B. Sc. (HONOURS)

IN MATHEMATICS AND COMPUTING

UNDER THE FRAMEWORK OF

HONOURS SCHOOL SYSTEM

2022-2023

PANJAB UNIVERSITY, CHANDIGARH

OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR

CHOICE BASED CREDIT SYSTEM

B.Sc. (HONOURS) MATHEMATICS AND COMPUTING (SEMESTER SYSTEM)

UNDER THE FRAMEWORK OF HONOURS SCHOOL SYSTEM

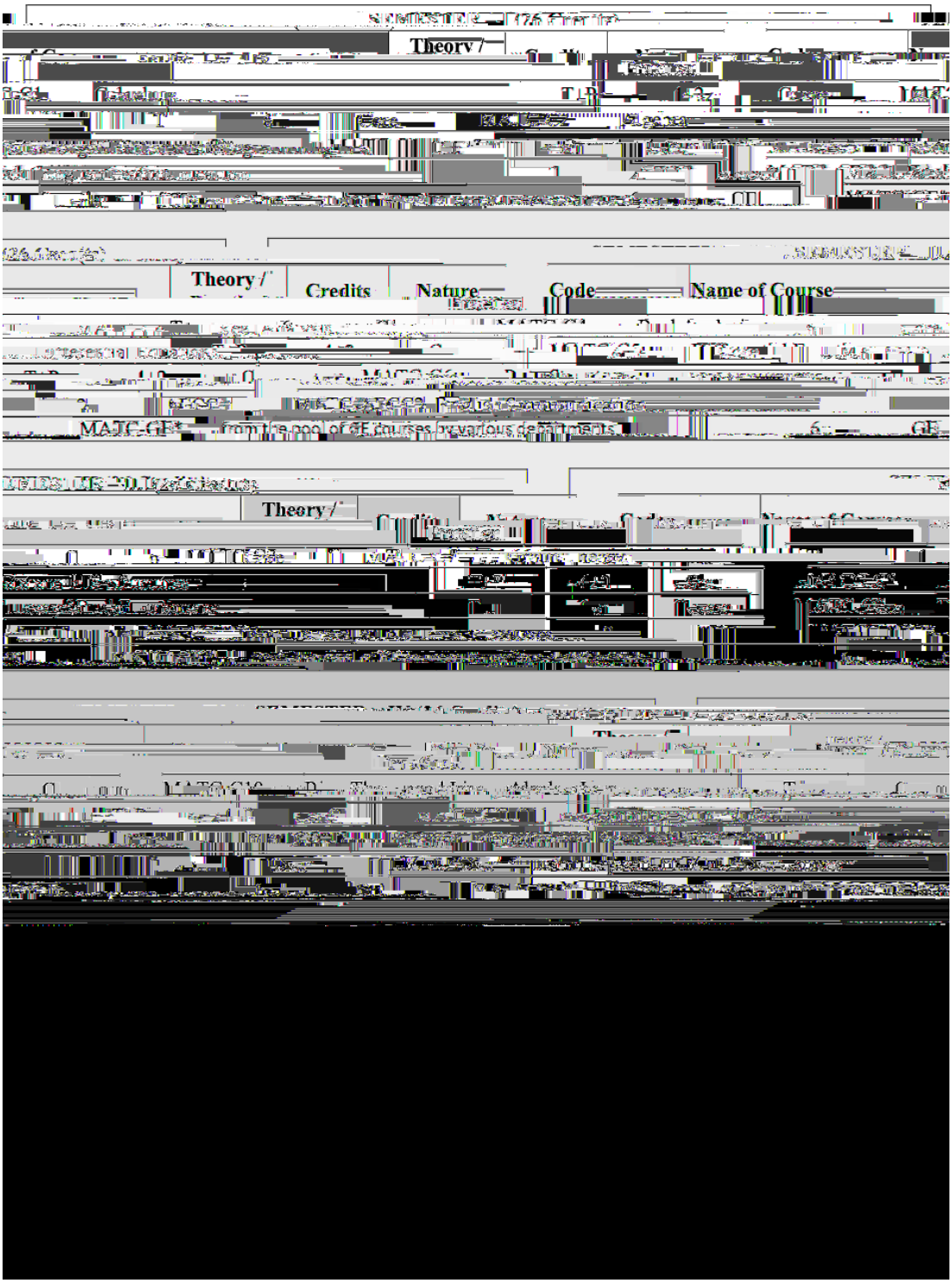
ACADEMIC SESSION 2022-2023

PREAMBLE

The objective of the proposed course is to teach the concepts of Mathematics and Computer Applications. The syllabus pertaining to B.Sc. (Honours) Mathematics and Computing (6 Semesters) in the subject of Mathematics and Computing under Honours School Framework has been framed as per provision of the UGC

Course Structure with Credit Details

Total Credits=152 (Core: 96, GE: 24, DSE: 24, SEC: 4, AECC: 4)



Important Notes

TEACHING HOURS

Each of Core, Generic Elective and Discipline Speci c Elective subjects consists of 60 contact hours, which consists of (i) 48 contact hours of teaching to be delivered exclusively by the teacher as per the scheduled time-table and (ii) 12 hours for the tutorials, interaction, discussion, assignments and seminars

MATC-C1: Calculus (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The main goal of this course is to deliver the basics of di erential and integral calculus, for real as well as multivariate functions. It is expected that the students develop a taste of writing proofs, particularly for Unit I, rather than applying formulas only.

Unit-I

Di erential Calculus: Precise de nition of limit, continuity, one-sided limit, limits involving in nity, asymptotes of graphs, tangents and the derivative at a point, the derivative of a function, extreme values of functions, mean value theorem, monotone functions and the rst derivative test, test for concavity, tracing of curves.

(Scope: Sections 2.3-2.6, 3.1, 3.2, 4.1-4.4 of (A)).

Unit-II

Integral Calculus: Riemann sums, de nite integrals, area between curves, volumes using cross sections and cylindrical shells, arc length and areas of surfaces of revolution.

(Scope: Sections 5.1, 5.6, 6.1-6.4 of (A)).

Unit-III

Multivariable Functions: Limits and continuity for functions of several variables, partial derivatives, the chain rule, directional derivatives, gradient vectors, tangent planes, extreme values and saddle points, Lagrange multipliers.

(Scope: Sections 14.2-14.8 of (A).).

Unit-IV

Multiple Integrals: Double integrals, triple integrals, Jacobian, substitutions in multiple integrals, Green's theorem, Stoke's theorem and the divergence's theorem.

(Scope: Relevant sections of Chapters 15, 16 of (A)).

MATC-C1: Calculus (Practical)(using Mathematica)Credits: 2Contact h

MATC-C2: Algebra

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The concepts and techniques from linear algebra are of fundamental importance in many scienti c disciplines The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

Unit-I

Review of system of linear equations, general theory of system of linear equations, n-dimensional vector space, linear dependence, rank of a matrix, system of homogenous and non- homogeneous linear equations, an axiomatic construction of theory of determinants.

(Scope as in chapters 1, 2, 3 of (A)).

Unit-II

A deeper look at Complex Numbers, taking roots of complex numbers, quick review of operations on polynomials, divisors and greatest common divisor, roots of polynomials, fundamental theorem, corollaries of fundamental theorem, rational fractions.

(Scope as in chapters 4 and 5 of (A)).

Unit-III

Evaluating roots of polynomials of third and fourth degree, bounds of roots, sturm's theorem, other theorems on the number of real roots, approximation of roots. (Scope as in chapter 9 of (A)).

Unit-IV

De nition of a linear space , an isomorphism, nite dimensional spaces, bases, linear transformation linear subspaces, characteristic roots and eigen values.

(Scope as in chapter 2 of (B)).

Essential Textbooks

(A) A. Kurosh *Higher Algebra,* MIR Moscow, 1982.

(B) Vivek Sahai and Vikas Bist, *Linear Algebra, 2nd Ed.,* Narosa Publishing house 2013.

Further Readings

1. David C. Lay, *Linear Algebra and its Applications (3rd Ed.),* Pearson Education Asia, 2007.
2. S.H. Friedberg, A.J. Insel and L.E. Spence, *Linear Algebra,* Prentice Hall, 2003.
3. K. Hoffman and R. Kunze, *Linear Algebra, (2nd Ed.),* Prentice-Hall of India, 1989.
4. S. Lang, *Linear Algebra,* Springer-Verlag, 1989.
5. P. Lax, Linear Algebra, *John Wiley and Sons,* New York. Indian Ed. 1997.
6. P. B. Bhattacharya, S.K. Jain and S. R. Nagpaul, *First Course in Linear Algebra,* Wiley Eastern Limited.

MATC-C3: Computer Organisation and Programming in C (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week (including Tutorials)

Max. Marks: 100 (Final-80+Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: This course will enable the student to understand the basics organization of computer organisation and programming with C. The main emphasis of the course is on problem solving aspect.

Unit-I

Computer Organisation: Evolution of Computers, Von Neumann Architecture, Combinatorial Blocks : Gates, Half Adder, Full Adder, Multiplexers, Decoders, Encoders; Sequential Building blocks : Flip Flops, Registers, Counters, Information representation: codes, xed and oating point representation Arithmetic: Addition and subtraction for sign magnitude and 2's complement numbers, integer multiplication using Booth's algorithms

Scope: Relevant Chapters of (B).

Unit-II

Getting Started with C, constants and variables and rules for constructing them, C keywords, The First C Program, Compilation and Execution, C-instructions, Type Declaration, Arithmetic and control Instructions, Integer and Float Conversions

Unit-IV

Arrays: Array Initialization, Array Elements in Memory, Passing Array Elements to a Function, Passing an Entire Array to a Function, Two Dimensional Arrays, Initializing a 2-Dimensional Array, Memory Map of a 2-Dimensional Array, Passing 2-D array to a Function.

Pointers: Pointer declaration, Address operator \&", Indirection operator *", Pointer and arrays, Pointers and 2-Dimensional Arrays, Pointer to an Array.

Scope: Chapter 9, 13-14 of (A).

MATC-C4: Real Analysis

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: Introduction to the cardinality of sets, completeness property of real numbers, sequences and series of real numbers and the limit and continuity of real functions.

Unit-I

Finite and in nite sets, countable and uncountable sets, Cantor's theorem, Schroder-Bernstein theorem,

Essential Textbooks

(A) R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis (3rd ed.),* John Wiley and Sons, 2002.

(B) N. L. Carothers, *Real Analysis,* Cambridge University Press 2000.

Further Readings

1. S. Abbott, *Understanding Analysis,* Springer-Verlag, 2008.
2. T. M. Apostol, *Mathematical Analysis(2nd ed. Reprint),* Narosa, 2002.
3. S. K. Berberian, *A First Course in Real Analysis,* Springer-Verlag, 1994.
4. S. K. Berberian, *Fundamentals of Real Analysis,* Springer-Verlag, 1998.
5. G. G. Bilodeau, G.E. Keough, *An Introduction to Analysis (2nd ed.),* Jones & Bartlett, 2010.
6. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis (2nd ed.),* Springer, 2004.
7. C. C. Pugh, *Real Mathematical Analysis,* Springer-Verlag, 2001.
8. B. S. Thomson, A. M. Bruckner and J. B. Bruckner,, *Elementary Real Analysis,* Prentice Hall, 2001.

MATC-C5: Di erential Equations (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week (including Tutorials)

Max. Marks: 100

MATC-C5: Di erential Equations (Practical)

(using Mathematica)

Credits: 2

Contact hours: 2 hrs/week 3 practicals per week (In groups of 15 students)

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3 hrs.

List of Practicals (using Mathematica)

1. Plotting and nding solution of rst order di erential equation.
2. Plotting and nding solution of second order di erential equation.
3. Plotting and nding solution of third order di erential equation.
4. Solution of initial value problems
5. Solution of boundary value problem.
6. Exponential growth model.
7. Exponential decay model.
8. Limited growth of population.
9. Orthogonal and Oblique Trajectories.
10. Solution of ODE by Reduction of order.
11. Power series solution and matching with exact solution.

Essential Textbooks

(A) Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Di erential Equation Approach using Maple and Matlab,* Second ed., Taylor and Francis group, London and 2009.

(B) Martha L. Abell and James P. Braselton, *Di erential Equations with MATHEMATICA,* 3rd ed., Elsevier Academic Press, 2004.

Further Readings

1. S. L. Ross, *Di erential Equations,* 3rd ed., John Wiley and Sons, India 2004.
2. E. A. Coddington, *An introduction to ordinary di erential equations,* Prentice- Hall of India, 1961.
3. C .H. Edwards and D. E. Penny, *Di erential Equations and Boundary Value problems Computing and Modeling,* Pearson Education India, 2005.
4. W. E. Boyce and R. C. Diprima, *Elementary di erential equations and boundary value problems*, Seventh Edition, John Wiley and Sons, Inc., 2001
5. Earl D. Rainville and P. E. Benediet, *Elementary di erential equations,* Seventh Edition, Macmillian, Publishing Company, 1989.

MATC-C6: Data Structures (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: To impart the basic concepts of data structures and algorithms, using functions and pointers. To understand structures and functions, arrays of structures and creation of lists. Also to understand concepts about searching and sorting techniques. Basic concepts about stacks, queues, lists, trees, graphs and writing algorithms for solving problems using fundamental data structures.

Unit-I

Basic Concepts: Introduction to Complexity, Data Structure and Data Structure operations. Applications of Data Structure, Basic data Structures. Arrays: Introduction, Types of Array, Memory representation, Applications and operations. Stacks: Introduction, memory representation, Applications and operations, Recursion.

Scope: Chapter 17-19 of (A).

Unit-II

Linked List: Operations:-traversing, searching, inserting, deleting, operations on header linked list, circular linked list, doubly linked list, memory representation, Applications, polynomial manipulation. Queue: Introduction, Types, Memory Representation and Applications.

Scope: Chapter 17-19 of (A).

Unit-III

Trees: De nition and Basic concepts, Representation in Contiguous Storage, Binary Tree, Binary Tree Traversal, Searching, Insertion and deletion in Binary trees, Binary Search tree. Graphs: Introduction, Memory Representation, Graph Traversal (DFS and BFS).

Scope: Chapter 17-19 of (A).

Unit-IV

MATC-C7: Group Theory - I

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The course is an introduction to Group Theory which is one of the most important subjects

Essential Textbooks

(A) J. A. Gallian,

MATC-C8: Data and File Structures (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: To impart the basic concepts of data structures and algorithms, using functions and pointers. To understand structures and functions, arrays of structures and creation of lists. Also to understand concepts about searching and sorting techniques. Basic concepts about stacks, queues, lists, trees, graphs and writing algorithms for solving problems using fundamental data structures.

Unit-I

Basic Concepts: Introduction to Complexity, Data Structure and Data Structure operations. Applications of Data Structure, Basic data Structures. Arrays: Introduction, Types of Array, Memory representation, Applications and operations. Stacks: Introduction, memory representation, Applications and operations, Recursion.

Scope: Chapter 17-19 of (A).

Unit-II

Linked List: Operations:-traversing, searching, inserting, deleting, operations on header linked list, circular linked list, doubly linked list, 23(op)-2f 218.51k2nBasi: .51k2ndatas(Scop)s,

Unit-IV

Searching: Binary and Linear Search; Sorting: Bubble sort, Insertion sort, Selection sort, Merge Sort, Quick sort. Comparison of various Searching and Sorting algorithms.

Scope: Chapter 17-19 of (A).

MATC-C8: Data and File Structures (Practical)

Credits: 2

Contact hours: 2 hrs/week 3 practical per week in a groups of 15 students

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3hrs.

Essential Textbooks

(A) Lipschutz, Seymour *Theory and Problems of Data Structures*, Tata McGraw Hill, 2001.

Further Readings

1. B. N. Karumanchi , *Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles* 5^{th} *Edition*, Made Easy, 2016.
2. B. W. Kernighan and Dennis M. Ritchie, *C Programming Language* 2^{nd} *Edition* Prentice Hall, 1988.
3. R.B. Patel, *Expert Data Structure in C* 4*th Edition*, Khanna Publishing House, 2018.
4. A. M. Tannenbaum, *Data Structure Using C*, Pearson, 1990.

MATC-C9: Theory of Real Functions

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
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Essential Textbooks

(A) W. Rudin, *Principles of Mathematical Analysis (3rd Ed.),* McGraw Hill, 1976.

(B) T. M. Apostol, *Mathematical Analysis (2nd Ed.),* Narosa, 2002.

Further Readings

1. S. Abbott, *Understanding Analysis,* Springer-Verlag, 2008.
2. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis (3rd Ed.)*, Wiley, 2002.
3. S. K. Berberian, *A First Course in Real Analysis,* Springer-Verlag, 1994.
4. N. L. Carothers, *Real Analysis,*Cambridge University Press 2000.
5. S. R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis,* Springer, 2006.
6. S. C. Malik and S. Arora, *Mathematical Analysis (3rd ed.),* New Age Publishers, 2008.
7. A. Mattuck, *Introduction to Analysis,* Prentice Hall, 1999.
8. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis, (2nd ed.),* Springer, 2004.
9. C. C. Pugh, *Real Mathematical Analysis,* Springer-Verlag, 2001.

MATC-C10: Ring Theory and Linear Algebra-I

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The course is an introduction to Ring Theory and Linear Algebra which is one of the most important subjects of algebra.

Unit-I

De nition and examples of rings, properties of rings, subrings and ideals, integral domains, Division rings and elds, characteristic of a ring, ideals and factor rings, ideal generated by a subset of a ring, algebra of ideals, prime and maximal ideals.

(Scope as in Chapters 12-15 of (A)).

Unit-II

Polynomial Rings over commutative rings, division algorithm and consequences, remainder theorem, factor theorem, reducibility tests, irreducibility tests, Eisenstein's irreducibility criterion, Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, eld of quotients and Embedding Theorems.

(Scope as in Chapter 15-17 of (A)).

Unit-III

Duality, canonical forms, the minimal polynomial, diagonalizable and triangulable operators, Jordan and rational forms.

(Scope as in Chapter 2 and 3 of (B))

Unit-IV

Inner Product Spaces , orthogonality, adjoint of a linear operator, Unitary Operators, Normal and Self-adjoint Operators. Polar and singular value decompositions, Bilinear Forms, the matrix of bilinear form, orthogonality, classi cation of bilinear form.

(Scope as in Chapter 4 and 5 of (B))

Essential Textbooks

(A) Joseph A. Gallian, *Contemporary Abstract Algebra, (4^{th} Edition),* Narosa Publishing House, 1999.

(B) Vivek Sahai and Vikas Bist, *Linear Algebra, (2^{nd} Edition),* Narosa 2013.

Further Readings

1. John B. Fraleigh, *A First Course in Abstract Algebra, (7^{th} Edition),* Pearson, 2002.
2. M. Artin, *Abstract Algebra, 2^{nd} Edition),* Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra, 4^{th} Edition),* Prentice- Hall of India Pvt. Ltd., 2004.
4. S. Lang,*Introduction to Linear Algebra, (2^{nd} Edition),* Springer, 2005.
5. Gilbert Strang,*Linear Algebra and its Applications,* Thomson, 2007.
6. S. Kumaresan,*Linear Algebra- A Geometric Approach,* Prentice Hall of India Pvt. Ltd.,1999.
7. K. Hoffman and R. A. Kunze, *Linear Algebra, (2^{nd} Edition),* Prentice-Hall of India Pvt. Ltd., 1971.
8. P. B. Bhattacharya, S.K. Jain and S. R. Nagpaul , *First Course in Linear Algebra,* Wiley Eastern Limited.
9. D.A.R. Wallace,*Groups, Rings and Fields,* Springer-Verlag London Ltd., 1998.
10. I. S. Luthar and I. B. S. Passi,*Algebra Volume II, Rings,* Narosa 1999.

MATC-C11: Programming with Python (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

Note:

1. The question paper will have nine questions. Question No.1 spread over the whole

Essential Textbooks

(A) R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis (3rd ed.),* Wiley, 2002.

(B) W. Rudin, *Principles of Mathematical Analysis (3rd ed.),* McGraw Hill, 1976.

Further Readings

1. S. Abbott, *Understanding Analysis,* Springer-Verlag, 2008.
2. T. M. Apostol, *Mathematical Analysis(2nd ed. Reprint),* Narosa, 2002.
3. S. K. Berberian, *A First Course in Real Analysis,* Springer-Verlag, 1994.
4. C. G. Denlinger, *Elements of Real Analysis,* Jones & Bartlett (Student Edition), 2011.
5. S. R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis,* Springer, 2006.

MATC-C13: Multivariate Calculus

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The main goal of this course is to deliver the mathematical rigour of di erential and integral calculus for multivariate functions. It also aims to discuss the basics of Fourier series and Fourier transforms, along with their applications.

Unit-I

Directional derivatives, total di erentiability, Jacobian, Chain rule, Mean value theorem for di erentiable functions, su cient condition for di erentiability, symmetry of mixed partial derivatives, Taylor's formula for real valued functions of several variables..

[Scope: Chapter 12-13 from (A)]

Unit-II

The gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of several variables, method of Lagrange multipliers, constrained optimization problems, convex functions, the inverse function theorem and the implicit function theorem.

[Scope: Chapter 12-13 from (A)]

Unit-III

Integration over a rectangle, Jordan regions, the integral over a Jordan region, iterated integrals, the change of variables formula.

[Scope: Chapters 10 and 11 from (B)]

Unit-IV

1-Forms and path Integrals, change of variables, di erential forms of higher order, Green's theorem, surface integrals and Stokes's theorem, Gauss's theorem, chains and cycles, the divergence theorem

[Scope: Chapters 10 and 11 from (B)]

MATC-C14: Probability and Statistics

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will*

Unit-IV

Continuous distributions and their interrelations: uniform, exponential, Erlang(k), Gamma, beta, normal, lognormal, Cauchy, Weibull, Laplace. Statement and interpretation of weak law of large numbers and strong law of large numbers, central limit theorem for independent and identically distributed random variables with finite variance.

(Scope: Chapter 5 and 7 of (A))

MATC-C15: Ring Theory and Linear Algebra-II

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: This is an advanced course in ring theory and linear algebra. MATC-C10 is a prerequisite for this course.

Unit-I

Historical discussion of the Fermat's Last Theorem, Factorization and Divisibility in integral domains, Irreducible and Prime elements in integral domains, Unique Factorizaion Domains (UFDs), Principal Ideal Domains (PIDs), Euclidean domains and relationships between them.

(Scope as in Chapters 8 of [A]).

Unit-II

Ring of Gaussian integers and its applications like characterisation of Pythagorean triples and primes that are sum of two squares, Factorization of polynomials in one variable over a eld, Unique factorization in R[X], R a UFD, irreducibility criterion.

(Scope as in Chapters 9 of [A]).

Unit-III

Modules, De nition and Examples, Comparison with vector spaces, Submodules, Quotient modules, Free modules, Discussion of cardinality of two bases of a free module, Homomorphisms, Simple and Semisimple Modules, Submodules and factor modules of Semisimple Modules.

(Scope as in Chapters 10 of [A]).

Unit-IV

Finitely generated torsion free modules over a PID, Structure of nitely generated modules over a PID and its applications like Rational and Jordan Canonical forms.

(Scope as in Chapters 12 of [A]).

Essential Textbooks

(A) D. S. Dummit and R. M. Foote, *Abstract Algebra (3rd Edition),* John Wiley and Sons, 2004.

Further Readings

1. B. Hartley and T. O. Hawkes, *Rings Modules and Linear Algebra,* Chapman and Hall, 1980.
2. John B. Fraleigh,

MATC-C16: Data Analytics using R (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week (including Tutorials)

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: Students in this course will learn how to turn data into useful information that will assist them in making better decisions. A variety of data analysis techniques, including descriptive, inferential, predictive, and prescriptive analysis, will be covered in this course.

Unit-I

Descriptive Statistics: Introduction to the course, calculations with R software, descriptive statistics, frequency distribution, graphics and plots, central tendency of data, variation in data, association of variables, probability distributions (discrete and continuous).

Unit-II

Inferential Statistics: Inferential statistics through hypothesis tests, permutation and randomization test. Regression and ANOVA: regression analysis, tting of linear models, ANOVA (analysis of variance, one-way and two-way). Machine Learning - Introduction and Concepts: Di erentiating algorithmic and model based frameworks. Regression: Ordinary least squares, ridge regression, K nearest neighbours regression and classi cation.

Unit-III

Supervised learning with regression and classi cation techniques: Bias-Variance dichotomy, model validation approaches, logistic regression, linear discriminant analysis, classi cation trees and support vector machines, Ensemble methods: Random forest, neural networks deep learning.

Unit-IV

Unsupervised Learning and Challenges for Big Data Analytics: Clustering associative rule, mining challenges for big data analytics. Prescriptive analytics: Creating data for analytics through designed experiments, creating data for analytics through active learning, creating data for analytics through reinforcement learning.

MATC-C16: Data Analytics using R (Practical)

Credits: 2

Contact hours: 2 hrs/week (3 practicals per week) In groups of 15 students

Max. Marks: 50 (Final 40+Internal Assessment-10) Time allowed: 3hrs.

Objective: Students in this course will learn how to turn data into useful information that will assist them in making better decisions. A variety of data analysis techniques, including descriptive, inferential, predictive, and prescriptive analysis, will be covered in this course.

Instructions: The concerned teacher will prepare assignment sheets based on the topics listed below or another topic related to the course, at his/her discretion:

List of Practical's

1. Topic: Descriptive Statistics
2. Topic: Inferential Statistics
3. Topic: Regression & ANOVA

3. P. L. Meyer, *Introductory probability and statistical applications,* Addison-Wesley Publishing Company, Inc., Philippines, 1970.
4. I. Miller, M. Miller, and J. E. Freund, *Mathematical Statistics with Applications, 7th Edition,* Pearson Education, Asia, 2006.
5. R. A. Johnson, I. Miller, and J. E. Freund, *Probability and Statistics for Engineers,* Pearson Education London, 2000.
6. J. L. Devore, *Probability and Statistics,* Paci c Grove: Brooks/Cole, 2000.
7.

MATC-SEC1: Logic and Sets

Credits: 2

Total Lectures: 20 2 hrs/per week (including Tutorials)

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3hrs.

Objective: The objective of this course is to introduce to the fundamentals of logic and naive set theory.

Unit-I

Logic: Introduction, propositions, Sentential Connectives, negation, conjunction and disjunction, implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators, Truth Tables, validity, consequence, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quanti ers: Introduction, Quanti ers, Binding variables and Negations.

The Pigeonhole principle.

Scope: Sections 2.1-2.6 and 5.5 of (A).

Unit-II

Set Theory: Sets, Relations, Equivalence Relations, Functions, Composition and Inversion for Functions, Operations for Collections of Sets, Ordering Relations.

The Natural Number Sequence, Proof and De nition by Induction, Cardinal Numbers, Countable Sets, Cardinal Arithmetic, Order types, Well-ordered Sets and Ordinal Numbers, The Axiom of Choice, the Well-ordering Theorem, and Zorn's lemma, Further Properties of Cardinal Numbers, Some Theorems Equivalent to the Axiom of Choice.

Scope: Sections 6-11 of Chapter 1 and Sections 1-10 of Chapter 2 of (B).

Essential Textbooks

(A) R. P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.

(B) Robert R. Stoll, *Set Theory and Logic,* Dover Publishers, 1979.

Further Readings

1. R. A. Brualdi, *Introductory Combinatorics (5^{th} ed.)*, Pearson, 2019.
2. P. R. Halmos, *Naive Set Theory,* Springer,1974.
3. E. Kamke, *Theory of Sets,* Dover Publishers, 1950.

MATC-SEC2: LaTeX and HTML

Credits: 2

Total Lectures: 20 2 hrs/per week

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3hrs.

Objective:

MATC-SEC3: Graph Theory

Credits: 2

Total Lectures: 20 2 hrs/per week (including Tutorials)

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3hrs.

Objective: The objective of this course is to introduce to the basics of graphs and trees, along with some applications.

Unit-I

De nition, examples and basic properties of graphs, pseudo graphs, subgraphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, planar graphs, Hamiltonian path and cycles, the adjacency matrix, Weighted graph, travelling salesman's problem, shortest path,, Graph coloring and chromatic polymonials.

Unit-II

trees, rooted trees, trees and sorting, weigted trees and pre x codes, biconnected components and articulation points, Dijkstra's algorithm, Floyd-Warshall algorithm, minimal spanning trees, trasnport networks, matching theory.

Scope: Chapters 11-13 of (A).

Essential Textbooks

(A) R. P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.

Further Readings

1. R. A. Brualdi, *Introductory Combinatorics (5th ed.)*, Pearson, 2019.
2. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
3. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory, 2nd Edition,* Pearson Education (Singapore) P. Ltd., 2003.
4. Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra, (2nd ed),* Springer (SIE), 2004.

MATC-SEC4: Computer Algebra Systems and Related Softwares

Credits: 2

Total Lectures: 20 2 hrs/per week (including Tutorials)

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3hrs.

Objective: The objective of this course is to teach pointers, structures in `C'. This course also introduces mathematical packages from programming point of view to help students to learn Mathematics, MATLAB and other package to solve the real life problems

Unit-I

Basics of MATLAB: MATLAB as a calculator, De ning Variables, Display format, Saving the variables stored in memory, Prede ned variable, Complex numbers, Vectors and Matrices. Control Flow: If-end, If-else-end, Elseif, Switch-case, For loops: Single for loops, Nested for loops, Special cases of the for loop,

MATC-DSE1: Number Theory

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The aim of this course is to teach the students about the basics of Elementary Number Theory starting with primes, congruences, quadratic residues, primitive roots, arithmetic functions. Apart from teaching the theory, stress will be on solving problems.

Unit-I

Divisibility, Greatest common divisor, Euclidean algorithm, The Fundamental theorem of arithmetic, Congruences, Residue classes and reduced residue classes, Chinese remainder theorem, Fermat's little theorem.

Unit-II

Wilson's theorem, Euler's theorem and its application to a cryptography, Arithmetic functions (n), $d(n)$, (n), (n), Mobius inversion formula, Greatest integer function.

Unit-III

Essential Textbooks

(A) D. M. Burton, *Elementary Number Theory, (7th Edition)* Tata McGraw Hill, 2014.

(B) I. Niven, H. S. Zuckerman and H. L. Montgomery, *An Introduction to the Theory of Numbers, (5th Edition),* John Wiley and Sons, 2004.

Further Readings

1. H. Davenport, *The Higher Arithmetic, (7th Edition),* Cambridge University Press, 1999.
2. G. H. Hardy and E. M. Wright, *An Introduction to Theory of Numbers, (6th Edition),* Oxford University Press, 2008.

MATC-DSE2: Arti cial Intelligence

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The contents of this subject to introduce the basic principles, techniques, and applications of Arti cial Intelligence. The contents of this subjects are focused to impart both theoretical and practical knowledge.

Unit-I

Introduction to Arti cial Intelligence (AI) and Problem Space: Introduction AI technique, Turing test, History and developments in AI, applications of AI, State space representation, production systems, systematic control strategies: Breadth rst search and Depth rst search, issues in the design ofs earch programs.

Game playing: MiniMax search procedure, reducing alternatives using Alpha-Beta pruning method examples. (Scope: Chapter 1-2 and 12 of (A))

Unit-II

Heuristic Search Technologies: Introduction to heuristic search, Generate and test, Hill Climbing, Best First search, A*, Problem reduction, AO*, constraint satisfaction and Means-ends-analysis techniques.

Knowledge representation: Information and knowledge, Knowledge representation methods - Propositional logic and rst order predicatelogic, Resolution principle, Semantic networks, Partitioned semantic nets, Frames, Scripts and conceptual dependencies. (Scope: Chapter 3-4 of (A))

Unit-III

Arti cial Neural Networks: basic, comparison of human brain and machine, biological neuron, general neuron model, activation functions, Perceptron learning rule, applications and advantages of neural networks. Brief introduction to single layer and multiplayer networks. Supervised and unsupervised learning, Backpropagation neural networks and kohonen self-organizing networks. (Scope: Chapter 2-4 of (B))

Unit-IV

Expert System: Introduction of Expert system and Knowledge acquisition.

Natural Language Processing: Introduction to Natural Language Processing and its components as: Morphological and Lexical Analysis, Syntactic Analysis, Semantic Analysis, Discourse Integration and Pragmatic Analysis. (Scope: Chapter 20-21 of (A))

Essential Textbooks

(A) E. Rich and K. Knight *Arti cial Intelligence*, Mc-Graw Hill, 2019.

(B) D. W. Patterson, *Introduction to Arti cial Intelligence and Expert Systems,* PHI, 1992.

Further Readings

1. G. F. Luger, *, ri riStrIntu971 0es0 Td [ste8(St*

MATC-DSE3: Group Theory II

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: This is an advanced course in group theory and MATC-C7 is a prerequisite for this course.

Unit-I

Group actions, Group acting on themselves by left multiplication and conjugation, Stabilizers, orbits and kernels, Orbit-Stabilizer relation, Permutation representation associated with a given group action.

Unit-II

Applications of group actions, Generalized Cayley's theorem, Index theorem, Class equation and its

Essential Textbooks

(A)

MATC-DSE4: Statics

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: Mechanics is one of the important branches of mathematics that nds application in almost all real world problems. This course is an introduction to statics, that is, the bodies at rest under action of forces. Students will be introduced to the concept of force, their addition and resolution, moments, couples, friction and equilibrium conditions. In addition, the centre of mass, gravity and stability of body will be taught.

Unit-I

Basic notions: Inertial and non-inertial frame of reference, Weight of body, Force, Force with contact and without contact, Force systems, Principle of transmissibility of forces, Basic concepts of mechanics. Forces acting on a particle: Parallelogram law of forces, Triangle law of forces and its converse, Polygon of forces, theorem, Lami's theorem and its converse, Components of a force in given directions. Resolution of forces, Theorem on resolved parts of two and more concurrent forces. Condition of equilibrium of any number of forces, Trignometric *m n* theorem, equilibrium of a rigid body under the action of three forces. (Scope as in Chapters 1, 2, 3 and 7 of S L Loney and Chapter 3 of A S Ramsey; All the relevant unsolved exercises of these chapters must be covered)

Unit-II

Parallel forces: Resultant of two like parallel forces, unequal unlike parallel forces, Theorem of resolved parts of two parallel forces, Centre of parallel forces, Centre of gravity. Moments and Couples: Moment of a force about a point, Moment of a force about a line; Couple, Moment of a couple, Varignon's theorem on moments of two coplanar forces. Composition of coplanar couples, Composition of a number of couples, equilibrium of couples, equivalence of couples.

(Scope as in Chapters 4, 5, 6 and 9 of S L Loney and Chapter 4 of A S Ramsey; All the relevant unsolved exercises of these chapters must to be covered)

Unit-III

Coplanar forces: Resultant of a system of coplanar forces, Resultant of three coplanar forces to two, Reduction of any number of coplanar forces to a single force or a single couple, Generalization theorem of resolved parts, generalisation of Varignon's theorem of moments, Condition of equilibrium of a system of coplanar forces, Reduction of two coplanar forces to a single force or a single couple Resultant of a force and a couple, Resolution of a force into a force and a couple, Reduction of a system of coplanar forces to a force and a couple.

(Scope as in Chapters 5 and 6 of A S Ramsey and Chapter 8 of S L Loney, All the relevant unsolved exercises of these chapters must to be covered)

Unit-IV

Friction: De nition and nature of friction, coe cient of friction, angle of friction, cone of friction, laws of friction, equilibrium of a particle on a rough plane, Problems on ladders, rods etc. Virtual Work: Work done by a force, Principle of virtual work with Applications.

(Scope as in Chapter 9 of A S Ramsey and Chapter 14, 15 and 17 of in S. L. Loney; All the relevant unsolved exercises of these chapters must to be covered)

Essential Textbooks

(A) S. L. Loney, *The Elements of Statics and Dynamics: Part 1 (Statics)*, A.I.T.B.S. Publishers 2015.

(B) A. S. Ramsey, *Statics,* Second Edition, CBS Publishers.

Further Readings

1. D. Kleppener and R.J.Kolenkow, *An Introduction to Mechanics,* McGraw Hill, 2009.
2. C. Kittel and W. Knight, *Mechanics Berkeley Physics (Vol.1),* McGraw Hill, 2011.
3. J. L. Synge, B. A. Griffith, *Principles of Mechanics.* 3^{rd} *ed.,* McGraw Hill, 1959.
4. J. L. Meriam, L. G. Kraige, *Engineering Mechanics: Statics. Vol.1,* Wiley, 2013.
5. Ashok S. Pandit, *Mechanics,* Narosa, 2001.
6. D. S. Mathur, *Mechanics,* S. Chand, 2014.

MATC-DSE5: Some Special Functions and Integral Transforms

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The objective of this course is to introduce the special function as a solution of speci c di erential equations and acquaint the students with their properties, Integral Transforms and their inverse have been introduced which help in solving the various initial and boundary value problems.

Unit-I

Legendre Polynomials { Orthogonal property of Legendre polynomials, Recurrence relations, Rodrigue's formula, generating function, Orthogonal and Orthonormal functions, Fourier- Legendre series.

Essential Textbooks

(A) R. K. Jain and S.R.K.Iyengar, *Advanced Engineering Mathematics,* 2nd Edition, Narosa Publishing House, 2004.

Further Readings

1. E. D. Rainville, *Special Functions,* NY Macmillan, 1960.

MATC-DSE6: Dynamics

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150

Unit-IV

Relative motion: Relative displacement, velocity and acceleration, motion relative to a rotating frame of reference. Momentum: Linear momentum, angular momentum, conservation of angular momentum, impulsive forces, principle of impulse and momentum, motion with respect to centre of mass of a system of particles. Impulsive motion: Collisions of elastic bodies, loss of energy during impact.

(Scope: Relevant topics in Chapters 6 and 8 of S L Loney and Chapter 10 and 11 of A S Ramsey: All the relevant unsolved exercises of these chapters must be covered)

Essential Textbooks

(A) A. S. Ramsey, *Dynamics,* Cambridge University Press.

(B) S. L. Loney, *The Elements of Statics and Dynamics: Part 2 (Dynamics)),* Arihant Prakashan.

Further Readings

1. A.P. Roberts, *Statics and Dynamics with Background in Mathematics,* Cambridge University Press, 2003.
2. M. Ray and G. C. Sharma, *A Text Book on Dynamics,* S. Chand and Company, 2008.
3. J.L. Synge and B.A. Griffith, *Principles of Mechanics,* Tata McGraw-Hill, 1959.

MATC-DSE7: Di erential Geometry

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: In this course the tools of calculus, di erential equations and linear algebra acquired in courses C1, C3, C4, C5, C9, C11 will be used to study problems in geometry.

Unit-I

Theory of Space Curves: Curves in the planes and in space, arc length, reparametrization, curvature, Serret-Frenet formulae. osculating circles, evolutes and involutes of curves, apace curves, torsion, Serret-Frenet formulae.

Unit-II

Theory of Surfaces Surfaces, smooth surfaces, tangents, normals and orientability, quadric surfaces, the rst and the second fundamental forms, Euler's theorem. Rodrigue's formula.

Unit-III

Gaussian Curvature, Gauss map and Geodesics: The Gaussian and mean curvatures, the pseudosphere, at surfaces, surfaces of constant mean curvature, Gaussian curvature of compact surfaces, the Gauss map, Geodesics, geodesic equations, geodesics of surfaces of revolution, geodesics as shortest paths, geodesic coordinates.

Unit-IV

Minimal Surfaces and Gauss's Remarkable Theorem: Plateau's problem, examples of minimal surfaces, Gauss map of a minimal surface, minimal surfaces and holomorphic functions, Gauss's Remarkable Theorem, isometries of surfaces, The Codazzi-Mainardi Equations, compact surface of constant Gaussian curvature

Essential Textbooks

(A) Andrew Pressley, *Elementary Di erential Geometry (4th Indian Reprint),* Springer, 2009.

Further Readings

1. T.J. Willmore, *An Introduction to Differential Geometry,* Dover Publications, 2012.
2. B. O'Neill, *Elementary Differential Geometry (2nd ed.),* Academic Press, 2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimensions,* Cambridge University Press 2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry,* Dover Publications, 1988.
5. S. Lang, *Fundamentals of Differential Geometry,* Springer, 1999.
6. B. Spain, *Tensor Calculus: A Concise Course,* Dover Publications, 2003.

Unit-IV

Monte Carlo Simulation Modelling: (deterministic) Area under a curve, volume under a surface, generating random numbers, middle square method, linear congruence. Monte Carlo Simulation Modelling: (probabilistic) detecting fair and unfair coin, dice, Inventory model: (Gasoline and consumer demand). Harbor system and morning rush hour modelling. Discrete probabilistic modeling: Discrete systems for transition matrix, system reliability, linear regression model (with case studies)

(Scope: Chapter 5-6 of (B)).

Essential Textbooks

(A) Belinda Barnes & Glenn R. Fulford,

MATC-DSE9: Metric Spaces and Complex Analysis

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 150 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: To deliver the notions of metric equivalence, homeomorphisms, path connectedness, along with the basics of the di erentiation and integration of complex functions.

Unit-I

Connected sets, unions, intersections and Cartesian products of connected sets, connected components,

MATC-DSE10: Computer Networks

Credits: 6

Contact hours: 60 6 hrs/per week (including Tutorials)

Max. Marks: 100 (Including Internal Assessment-30) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: The objective of the course is to o er knowledge about computer network related hardware and software using a layered architecture. It is also aimed to provide good understanding of the concepts of network security, wireless and various emerging network technologies.

Unit-I

Computer Network: Network Hardware and Software, Network Topologies, Uses of Computer Networks, OSI Reference Model, TCP/IP reference model, Comparison of OSI with TCP/IP model.

Physical Layer: Transmission media: Twisted pair, Coaxial cable, Fiber optics, Wireless Transmission (Radio, Microwave, and Infrared), Switching: Circuit Switching, Message Switching, Packet Switching & their comparisons. ISDN and its services, Multiplexing: Frequency Division, Time Division, Wave Length Division, MODEMS.

Unit-II

Data Link Layer: Design Issue, Framing, Errors Detection and Correction Code: Check sum, CRC, Hamming code, Data Link Protocols for noisy and noiseless channels, Sliding Window Protocol: Stop and Wait ARQ, Go-back-N ARQ, Selective Repeat ARQ. Medium Access Sub-Layer: Introduction to Static and Dynamic channel allocation, IEEE standards 802.3.

Unit-III

Network Layer: Design Issues, network layer addressing, network layer datagram, IP addressed Classes. Sub netting-Sub network, Subnet mask, Routing Algorithm: Shortest Path Routing, Flooding, Broadcast and Multicast routing, Congestion control: Principles of Congestion Control, Congestion prevention policies, Leaky bucket and token bucket algorithms.

Unit-IV

Application Layer: Domain Name system (DNS), DNS name space, DNS Servers, World Wide Web, HTTP, e-mail: Architecture and Services, Message Component, Multipurpose Internet Mail Extensions (MIME), Simple Mail Transfer Protocol (SMTP), Post O ce Protocol (POP), Remote Login and File transfer protocol, Introduction to Network Security.

Essential Textbooks

(A) Andrew S. Tanenbaum, *Computer Networks, (6th edition)* Pearson Publications, 2021.

(B) Behrouz A. Forouzan, *Data Communication and Networking (5th edition),* Tata McGraw Hill, 2017.

Further Readings

1. Theodore S. Rappaport, *Wireless Communication: Principle and Practices (2nd edition),* Pearson Publication, 2010.
2. Charlie Kaufman, Radio Perlman, Mike Speciner, *Network Security (2nd edition),* PHI, 1995.
3. Mayank Davel, *Computer Networks,* Cengage Learning, 2012.

MATC-DSE11: PDE and System of ODE (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week (including Tutorials)

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

Objective: To study Ordinary di erential equations in more than two variables, Partial di erential equations of the rst and second order and systems of linear equations.

Unit-I

Ordinary di erential equations in more than two variables-Surfaces and curves in three dimensions, Simultaneous di erential equations of rst order and the rst degree in three variables, Methods of solutions of , Orthogonal trajectories of a system of curves on a surface, Pfa an di erential forms and equations, Solution of Pfa an di erential equations in three variables.

(Scope: Chapter 1 (sections 1.1-1.6) of (A)).

Unit-II

Partial di erential equations of the rst order-Partial di erential equations, Origins of rst order partial

MATC-DSE11: PDE and System of ODE (Practical) (using MATLAB)

Credits: 2

Contact hours: 2 hrs/week (3 practicals per week) In groups of 15 students

Max. Marks: 50 (Final 40+Internal Assessment-10) Time allowed: 3hrs.

List of Practicals (using MATLAB)

- Solution of Cauchy problem for rst order PDE.
- Finding and plotting the characteristics for the rst order PDE.
- Plot the integral surfaces of a given rst order PDE with initial data.
- Solution of one dimensional heat equation.
- Solving system of ODEs.

Essential Textbooks

(A) I N Sneddon, *Elements of Partial di erential equations,* Dover Publications, Inc. Newyork, 2006.

(B) S.L. Ross, *Di erential equations (3rd ed.),* John Wiley and Sons, India, 2004.

Further Readings

1.

MATC-DSE12: Numerical Methods (Theory)

Credits: 4

Contact hours: 48 4 hrs/per week

Max. Marks: 100 (Including Internal Assessment-20) Time allowed: 3hrs.

- *Candidates will be asked to attempt ve questions out of nine, carrying equal marks. Question No.1 spread over the whole syllabus will be compulsory.*
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MATC-DSE12: Numerical Methods (Practical)

(using MATLAB)

Credits: 2

Contact hours: 2 hrs/week 3 practicals per week (In groups of 15 students)

Max. Marks: 50 (Including Internal Assessment-10) Time allowed: 3 hrs.

List of Practicals (using MATLAB)

1. Calculate the sum 1 + 1=2 + 1=3 + 1=4 + + 1=*N:*
2. To nd the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method.