analysis.	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Advanced Engineering Mathematics: kreyszig; Wiley-India, 10th edition ISBN-978-1-119-45592-9	2020
2.	Advanced Engineering Mathematics: Jain and lyenger; Narosa, 5th Edition ISBN-978-81-8487-560-7	2019
3.	Advanced Engineering Mathematics: Alan Jeffery; Academic Press ISBN-978-93-80501-50-5	2010
4.	Advanced Engineering Mathematics: Peter V. O'Neil Cengage Learning. ISBN-978-81-315-0310-2	2007
5	Advanced Engineering Mathematics: Dennis G. Zill, Jones and Bartee Publications 6th Ed. ISBN-978-12844105902.	2016

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 102 :	**L**	**T**	**P**	NIL
Discrete Mathematics	**3**	**1**	**0**	

Course Objective: To provide knowledge of combinatorial problem, algebraic structure, logic and graph theory required for building mathematical foundation**.**

Course Outcome (CO):

CO1	Describe concepts of set theory, relations, functions, and discrete structures to solve various problems.
CO2	Apply logical equivalences to simplify and manipulate logical expressions, and apply rules of inference to derive conclusions from premises in both propositional and predicate logic.
CO3	Apply the concepts of counting principles and combinatorics to solve problems, identify various algebraic structures and describe their properties.
CO4	Describe lattices and explain the structure of Boolean algebra to construct and simplify Boolean expressions.
CO5	Illustrate, formulate and solve the problems based on the concepts of graphs and trees.

S. No.	Contents	Contact hours
1.	**Set theory:** Basic concepts of set theory, operations on sets, Cartesian products, relations, equivalence relation, equivalence classes, operations on relations, partial order relation, Hasse diagram, functions, recursive functions.	8
2.	**Logic:** Proposition, compound propositions, well-formed formulae, truth tautology, contradiction, equivalence, algebra of proposition, normal forms, theory of inference, predicate logic: predicates, quantifiers, free and variables, theory of inference for predicates.	8
3.	**Combinatorics:** Permutations, combinations, recurrence relations, generating functions. Algebraic structures: Definition and their properties, introduction to semigroups, monoids and groups, homomorphisms, Rings and their homomorphisms.	10
4.	**Lattices and Boolean algebra:** Definition of lattice, properties of lattices, bounded, complemented, distributive and complete lattice, Introduction, axioms and theorems of Boolean algebra, algebraic manipulation of Boolean expressions.	8
5.	**Graph Theory:** Graphs, digraphs, adjacency matrix, incidence matrix, connectivity, subgraphs, trees, spanning tree, complete graphs, walk, path, cycle.	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill	1997
2.	C. L. Liu, Elements of Discrete Mathematics, 2nd Edition, Tata McGraw-Hill	2000
3.	Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw-Hill	2001
4.	A. M. Raigorodskii, M. T. Rassias, Discrete Mathematics and Applications, 1st Edition, Springer	2020

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 104 :	**L**	**T**	**P**	NIL
Complex Analysis	**3**	**1**	**0**	

Course Objective: To acquaint the students with the knowledge of complex variables, contour integration, conformal mappings.

Course Outcome (CO):

CO1	Describe complex numbers, variables, and functions and their various representations.
CO2	Analyse analytic functions, solve problems using Cauchy-Riemann equations and construct analytic functions.
CO3	Examine and apply various types of transformation types.
CO4	Evaluate the complex integrals using various techniques.
CO5	Apply series expansion, examine various types of singularities and calculate the residues.

S. No.	Contents	Contact hours
1.	Algebra of complex numbers, the complex plane, polynomials, power series, radius of convergence, transcendental functions, Riemann Sphere, Stereographic Projection.	8
2.	Analytic functions, Cauchy-Riemann equations, Harmonic functions, Construction of analytic functions.	8
3.	Linear and bilinear Transformation, cross ratio and conformal Mappings.	8
4.	Line integral in the Complex Plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of Analytic functions, Morera's theorem, Cauchy's estimate, Liouville's theorem, Fundamental theorem of Algebra.	9
5.	Taylor Series and Laurent Series, Singularities, types of singularities, zeros and poles, Residues, Residue theorem and its applications to evaluate improper real integrals.	9
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	J. B. Conway, Functions of One Complex Variable, Springer	2012
2.	J. Bak and D. J. Newman, Complex Analysis	2017
3.	Churchill and Brown, Complex Analysis with applications, Dennis G. Zill & Shanahan, Jones & Bartlett (student edition) 2nd Edition.	2009
4.	Complex variable, Schaum series	
5	A. Bourchtein and L. Bourchtein, Complex Analysis, 1st Edition, Springer	2021

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 106 : MATLAB Programming	**L**	**T**	**P**	NIL
	0	**0**	**4**	

Course Objective: To introduce fundamentals of MATLAB programming and perform mathematical operations in MATLAB.

Course Outcome (CO):

CO1	Recognize different data types and structures available in MATLAB and Describe the principles behind MATLAB's mathematical operations and matrix manipulation.
CO2	Apply MATLAB to analyze and visualize data.
CO3	Evaluate MATLAB code for correctness and efficiency and Decompose complex problems into smaller, manageable tasks in MATLAB
CO4	Judge the suitability of MATLAB for different computational tasks and scenarios and Assess the effectiveness of MATLAB solutions in addressing specific problems.
CO5	Design and implement MATLAB-based projects and simulations.

S. No.	Contents	Contact hours
1.	**Introduction to MATLAB:** Starting MATLAB, Working in the Command Window, Arithmetic Operations with Scalars, Elementary Math Built-in Functions, Defining Scalar Variables, Commands for Managing Variables.	4
2.	**Arrays:** One-Dimensional and Two-Dimensional Arrays, Array Addressing, Adding and Deleting Elements, Built-in Functions for Handling Arrays, Strings, Mathematical Operations with Arrays: Addition, Subtraction, Multiplication, and Division, Generation of Random Numbers.	6
3.	Relational and Logical Operators, Conditional Statements, Switch Case, Loops, Break and Continue commands. **2-D Plots**: The plot command, fplot command, plotting multiple graphs in same plot, histograms.	6
4.	**Polynomials and Symbolic Math**: Polynomials, Curve Fitting, Solving Algebraic Equations, Differentiation, Integration.	5
	Total	**21**

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	MATLAB: A Practical Introduction to Programming and Problem Solving, Dorothy Attaway, Butterworth-Heinemann, 6th Edition, ISBN – 978-0323917506.	2022
2.	Beginning MATLAB and Simulink: From Beginner to Pro, Sulaymon Eshkabilov, Apress, 2nd Edition, ISBN – 978-1484287477.	2022
3.	MATLAB: An Introduction with Applications, Amos Gilat, John Wiley & Sons Inc., 6th Edition, ISBN – 978-1119299257.	2017

List of Experiments:

1. WAP for basic arithmetic operations with scalars in MATLAB. [CO 1]
2. WAP to demonstrate mathematical built-in functions in MATLAB. [CO 1]
3. WAP to create 1-D and 2-D arrays in MATLAB. Further, add and delete elements in the arrays. [CO 2]
4. WAP to perform mathematical operations (addition, subtraction, array multiplication, array division) on arrays in MATLAB. [CO 2]
5. WAP to demonstrate conditional statements and switch case in MATLAB. [CO 3]
6. WAP to demonstrate loops in MATLAB. [CO 3]
7. WAP to construct plots using the plot/fplot command in MATLAB. [CO 4]
8. WAP to construct histograms in MATLAB. [CO 4]
9. WAP to solve polynomials and algebraic equations in MATLAB. [CO 5]
10. WAP to demonstrate differentiation and integration in MATLAB. [CO 5]

THIRD SEMESTER

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 201 :	L	T	P	Basic Mathematics and
Data Structure	3	0	2	Discrete structures

Course Objective: To introduce the concept of complexity of algorithms and to introduce different kinds of data structures with their respective operations.

Course Outcome (CO):

CO1	Represent and organize data using different data structures.
CO2	Design algorithms to create and manipulate data structures.
CO3	Estimate and compare the performance of various operations performed on the data structures.
CO4	Employ various sorting techniques to sort the data.
CO5	Illustrate the usage of hashing functions and collision resolution techniques.

S. No.	Contents	Contact hours
1.	Introduction: Introduction to abstract data types, design, implementation and applications. Introduction to Algorithm, Time complexity and Space complexity Trade off. Introduction Arrays and Strings: Representation of Arrays in Memory: one dimensional, Two dimensional and Multidimensional, operations on array. Strings and String Operations. Stacks: Introduction, Operations on Stacks, Array representation of Stacks Applications of Stacks: recursion, Polish expression and their compilation conversion of infix expression to prefix and postfix expression. Queues: Introduction, Operations of Queues, Representations of Queues Applications of Queues, Priority queues.	10
2.	Linked Lists: Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching. Applications of Linked List. Concepts of Circular linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.	7
3.	Graphs: Introduction to types of graphs, representation and transversal, shortest path, and transitive closure. Activity networks, topological sort, and critical paths. Spanning trees, Binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion. Applications of Binary search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B trees, B+ trees.	10
4.	Sorting: Insertion Sort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting.	8
5.	File Structure: File Organization, Indexing & Hashing, Hashing Functions, Collision Resolution Techniques.	7
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	"Fundamentals of Data structures in C", E. Horowitz, Sartaj Sahni, Susan Anderson-Freed, Universities Press	2017
2.	"Data Structures using C", Tannenbaum, Yedidyah Langsam, Augenstein, Pearson.	2019
3.	"An introduction to data structures with application", Jean Paul Tremblay & Pal G. Sorenson, McGraw Hill	2017
4.	"Data Structure and Program Design in C", R.L. Kruse, B.P. Leary, C.L. Tondo, PHI	2009

Details of Course

Course Title	Course Structure			Pre-Requisite
MC 203 : Real Analysis	L	T	P	Nil
	3	1	0	

Course Objective: To impart knowledge of real numbers system, sequences, metric spaces, and Riemann integral.

Course Outcome (CO):

CO1	Describe the basic concepts of Real numbers system, sets and bounds.
CO2	Explain the convergence of real sequences.
CO3	Demonstrate the understanding of Metric spaces and its topology.
CO4	Explain continuity and uniform continuity in Metric spaces.
CO5	Identify the Riemann integrability of a given function.

S. No.	Contents	Contact hours
1.	Real number system $\mathbb{R}$, Peano's Postulate/Axiom, countable and uncountable sets, concepts of bounds, least upper bound & greatest lower bound, order and completeness properties of $\mathbb{R}$, Archimedean property of real numbers.	8
2.	Definition of real sequence, sub-sequence, bounded sequence, convergence of a sequence (Limit of a sequence), monotone sequences and their convergence, operations on convergent and divergent sequences, Bolzano-Weierstrass theorem for sequences, Cauchy sequence, Cauchy's general principle for convergence, Nested intervals.	9
3.	Definition and examples of Metric Spaces, limits of functions in a metric space, Pseudo metric space, Euclidean space, continuity of functions, open and closed spheres, open sets, closed sets, closure, inverse image of an open or a closed set, convergent sequences in metric space.	9
4.	Cluster points, Convergent sequences in metric space, Cauchy sequence in a metric space, Neighbourhood.	8
5.	Concept of set of measure zero, Riemann sums, Riemann integral, criterion for integrability, properties of Riemann integral, fundamental theorem of calculus.	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publicati
1	Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH publishing Co.	2020
2	Bartle, R.G., and Sherbert, D.R., Introduction to real analysis (4^{th} edition), John Wiley & Sons, Inc., New York.	2011
3	Mathematical Analysis, Apostol, Narosa pub. House (2^{nd} Edition).	2002
4	Mathematical Analysis, S.C. Malik and Savita Arora (5^{th} Edition) New Age International publishers.	2017
5	Principles of Mathematical Analysis, Walter Rudin, 3rd Edition, Mc Draw Hill.	2017

Details of Course

Course Title	Course Structure			Pre-Requisite
	L	T	P	
MC 205: Probability & Statistics	3	0	2	Nil

Course Objective: To acquire knowledge on descriptive statistics, random variables, specific probability distributions and their real life applications specifically, in science and engineering. Acquaintance with the tools for the large and small sample testing.

Course Outcome (CO):

CO1	Prepare the data set and Summarize its main features. (exploratory data analysis). Also student shall be able to calculate and infer for real problems on the basis of probabilistic theory.
CO2	Describe and identify the various probability distribution function and infer their statistical properties. The student shall be able to derive the relation between bivariate random variables.
CO3	Analyze and apply the laws of Sampling. Also, be able to perform random sampling, identify the methods of estimation and main properties of estimators and find confidence intervals for parameter estimates.
CO4	Compute and interpret the results of Bivariate Regression and Correlation Analysis, for forecasting and investigating the relationships between them. Define and perform hypothesis testing and perform ANOVA.
CO5	Demonstrate the qualitative and quantitative properties of data using appropriate diagrams, tabulations, hypotheses testing and summaries using SPSS.

S.No	**Contents**	**Contact Hours**
1	Descriptive statistics**,** Axioms on probability, Conditional probability, Addition and multiplication rules, Bayes' Theorem. Random variables: Discrete and Continuous, Probability mass and density functions, Joint marginal and conditional distributions.	8
2	Mathematical Expectation, Variance, Covariance, Moment generating function, Markov's inequality, Chebyshev's inequality. Correlation and Regression, Rank Correlation.	8
3	Binomial, Negative binomial, Poisson, Geometric, Hypergeometric, Uniform, Normal, Exponential, Gamma, Weibull, Erlang and Beta distributions.	8
4	Central limit theorem. Types of sampling, Parameter and statistic. Sampling distribution, Confidence intervals, Hypothesis testing, Sampling of attributes and variables, Tests of significance for large sample testing.	9
5	Exact sampling distributions: Chi-square, Student's t, Snedecor's F and their applications. ANOVA: one and two-way classification.	9
	Total	**42**

Suggested Books

S.No	Name of Books/Authors/Publishers	Year of Publication
1	Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press.	2021
2.	Probability and Statistics for Engineers and Scientists, Walpole	2013
3	Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, Sultan Chand and Sons.	2017
4	Meyer, Introductory Probability and Statistical Application, Oxford and IBH Publishing.	2002
5	Kishor S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Application, Wiley.	2006

Details of Course

Course Title	Course Structure			Pre-Requisite
MC 207 : Modern Algebra	L 3	T 1	P 0	Basic knowledge of set theory

Course Objective: To impart the knowledge of algebraic structure of Groups, Rings, Integral Domains and Fields.

Course Outcome (CO):

CO1	Identify different algebraic structures like groups, rings, fields etc. and to apply them in various science related problems.
CO2	Apply concepts of abstract algebra with various scientific tools to evolve new ideas to solve practical problems.
CO3	Demonstrate problem solving skills in the context of abstract algebra topics through consideration of examples, pattern exploration, conjecture, proof construction, and generalization of results.
CO4	Apply algebraic concepts such as groups and ring theory to model, analyze and solve real-world problems.
CO5	Comprehend abstract definitions and theorem statements by building examples and non-examples of definitions, and drawing conclusions using definitions and theorems given mathematical information.

S. No.	Contents	Contact hours
1.	Groups, Abelian groups, Subgroups, Centre of a group, Order of a group and an element, Cyclic groups, groups of prime order. Cayley's digraph of cyclic groups.	08
2.	Permutation groups, Alternating subgroup, Important examples of groups such as S3(Symmetric group of order 6), K4 (Klein's 4 –group) and Q8 (Quaternion group) groups. Cosets, Lagrange's Theorem for finite groups, Normal subgroup, Quotient group.	09
3.	Group Homomorphism, Isomorphism, Kernel of group homomorphism, Fundamental theorem of group homomorphism, Cayley's theorem.	09
4.	Ring, Subring, Integral domain, Field, Ideal of a ring, Quotient ring, Ring homomorphism, Isomorphism, and some elementary properties.	08
5.	Prime ideal, Maximal ideal, Ring of polynomials and their properties.	08
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	Joseph A. Gallian, Contemporary Abstract Algebra (10^{th} Edition), Narosa Publishing House.	2021
2	N. S. Gopalakrishnan, University Algebra, New Age International Publishers.	2004
3	I. N. Herstein, Topics in Algebra (2^{nd} Edition), Wiley Eastern Limited	2006
4	Khanna and Bhamri, A course in Abstract Algebra (5^{th} Edition), Vikas Publishing House.	2017
5	D. S. Dummit and R. M. Foote, Abstract Algebra (3^{rd} Edition), John Wiley and Sons.	2011

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 209 : Database Management System	L	T	P	NIL
	3	0	2	

Course Objective: To provide knowledge about the principles, concepts and applications of Database Management System.

Course Outcome (CO):

CO1	Describe the fundamental elements of relational database management systems and related concepts.
CO2	Explain the basic concepts of different data models, relational database design, relational algebra, and SQL and Design ER-models to represent real-life database applications.
CO3	Apply the concepts to design the relational database from the ER-model and formulate SQL and PL/SQL queries for implementation and maintenance of the database.
CO4	Improve the database design by performing the concept of normalization.
CO5	Apply basic database storage structures and access techniques like file and page organizations, indexing methods including B tree, and hashing for optimal database organization.

S. No.	Contents	Contact hours
1.	Introduction: Database system concepts and its architecture, Data models, schema and instances, Data independence and data base language and interface, Data definition languages, DML Data modeling using Entity Relationship Model: ER model concept, notation for ER diagrams mapping constraints, Keys, Concept of super key, candidate key, primary key generalizations, Aggregation, transforming ER diagrams to tables, extended ER model.	8
2.	Relational Data Model and Language: Relational data model concepts, integrity constraints, Keys domain constraints, referential integrity, assertions, triggers, Database language, Relational algebra, relational calculus, domain and tuple calculus, SQL data definition queries and updates in SQL.	9
3.	Database Design: Functional dependencies, normal forms, 1NF, 2NF, 3NF and BCNF, multi-valued dependencies, fourth normal form, join dependencies and fifth normal forms, loss less join decompositions, normalization using FD, MVD and JDs.	8
4.	File Organization, Indexing and Hashing: Basic concepts, Static Hashing, Dynamic Hashing, Ordered indices, Multi-level indexes, B-Tree index files, B+-Tree index files, Buffer Management.	8

5.	Transaction processing concepts: Transaction processing system, schedule and recoverability, Testing of serializability, serializability of schedules, conflict & view serializable schedule recovery from transaction failures, deadlock handling. Concurrency Control Techniques: Locking Techniques, time stamping protocols, multiple granularities and multi-version schemes.	9
	Total	42

Suggested Books:

S. No.	NameofBooks/Authors/Publishers	Year of Publication
1.	Elmasri, Navathe, "Fundamentals of Database systems", Addison Wesley	2010, 6th Edition
2.	Korth, Silbertz, Sudarshan, "Data base concepts", McGraw-Hill.	2019
3.	Ramakrishna, Gehkre, "Database Management System", McGraw-Hill	2003, 3rd Edition

FOURTH SEMESTER

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 202 :	L	T	P	Nil
Operating System	3	0	2	

Course Objective: To familiarize with the fundamental principles of the operating system, its services and functionalities, the concepts of processes, synchronization and scheduling, memory management and need for protection in computer systems.

Course Outcome (CO):

CO1	Describe the design principles and basic elements like processes, threads, memory, files, I/O devices etc. of the operating system.
CO2	Compare the performance and design trade-offs of design options and issues involved in process scheduling and synchronization and deadlock management.
CO3	Explain the concepts of memory management techniques and compare the design trade-offs of methods for allocating space to files and processes for main memory, virtual memory, and hard disk management.
CO4	Implementing operating system concepts and system calls.
CO5	Contrast the various types of operating systems and their functionalities.

S. No.	Contents	Contact hours
1.	Operating System – Introduction and Evolution of Operating System (OS) - Batch, Interactive, Time-Sharing, Real-Time System, System protection. Computer-System Organization and Architecture, OS Structure - System Components, System structure, OS Services, User - OS Interface, System Calls.	8
2.	Process Management I - Process concept, Inter Process Communication, Process operations. Process Threads - Introduction and Multithreading Models. CPU Scheduling - Scheduling Concept, Performance Criteria, Scheduling Algorithms, Multiple-Processor Scheduling.	8
3.	Process Management II - Process Concurrency - Producer Consumer Problem, Critical Section problem and Solution, Mutex Locks, Semaphores, Classical problems in Concurrency. Deadlock Management - System Model, Deadlock Characterization, Prevention, Avoidance, Banker's Algorithm, Deadlock Detection, Recovery from deadlock.	9

4.	Memory Management - Basics, Memory protection, Multiprogramming with fixed partition and variable partition, Multiple base register, Paging, Segmentation, Page Table Structure. Virtual Memory - Basic concepts, Demand paging, Copy-on-write, Performance, Page replacement algorithms, Thrashing.	9
5.	Disk Management - Disk Structure and its attachments, Disk Scheduling Algorithms. File Management - File Concept and Access Methods, File System structure and its Implementation, Directory Structure and its implementation. I/O Management - I/O devices and organization, I/O functions, I/O Buffering. Case studies – Windows Linux and Unix	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Abraham Silberschatz, Peter B. Galvin, “Operating System Concepts”	9th Edition/ 2013
2.	Andrew Tanenbaum, Albert Woodhull, “Operating Systems Design and Implementation”	3rd Edition / 2015
3.	William Stallings, "Operating Systems: Internals and Design Principles"	9th Edition / 2018

Details of Course

Course Title	Course Structure			Pre-Requisite
MC 204 : Scientific Computing	L	T	P	Nil
	3	0	2	

Course Objective: The course will develop numerical methods aided by technology to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integrals. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs. The course will further develop problem solving skills.

Course Outcome (CO):

CO1	Apply numerical methods to obtain the errors and the approximate solutions to the linear and non-linear transcendental and polynomial equations.
CO2	Describe the Eigen value problems for the system of linear algebraic equations and analyze the applications.
CO3	Identify numerical methods for various mathematical operations and tasks, such as interpolation formulae like forward, backward, and divided difference formulae.
CO4	Apply the appropriate techniques for numerical differentiation and integration problems
CO5	Design the numerical solution of initial value problems of the ordinary differential equations with implicit and explicit methods as appropriate

S. No.	Contents	Contact hours
1.	Solution of Transcendental and polynomial equations: Types of error in numerical methods, significant digits, Bisection method, Fixed point iteration method, Secant method, Regula Falsi method, Newton - Raphson method and their convergence, Solution of system of nonlinear equations using Newton -Raphson method.	8
2.	System of Linear Algebraic equations and Eigen value problems: Ill conditioned equations, Methods for solving system of equations: Direct and Iterative methods, convergence of iterative methods, power method.	8
3.	Interpolation: Finite Difference operators and their properties, Interpolation of equal spacing intervals: Newton and Gauss forward and backward formula, Bessel's and Sterling Interpolation formulae, Interpolation of Unequal intervals: Newton's Divided difference Central difference formulae: Lagrange's method, Hermite interpolation, Piecewise and quadratic Spline Interpolation.	9

4.	Numerical Differentiation and Integration: Optimum choice of step length, Differentiation: formulae, derivatives with unequal intervals, Integration: Newton's Cotes formula, Gauss Quadrature formula, Trapezoidal formula, Simpson's $(1/3)^{rd}$ rule and error estimates, Method of undetermined coefficients, Romberg integration, Richardson Extrapolation.	8
5.	Numerical solution of ODE: Initial Value Problems: Picard's method, Taylor series method, Convergence of Numerical methods and Routh- Hurwitz criteria for stability, Euler's and Modified Euler's method, Classical Runge- Kutta method, Predictor- Corrector method, Milne's method, Adams- Moulton method.	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	Numerical Methods for Scientific and Engineering Computation by M. K. Jain and S.R.K. Iyengar, New Age International Publishers.	2007
2	Applied Numerical Analysis, Gerald &Wheatley, Addison – Wesley.	2003
3	Elementary Numerical Analysis, S.D. Conte, & C. Deboor, Tata Mc- Graw hill.	2005
4	A First Course in Numerical Methods, By Uri Ascher, SIAM	2011
5	R. S. Gupta, Elements of Numerical Analysis, 2nd Edition	2015

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC 206:	L	T	P	Data Structures
Algorithm Design and Analysis	3	1	0	

Course Objective: To introduce the concept of algorithmic efficiency by analyzing various algorithms such as Searching,Sorting, Divide-and-Conquer algorithms and to know detail about Greedy Paradigm, Principle of Dynamic Programming, Back Tracking, Branch and Bound, and Computational Complexity.

Course Outcome (CO):

CO1	Design efficient algorithms for real-life problems using different algorithmic paradigms and identify the limitations of each algorithmic paradigms for problem solving
CO2	Design and analyze the running time of algorithms in terms of asymptotic notation.
CO3	Describe different paradigms of algorithm design, such as Divide & Conquer, Greedy, Dynamic Programming, etc., and conclude the correctness.
CO4	Compare the notion of tractable and intractable problems and develop algorithms for computationally intractable problems.
CO5	Solve and analyze the inter-disciplinary real-world problems including sorting problems, trees and graphs problems, and recurrence relations.

S. No.	Contents	Contact hours
1.	Introduction: Concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations. Growth of Functions, Recurrence Relation, Master's Theorem, Correctness of Algorithm. Divide and Conquer Approach: Introduction, Analysis of Run time and Correctness of divide and conquer based Searching and Sorting algorithms, Heap sort, Strassen's matrix multiplication.	8
2.	Greedy Method: Overview of the greedy paradigm examples of exact optimization solution: minimum cost spanning tree, approximate solutions: Knapsack problem, Kruskal's algorithm and Prim's algorithm for finding Minimum cost spanning tree, Dijkstra's algorithm for single source shortest path problem.	9
3.	Dynamic programming: Principle of dynamic programming. Applications: Bellman Ford Algorithm for single source shortest path problem, Floyd-Warshall algorithm for all pair shortest path problem, 0/1 Knapsack Problem, Matrix chain multiplication, Traveling salesman Problem, longest Common sequence (LCS).	8
4.	Back tracking: Overview, 8-queen problem, and 0/1 Knapsack problem, Subset Sum Problem, Traveling Salesman problem. Branch and bound: LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem.	8

5.	Computational Complexity: Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP-complete classes, examples: Circuit Satisfiablity, Vertex cover, Subset Sum problem, Randomized Algorithms, String Matching, NP-Hard and NP-Completeness, Approximation Algorithms, Sorting Network, Matrix Operations, Polynomials and FFT, Number Theoretic Algorithms.	9
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. "Introduction to Algorithms", MIT Press.	4th edition 2022
2.	Horowitz, Ellis, Sartaj Sahni, and Sanguthevar Rajasekaran. "Computer algorithms C++: C++ and pseudocode versions" Macmillan.	1997
3.	Sara Baase and Allen Van Gelder. "Computer algorithms: introduction to design and analysis" Pearson Education India, 2009.	3rd edition 2009

Details of Course

Course Title	Course Structure			Pre-Requisite
MC 208 : Linear Algebra	L	T	P	Nil
	3	1	0	

Course Objective: The objective of this paper is to impart knowledge of vector space, linear transformation, bilinear form and Inner Product spaces.

Course Outcome (CO):

CO1	Explain computational techniques and algebraic skills essential for the study of systems of linear equations and matrix algebra.
CO2	Apply geometric properties and strategies to model and solve problems of vector spaces.
CO3	Compute and recognise the properties of special matrices.
CO4	Apply eigen vectors in obtaining canonical forms of matrices.
CO5	Describe inner product spaces, bilinear forms and positive definiteness of real quadratic forms.

S. No.	Contents	Contact hours
1.	Vector spaces, Properties of vector spaces, Subspaces, Linear dependence and independence, Linear span, Bases and Dimension, Linear Sum, Direct Sum, Quotient Spaces.	8
2.	Linear transformations, Range and Null spaces, Rank–Nullity theorem and its application, Inverse linear transformation, Representation of linear transformations by matrices, Change of basis, Dual space, Dual bases .	10
3.	Transpose of a linear transformation, Eigen values and Eigen vectors, Cayley–Hamilton Theorem, Diagonalization, Minimal polynomials, Jordan canonical form.	8
4.	Inner product spaces, norm of a vector, orthogonality, orthonormal set, orthonormal basis, Gram-Schmidt orthonormalization, orthogonal projections, Linear functional and adjoints, Hermitian, self-adjoint.	8
5.	Unitary and normal operators, Bilinear forms, Symmetric and skew-symmetric bilinear forms, Real quadratic forms, Positive definiteness	8
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	K. Hoffmann and R. Kunze, Linear Algebra, 2nd Edition , Pearson	2015
2	G. Hadley, Linear Algebra, Narosa publication	2002
3	Gilbert Strang, Linear Algebra and its applications, Cengage Learning, 4th edition	2007
4	Serge Lang, Introduction to Linear Algebra, Springer	2004
5	Linear Algebra, Fourth edition, Schaum's outlines	2015

Details of Course

Course Title	Course Structure			Pre-Requisite
MC 210: Differential Equations	L	T	P	Basic knowledge of calculus and matrix
	3	0	2	

Course Objective: To impart the knowledge of ordinary and partial differential equations and to analyze and solve the physical problems.

Course Outcome (CO):

CO1	Evaluate linear systems of differential equations, both homogeneous and non-homogeneous by matrix method and Sturm-Liouville boundary value problems including orthogonality properties.
CO2	Analyse the stability of linear and non-linear differential equations through phase portrait diagram.
CO3	Formulate partial differential equations, evaluate linear, quasi linear and non-linear first order PDEs and address Cauchy's problem for first order PDE.
CO4	Solve homogeneous and non- homogeneous linear PDE with constant coefficients and classify second order PDE to determine characteristics.
CO5	Apply the method of separation of variables to solve initial and boundary value problem including heat equation, wave equation and Laplace equation.

S. No.	Contents	Contact hours
1.	Ordinary differential Equations I (ODEs): Solutions of linear system of differential equations (homogenous and non-homogenous) by matrix method, Sturm-Liouville boundary values problems including characteristic functions and orthogonality.	8
2.	Ordinary differential equations II: Linear and Non-linear autonomous systems, Phase plane, Paths, Critical Points and its types, Stability of the critical points, Phase plane analysis, Liapunov's direct method, periodic solutions, limit cycle.	8
3.	Partial differential equations I (PDEs): Formation of PDEs, Linear and Quasi- linear first order PDEs (Lagrange form), Cauchy's problem for first order PDEs, Non-linear first order PDEs: Standard forms and Charpit's method.	8
4.	Partial differential equations II: Linear Homogeneous and Non-homogeneous second and higher order PDEs with constant coefficients, Classification of second order PDEs, Characteristic equations and characteristic curves, method of separation of variables.	9
5.	Applications of partial differential equations: One-dimensional heat equation, one-dimensional wave equation, two-dimensional heat equation (solution of Laplace equation in Cartesian and polar coordinates).	9
	Total	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Martin Braun, Differential equations and their applications, Springer, 4th Edition	1993
2.	S. L. Ross, Introduction to Ordinary Differential Equations, John Wiley & Sons, 4th Ed.	1989
3.	R.K Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa, 5th Ed.	2017
4.	K S Rao, Introduction to Partial Differential Equations, Prentice Hall India, 3rd Edition	2011
5.	E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications, 10th Edition	2017
6.	Peter V.O. Neil: Partial Differential equations: Peter V. O'Neil, Wiley Publication, 3rd Ed.	2014