B. Sc. (HONOURS)

IN MATHEMATICS AND COMPUTING

(IIIrd year)

UNDER THE FRAMEWORK OF

HONOURS SCHOOL SYSTEM

2024-2025

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 2024-2025

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 module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit-wise and contents are included in such a manner so that due importance is given to requisite intellectual skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. (Honours) in Mathematics.

EVALUATION

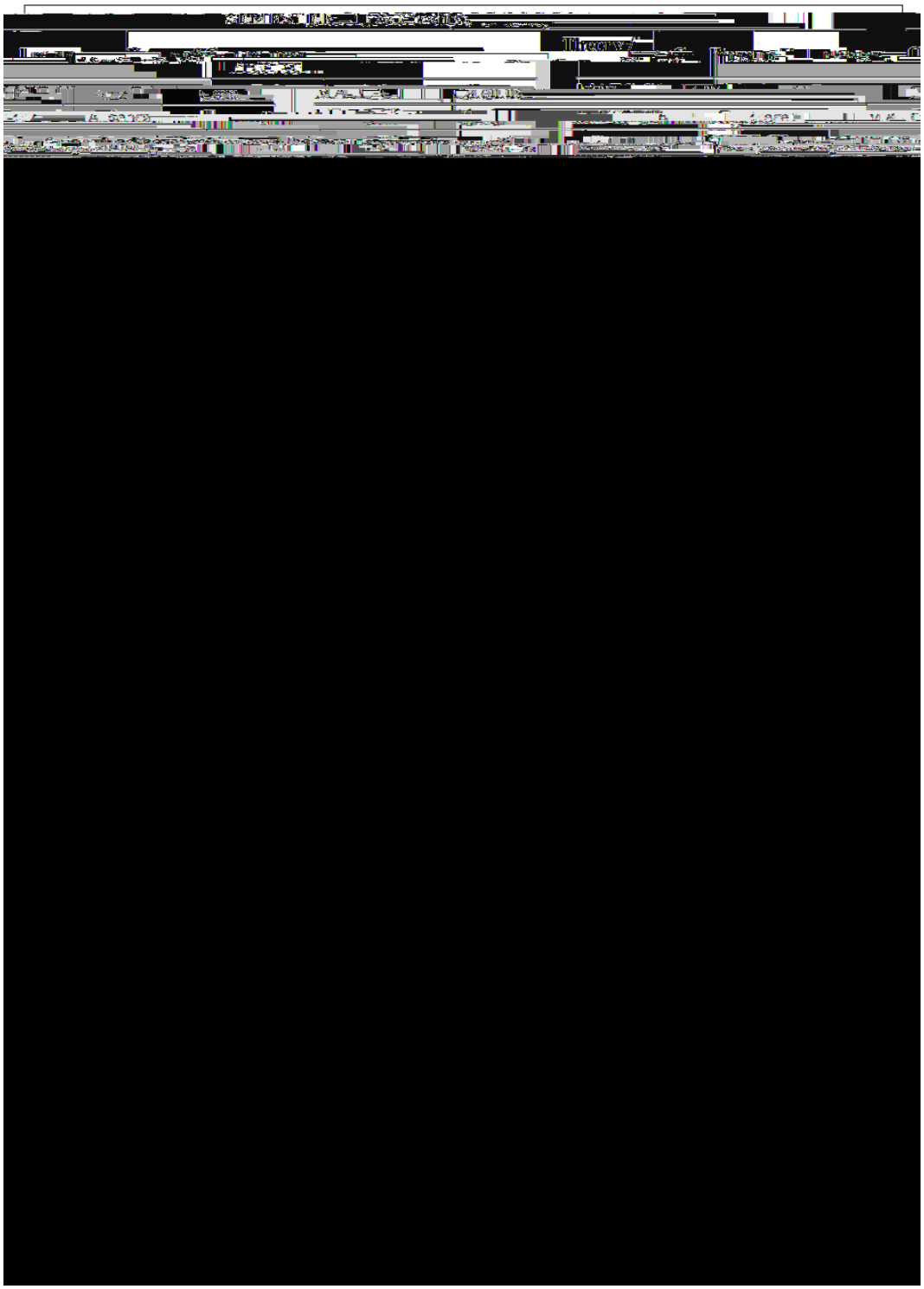
1. There shall be one Mid Term Examination of 20% Marks in each semester.
2. There shall be continuous internal assessment for practicals of 20% marks.
3. Each practical examination shall be of 3 hours duration.
4. The end-semester examination will be of 80% marks.

Pattern of End-Semester Question Paper

1. Nine questions in all with equal weightage. The candidate will be asked to attempt ve questions.
2. One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
3. The remaining eight questions will have Four Units comprising two questions from each unit.
4. Candidate will be asked to attempt one question from each unit and the compulsory question.

Course Structure with Credit Details

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



SKILL ENHANCEMENT COURSES (SEC)

Each student of B.Sc. (Honours) Mathematics and Computing has to opt the following SEC courses in the second year.

1. Any one of the following SEC courses in Semester III:
   (a) MATC-SEC1: Logic and Sets.
   (b) MATC-SEC2: LaTeX and HTML.
   (c) MATC-SEC3: Graph Theory.
   (d) MATC-SEC4: Computer Algebra Systems and Related Software.

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

Each student of B.Sc. (Honours) Mathematics and Computing has to opt four DSE courses in the third year of the degree out of the following:

1. MATC-DSE1: Number Theory.
2. MATC-DSE2: Arti cial Intelligence.
3. MATC-DSE3: Group Theory II.
4. MATC-DSE4: Statics.
5. MATC-DSE5: Some Special Functions and Integral Transforms
6. MATC-DSE6: Dynamics.
7. MATC-DSE7: Di erential Geometry.
8. MATC-DSE8: Mathematical Modeling.
9. MATC-DSE9: Metric Spaces and Complex Analysis.
10. MATC-DSE10: Computer Networks.
11. MATC-DSE11: PDE and System of ODE.
12. MATC-DSE12: Numerical Methods.
13. MATC-DSE13: Project Work.

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 (attended/delivered) by the students.

Important Notes

1. Students interested in continuing to MSc (Hons) Mathematics from the Department of Mathematics, Panjab University, Chandigarh, must opt for the following DSE courses:
   (a) MATC-DSE3: Group Theory II for Semester V.
   (b) MATC-DSE9: Metric Spaces and Complex Analysis for Semester VI.

MATC-C13: Multivariate Calculus

Essential Textbooks

(A) T. M. Apostol, *Mathematical Analysis, Narosa, 12th Reprint 2002.*

(B) Joseph L. Taylor, *Foundations of Analysis, Pure and Applied Undergraduate Texts, 18, American Mathematical Society, Providence, RI, 2012.*

Further Readings

1. E. Kreyszig, *Advanced Engineering Mathematics (*10^{th} *ed.)*, John Wiley and Sons, 2011.
2. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus,* Springer, 2005.
3. W. Rudin, *Principles of Mathematical Analysis, (*3^{rd} *ed.)*, McGraw Hill, 1976.
4. J. Stewart, *Multivariable Calculus, Concepts and Contexts (*7^{th} *ed.)*, Brooks/Cole, Cengage Learning, 2012.
5. M. Spivak,

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 have to attempt one from each unit.*

Objective: This course provides basic concepts of probability theory and the logic of statistical reasoning. It covers the detailed concepts of random variables, probability functions, distributions, expectations, moments, and central limit theorems. Throughout the course, concepts will be dealt with examples from real-life applications like environmental regulation, genetics, nancial regulation, and telecommunications, etc.

Unit-I

Sample space, probability axioms, conditional probability, Bayes' theorem and independence of events. Concept of real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions. Functions of a random variable.
(Scope: Chapter 1 and 2 of (A))

Unit-II

Mathematical expectation, moments, moment generating function, characteristic function. Moment inequalities: Markov inequality, Chebyshev-Bienayme inequality, Lyapunov inequality. Multiple random variables, independent random variables, joint cumulative distribution function, joint probability mass/density functions, marginal probability mass/density functions. Functions of several random variables. Order statistics and their distributions.
(Scope: Chapter 3 and 4 of (A))

Unit-III

Covariance, correlation, joint moments and conditional expectation. Discrete distributions and their interrelations: Degenerate, two-point, uniform, Bernoulli, binomial, geometric (case I and II), negative binomial (case I, II, and III), hypergeometric, Poisson.
(Scope: Chapter 5 of (A))

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))

Essential Textbooks

(A) V. K. Rohatgi, and A. K. Md. Ehsanes *An Introduction to Probability and Statistics*, John Wiley & Sons, 2015.

Further Readings

1. R. V. Hogg, J. W. McKean and A. T. Craig, *Introduction to Mathematical Statistics,* Pearson New International Edition, Asia, 2007.
2. W. J. Stewart, *Probability, Markov chains, Queues, and Simulation: The Mathematical basis of Performance Modelling,* Princeton University Press, 2009.
3. I. Miller, M. Miller, and J. E. Freund, *Mathematical Statistics with Applications,* 7^{th} *Edition,* Pearson Education, Asia, 2006.
4. R. A. Johnson, I. Miller, and J. E. Freund, *Probability and Statistics for Engineers,* Pearson Education London, 2000.
5. S. M. Ross, *Introduction to Probability Models,* Academic press, 2014.
6. J. L. Devore, *Probability and Statistics,* Paci c Grove: Brooks/Cole, 2000.
7. J. L. Devore, *Probability and Statistics for Engineering and the Sciences,* Cengage Learning, 2015.
8. Ali Grami, *Probability, Random Variables, Statistics, and Random Processes,* John Wiley & Sons, Inc, 2020.

MATC-C15: Ring Theory and Linear Algebra-II

Credits: 6

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

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:

MATC-C16: Data Analytics using R (Practical)

Credits: 2

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

Primitive roots and indices. Quadratic residues, Legendre symbol, Euler's criterion, Gauss's lemma, Quadratic reciprocity law, Jacobi symbol.

Unit-IV

Representation of an integer as a sum of two and four squares. Diophantine equations, x

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: Artificial Intelligence

Credits: 6

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

Expert System:

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 applications., Simplicity of $A_n; n > 4$:

Unit-III

p-Groups, Sylow's theorems and its applications, Semidirect products, Groups of order $p^2; p^3$ and pq, Classi cation of groups of order upto 15:

Unit-IV

Normal and subnormal series, Derived series, composition series, solvable groups and nilpotent groups, Zassenhaus lemma, Schreier re nement theorem, Jordan Holder's theorem.

Scope as in chapters 3, 4, 5, 6 of [A]

Essential Textbooks

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

Further Readings

1. John B. Fraleigh, *A First Course in Abstract Algebra (7th ed.),* Pearson, 2002.
2. M. Artin, *Abstract Algebra (2*

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

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 (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: Dynamics is one of the important branches of mathematics that nds application for bodies in motion. This course is to study the motion of moving body. Students will be introduced to the concept of motion along a straight line with constant and variable acceleration. In addition, motion in a plane, SHM, projectile, work, power energy, momentum and impulsive motion will be taught.

Unit-I

Basic notions: Kinematics, kinetics, uniform motion, position, displacement, velocity, acceleration, uniform velocity, Linear momentum.

Motion of a particle in a straight line: Motion of a particle with constant acceleration, motion of a body let fall free from rest, motion of a body projected vertically upwards.

(Scope: Relevant topics in Chapter 1, 3 and 4 of A S Ramsey; All the relevant unsolved exercises of these chapters must be covered)

Unit-II

Newton's Laws of Motion: Newton's Laws of Motion, Motion of two particles connected by a string, Motion along a smooth inclined plane, constrained motion along a smooth inclined plane.

Variable acceleration: Simple harmonic motion.

(Scope: Relevant topics in Chapter 4, 5 and 11 of S L Loney; All the relevant unsolved exercises of these chapters must to be covered)

Unit-III

Motion of a particle in a plane: Composition and resolution of velocities and Acceleration in a plane, Projectiles, motion in a circle, Motion under constraint.

Work and energy: Work, Conservative elds and the potential energy, work done against gravity, Potential energy of a gravitational eld.

(Scope: Relevant topics in Chapter 6, 7, 9 and 10 of S L Loney: All the relevant unsolved exercises of these chapters must be covered)

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 Di erential Geometry,* Dover Publications, 2012.
2. B. O'Neill, *Elementary Di erential Geometry (*2

MATC-DSE8: Mathematical Modelling

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: Modelling involves formulating real-life situations or converting mathematical concepts into a real or plausible situation. It covers a number of basic modelling tasks, including constructing the mathematical model from scratch. This course exposes students to empirical, deterministic, probabilistic, and simulation modelling.

Unit-I

Introduction to mathematical modelling, modelling approaches, Classi cations and some characteristics of Mathematical Modelling, limitations of Mathematical Modelling. Compartmental models: Exponential decay, lake pollution models, drug assimilation into the blood (single pill and course of pills), equilibrium points and stability (with case studies). Models of single populations: Exponential growth, density-dependent growth, limited growth with harvesting, discrete population growth and chaos, Time-delayed regulation (with case studies).

(Scope: Chapter 1-3 of (A)).

Unit-II

Interacting population models: In uenza outbreak, predators and prey, competing species, model of a battle (with case studies). Phase-plane analysis of epidemic model, battle model, predators prey, competing species models.

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

Unit-III

Heat and mass transport models: Newton's law of cooling, water heater, heat conduction and Fourier's law, heat conduction through a wall, radial heat conduction, di usion. Time dependent heat models: case studies of cooling, water heater, heat loos through wall, double glazing, cooling computer chip and tumor growth.

(Scope: Chapter 9-11 of (A)).

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, *Mathematical Modeling with Case Studies, A Di erential Equation Approach using Maple and Matlab, (2nd Edition),* Taylor and Francis group, London and 2009.

(B) Frank R. Giordano, Maurice D. Weir & William P. Fox, *A First Course in Mathematical Modelling, Thomson Learning,* London and 2003.

Further Readings

1. E. A. Bender, *An Introduction to Mathematical Modelling,* Dover Publications, 2000.
2. L. D. Clive,, *Principles of Mathematical Modelling,* Elsevier, 2004.
3. J. N. Kapoor, *Mathematical Modelling,* New Age International Publishers, 2nd Edition, 2021
4. M.M. Meerschaert, *Mathematical Modelling,* Academic Press, 4th Edition, 2013.
5. Rutherford, *Mathematical Modelling Techniques,* Dover Publications, 2012.

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, totally disconnected metric spaces, paths, path-wise connectedness, polygonal connectedness in R^n; equivalent metrics, uniform equivalence, Lipschitz equivalence and homeomorphisms.

(Scope: Sections 11.1 - 11.9, 13.1 - 13.3 and 13.6 of (B)).

Unit-II

Line and circle in the complex plane, the extended complex plane and its spherical representation, Multivalued functions and their branches, argument, logarithm and power functions.

Derivative of a complex function, Cauchy-Riemann equations, su cient conditions for di erentiability, analytic functions, analyticity at in nity, harmonic functions and their conjugates.

(Scope: Sections 1.3, 1.6, 2.1 - 2.7, 3.5-3.7 of (A)).

Unit-III

Curves, simply closed curves, complex line integral, primitives, path independence. Cauchy-Gaursat's theorem for rectangles, disks and for simply connected domains. Extensions of the Cauchy-Gaursat's theorem, winding number, Cauchy integral formula and its applications.

(Scope: Sections 4.1 - 4.7 of (A)).

Unit-IV

Liouville's theorem, Gauss' mean value theorem and maximum modulus principle. Introduction to the Taylor and Laurent series expansions of complex functions.

Bilinear transformations, images of half planes and disks by bilinear transformations, cross ratio, introduction to conformal transformations and the Riemann mapping theorem (statement only).

(Scope: Sections 4.8 , 4.9, 6.3, 6.5, 9.2 - 9.6 of (A)).

Essential Textbooks

(A) H. S. Kasana, *Complex Variables: Theory and Applications (2nd Edition),* PHI, 2005.

(B) M. O. Searchoid, *Metric Spaces (4th Indian Reprint),* Springer, 2014.

Further Readings

1. J. Bak and D. J. Newman, *Complex Analysis (2nd ed.),* Springer-Verlag, 1997.
2. J. W. Brown, R. V. Churchill, *Complex Variables & Applications (8th ed.),* McGraw{Hill, 2009.
3. N. L. Carothers, *Real Analysis,* Cambridge University Press, 2000.
4. J. B. Conway, *Functions of One Complex Variable (2nd ed.),* Narosa, Reprint 2002.
5. S. Kumaresan, *Topology of Metric Spaces (2nd ed.),* Narosa, 2011.
6. S. Ponnusamy, *Foundations of Complex Analysis (2nd ed.),* Narosa, 2005.
7. S. Shirali and H. L. Vasudeva, *Metric Spaces,* Springer-Verlag, 2006.
8. G. F. Simmons, *Introduction to Topology and Modern Analysis,* McGraw-Hill, 2004.

MATC-DSE10: Computer Networks

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.*
-

Unit-IV

Application Layer: Domain Name system (DNS), DNS name space, DNS Servers, World Wide Web,

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 di erential equations, Cauchy's problem for rst order equations, linear equation of rst order, Integral surface passing through a given curve, Surfaces orthogonal to a given system of surfaces, Non-linear partial di erential equation of the rst order, Cauchy method of characteristics, Compatible system of rst order equations, Charpit's method, Special types of rst order equations, Solutions satisfying given conditions, Jacobi's method, Applications of rst order equations.

(Scope: Chapter 2 of (A)).

Unit-III

PDEs of second order-The origin of second order equations, Linear pdes with constant coe cients, separation of variables. Solution of Laplace equation, Heat equation and Wave equation with separation of variables in two dimensions.

(Scope: Chapter 3 of (A)).

Unit-IV

Systems of linear di erential equations, types of linear systems, di erential operators, an operator method for linear systems with constant coe cients, Basic Theory of linear systems in normal form, homogeneous

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.),*

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.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: To acquaint the students with Numerical approximations, convergence problems, Solution of polynomial and simultaneous equations, Di erent rules of Numerical integration.

Unit-I

Algorithms, Convergence, Error Analysis: Relative error, Truncation error, Round o error, order of approximation, order of convergence, Propagation.

Solution of Non-linear equations: Bisection method, Secant Method, Method of false position, Newton Raphson Method, xed point iteration method, Convergence analysis and order of convergence for all these methods.

Unit-II

Solution of system of linear equations: Gaussian Elimination method, Gauss Jordan, Gauss Jacobi method, Gauss- Seidel Method, LU decomposition Method, Successive-over-relaxation (SOR) iteration methods and their convergence, ill and well conditioned systems, Rayleigh's power method for eigen-values and eigen-vectors.

Unit-III

Interpolation: Errors in polynomial interpolation, Finite di erence operators, Newton's Gregory forward and backward interpolation Formula, and Central di erence interpolation formula: Gauss', Striling's, Bessel's, Everett's. Lagranges interpolation formula and Newton divided di erence interpolation formula.

Unit-IV

Numerical Integration: Midpoint rule, Trapezoidal rule, Simpson's 1/3 rule, Simpsons 3/8 rule,

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 $1 + 1=2 + 1=3 + 1=4 + \cdots + 1=N$:
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.
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpson's rule.