B. Sc. (HONOURS)

IN MATHEMATICS

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 (SEMESTER SYSTEM)

UNDER THE FRAMEWORK OF HONOURS SCHOOL SYSTEM

ACADEMIC SESSION 2022-2023

PREAMBLE

To teach the fundamental concepts of Mathematics and their applications. The syllabus pertaining to B.Sc. (Honours) Mathematics (3 Year course & 6 Semesters) in the subject of Mathematics under Honours School framework has been upgraded 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 School) 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.

Note: For any course (Core/DSE/SEC) with practicals, the faculty member teaching the theory part will deliver the following for every practical session.

A handout of iterative formulas to be used in the practical session.

At least three problems of distinctive nature, to be discussed during the practical session.

A soft copy of programming codes/commands, required to build corresponding programs.

Course Structure with Credit Details

(Total Credits=152)

Semester	Nature of Course	Course Codes	No. of Courses	Credits
I	Core Courses	MAT-C1, MAT-C2	2	6 2 = 12
	Ability Enhancement Courses	AECC1 or AECC2	1	2
	General Elective Courses*		2	6 2 = 12
Total			5	26
II	Core Courses	MAT-C3, MAT-C4	2	6 2 = 12
	Ability Enhancement Courses	AECC1 or AECC2	1	2
	General Elective Courses*		2	6 2 = 12
Total			5	26
III	Core Courses	MAT-C5 to MAT-C7	3	6 3 = 18
	Skill Enhancement Courses	MAT-SEC1 to MAT-SEC5	1	2
	General Elective Courses*		1	6
Total			5	26
IV	Core Courses	MAT-C8 to MAT-C10	3	6 3 = 18

Core Courses

Semester	Course Code	Name of Course
I	MAT-C1	Calculus*
	MAT-C2	Algebra
II	MAT-C3	Real Analysis
	MAT-C4	Di erential Equations*
III	MAT-C5	Theory of Real Functions
	MAT-C6	Group Theory I
	MAT-C7	PDE and System of ODE*
IV	MAT-C8	Numerical Methods*
	MAT-C9	Riemann Integration and Series of Functions
	MAT-C10	Ring Theory and Linear Algebra I
V	MAT-C11	Multivariate Calculus
	MAT-C12	Group Theory II
VI	MAT-C13	Metric Spaces and Complex Analysis
	MAT-C14	Ring Theory and Linear Algebra II

*These courses also have practicals worth 2 credits, along with 4 credits for their theory. In such courses, the faculty member teaching theory part will design a weekly handout of at least three problems, to be discussed during practical sessions.

**DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in Semesters V-VI)

1. MAT-DSE1: Number Theory.
2. MAT-DSE2: Probability and Statistics.
3. MAT-DSE3: Discrete Mathematics.
4. MAT-DSE4: Statics.
5. MAT-DSE5: Some Special Functions and I1 476.tsMe4334(I1 476.tsMe43(In)-291(suc)28(h)-291(courses,)]TJ -14.944 -9

4. MAT-SEC4: Computer Algebra Systems and Related Software.
5. MAT-SEC5: Programming with C.

**Courses under these will be o ered only if a minimum of 10 students opt for the same.

MAT-C1: Calculus (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: 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)).

MAT-C1: Calculus (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. Matrix operations (addition, multiplication, inverse, transpose, determinant and rank).
2. Plotting of graphs of polynomials of degree 4 and 5, the derivative graph, the the second derivative graph and comparing them.
3. Plotting functions $e^{a}x + b; log(ax + b); 1=(ax + b); sin(ax + b); cos(ax + b); jax + bj$ and to illustrate the e ect of a and b on the graph.
4. Obtaining surfaces of revolution of curves.
5. Tracing of conics in Cartesian coordinates/ polar coordinates. 3D plots.
6. Computation of limits, derivatives and integration of vector functions.
7. Tangent planes to surfaces at a given point.
8. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using Cartesian coordinates.

Essential Textbooks

(A) George B. Thomas, Maurice D. Weir and Joel R. Hass, Thomas' *Calculus, 12th Ed., Pearson Education*, 2014.

Further Readings

1. Joseph L. Taylor *Foundations of Analysis,* Pure and Applied Undergraduate Texts, 18, American Mathematical Society, Providence, RI, 2012.
2. Shanti Narayan, *Integral Calculus,* S. Chand and Company Ltd, 2001.
3. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), 2007.
4. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons, 2002.
5. R. Courant and F. John, *Introduction to Calculus and Analysis (Volumes I & II),* Springer-Verlag, Inc., 1989.

MAT-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

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.

MAT-C3: 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.*
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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.

MAT-C4: Di erential Equations (Theory)

Credits: 4

Total Lectures: 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: To exhibit the techniques for obtaining solutions to ordinary di erential equations, the basic ideas and the theory behind those techniques.

Unit-I

Classi cation of Di erential Equations: Their Origin and applications. Nature and method of solutions. Initial and boundary value problem. Existence and uniqueness theorem. Exact di erential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. Clairaut equation.
(Scope as in Chapter 1-2 of (A))

Unit-II

Applications of First Order Equations: Orthogonal and oblique trajectories. Higher-Order Linear Di erential Equations: Basic Existence Theoremes.Exi6tThTheoremreo(1933 Td [(i5om.)o)-352(Thesic)-22blique heorem8mgheo38 -2m83

MAT-C4: 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)

MAT-C5: 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.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: Introduction to the theory of real functions, their derivatives and functions of bounded variation. Analogues to general metric spaces and, in particular, nite dimensional Euclidean spaces are also expected for continuity and convergence.

Unit-I

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.

MAT-C6: Group Theory-I

Credits: 6

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

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

Essential Textbooks

(A) J. A. Gallian, *Contemporary Abstract Algebra, (4^{th} ed.),* Narosa, 1999.

(B) M. Artin, *Abstract Algebra,(2^{th} ed.),* Pearson, 2011.

Further Readings

1. I. N. Herstein, *Topics in Algebra, Wiley Eastern Limited,* India, 1976.
2. I. S Luthar and I.B.S. Passi, *Algebra Volume 1: Groups,* Narosa, 1999.
3. J. B. Fraleigh, *A First Course in Abstract Algebra, (7^{th} ed.),* Pearson, 2002.
4. J. J. Rotman, *An Introduction to the Theory of Groups, (4^{th} ed.),* Springer-Verlag, 1995.
5. S. Singh and Q. Zameeruddin *Modern Algebra, (7^{th} ed.),* Vikas Publishing House, 1993.

MAT-C7: 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,*

MAT-C8: Numerical Methods (Theory)

Credits: 4

Total Lectures: 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: 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, Composite Trapezoidal rule, Composite Simpson's rule. Boole's Rule and Weddles rule, Romberg integration, Newton Cotes integration formula, Gaussian Quadrature and generalized quadrature. Numerical double integration.

(Scope as in relevant sections of Chapters 1-4 of (A)).

MAT-C8: 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.
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.

Note: For any of the CAS (Computer aided software) Data types-simple data types, oating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Essential Textbooks

(A)

4. F. B. Hildebrand, *Introduction to Numerical Analysis,* Courier Corporation, 1987.
5. Brian Bradie, *A Friendly Introduction to Numerical Analysis,* Pearson, 2007.
6. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods, 7th Ed.*, PHI, 2013.
7. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, PHI, 2012.
8. S. S. Shastry, *Introductory methods of numerical analysis,* PHI, 2012.

MAT-C9: Riemann Integration and Series of 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.*
- *There will be two questions from each unit and the students will have to attempt one from each unit.*

Objective: To deliver the theory and applications of Riemann integration, improper integrals, uniform convergence and power series.

Unit-I

The Riemann integral, Riemann integrable functions, fundamental theorem of calculus, the Darboux integral, equivalence theorem. Mean value theorems for the integral calculus.

(Scope: Sections 7.1 { 7.4 of (A)).

Unit-II

Introduction to the Riemann-Stieltje's integral. Improper integrals, tests for convergence of improper integrals. Introduction to the Henstock-Kurzweil integral.

(Scope: Relevant sections from (B), Chapter 11 of (1) and section 10.1 of (A)).

Unit-III

Pointwise and uniform convergence of sequence of functions, interchange of limits, series of functions, Weierstrass' M-test, a continuous nowhere di erentiable function, Weierstrass approximation theorem. Power series, multiplication of two series.

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*

MAT-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 fr unit and6*

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.

MAT-C11: 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)]

MAT-C12: 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 MAT-C6 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 (2nd ed.),* Pearson, 2011.
3. I.S. Luthar and I.B.S. Passi, *Algebra, Volume 1: Groups,* Narosa, 1996.
4. Joseph A. Gallian, *Contemporary Abstract Algebra (4th ed.),* Narosa, 1999.
5. I.N. Herstein, *Topics in Algebra,* Wiley Eastern Limited, India, 1976.
6. S. Singh and Q. Zameeruddin, *Modern Algebra (7th ed.),* Vikas Publishing House, 1993.

MAT-C13: 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, 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

The extended complex plane and its spherical representation, line and circle in the complex plane, bilinear transformations, images of half planes and disks by Mobius transformations, cross ratio, introduction to conformal transformations and the Riemann mapping theorem.

Multivalued functions and their branches, argument, logarithm and power functions.

(Scope: Sections 1.6, 9.2 - 9.4, 3.5 - 3.7 of (A)).

Unit-III

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.

Curves, simply closed curves, complex line integral, primitives, path independence.

(Scope: Sections 2.4 - 2.7, 4.1 - 4.3 of (A)).

Unit-IV

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, Liouville's theorem, Gauss' mean value theorem and maximum modulus principle.

Introduction to the Taylor and Laurent series expansions of complex functions.

(Scope: Sections 4.4 - 4.9, 6.3, 6.5 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.

MAT-C14: 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. MAT-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, *A First Course in Abstract Algebra (7th ed.),* Pearson, 2002.
3. M. Artin, *Abstract Algebra (2nd ed.),* Pearson, 2011.
4. Joseph A. Gallian, *Cont0 Td [Ra 0 T2l6yra Tf 4.98a]TJ/F10 6.9738 Tf 4.982 3.615 Td [(nd)]TJ/F47 9.9626 Tf 135*

4.

MAT-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

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.

MAT-DSE2: 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

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))

MAT-DSE3: Discrete Mathematics

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*

MAT-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*

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,

MAT-DSE5: Some Special Functions and Integral Transforms

Credits: 4

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 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.

Chebyshev Di erential Equation, Chebyshev polynomials of rst and second kind and relation between them.

Unit-II

Generating function, orthogonal property, Recurrence formulae, Fourier Chebyshev Series.

Bessel's functions. Strum-Liouville Problem { Orthogonality of Bessel functions, Reccurence formulae, Generating function, Fourier-Bessel Series.

Unit-III

Laplace Transforms, Inverse Laplace transform, Solution of initial value problems using Laplace transforms, Translation theorems, Laplace transform of Dirac-Delta function, Di erentiation and Integration of Laplace transform, Convolution theorems, Laplace transform of periodic functions, Laplace transform method to solve some ordinary di erential equations.

Unit-IV

Review of Fourier series, Fourier integrals, Fourier transforms, Applications of Fourier series and Fourier transforms.

Scope: Chapters 7,8,9 of (A).

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.

MAT-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.

MAT-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:

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.

MAT-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.*
-

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.

MAT-DSE9: 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.

MAT-DSE9: 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. J. L. Devore, *Probability and Statistics for Engineering and the Sciences,* Cengage Learning, 2015.
8. D. C. Montgomery and G. C. Runger, *Applied statistics and probability for engineers,* John Wiley & Sons, 2010.
9. G. Shmueli, N. R. Patel and P. C. Bruce, *Data mining for business intelligence: Concepts, techniques, and applications in Microsoft O ce Excel16 0 Tt24t9 826 64 225.38.112615 Td [(th)rJ/F47 9.9626 Tf 190.*

MAT-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 (5th ed.)*, Pearson, 2019.
2. P. R. Halmos, *Naive Set Theory,* Springer,1974.
3. E. Kamke, *Theory of Sets,* Dover Publishers, 1950.

MAT-SEC2: LaTeX and HTML

Credits: 2

Total Lectures: 20 2 hrs/per week

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

Objective: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages. After studying this course the student will be able to

1. Typeset mathematical formulas, use nested list, tabular & array environments.
2. Create or import graphics.
3. Use beamer to create presentation and HTML to create a web page.

Unit-I

Getting Started and Mathematical Typesetting with LaTeX (Lectures: 12)

Introduction to TeX and LaTeX, Typesetting a simple document, Adding basic information to a document, Environments, Footnotes, Sectioning and displayed material. Accents and symbols, Mathematical Typesetting (Elementary and Advanced): Subscript/ Superscript, Fractions, Roots, Ellipsis, Mathematical Symbols, Arrays, Delimiters, Multiline formulas, Spacing and changing style in math mode.

Unit-II

Graphics and Beamer Presentation in LaTeX and HTML (Lectures: 16)

Graphics in LaTeX, Simple pictures using PS Tricks, Plotting of functions, Beamer presentation. HTML basics, Creating simple web pages, Images and links, Design of web pages.

Essential Textbooks

(A) Donald Bindner and Martin Erickson, *A Student' s Guide to the Study, Practice, and Tools of Modern Mathematics,* CRC Press, Taylor & Francis Group, LLC, 2011.

(B) L. Lamport, *LATEX: A Document Preparation System, User's Guide and Reference Manual (*2^{nd} *ed.),* Addison-Wesley, 1994.

MAT-SEC3: Graph Theory

Credits: 2

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

MAT-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, While loops. Functions: General Structure of function, Scope of variables, Passing variable, The Return statement, Nargin and nargout, Recursive functions. Plotting: Basic two-dimensional plots, Line styles, Markers, Colors, Plot Color, Plotting grid, Axis command, Placing text on a plot, Modifying text with Tex commands.

Unit-II

Use of Mathematica, Maple, and Maxima as calculator, in computing functions, in making graphs; MATLAB/Octave for exploring linear algebra and to plot curve and surfaces; the statistical software R: R as a calculator, explore data and relations, testing hypotheses, generate table values and siFlo tata

MAT-SEC5: Programming with C

Credits: 2

Total Lectures: 20 2 hrs/per week

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

Objective: The objective of this course is to make the student understand programming language concepts, mainly control structures, reading a set of data, stepwise re nement, function and arrays. After completion of this course, the student is expected to analyse the real life problem and write programs in `C' language to solve problems. The main emphasis of the course is on problem solving aspect.

Unit-I

Programming Process: Steps in developing of a program, Data Flow Diagram, Algorithm development, Flowchart, Pseudo Code, Testing and Debugging. Fundamentals of C Languages: History of C, Character Set, Identi ers and Keywords, Constants, Types of C Constants, Rules for Constructing Integer, Real and character Constants, Variables, Data Types, rules for constructing variables. Operators and Expressions: C Instructions, Arithmetic operators, Relational operators, Logical operators, Assignment Operators Decision Control Structure: Decision making with IF-statement, IF-Else and Nested IF Else, The else if Clause. Loop Control Structure: While and do-while, for loop and Nested for loop, Case Control Structure: Decision using switch, The goto statement. Functions In C

Unit-II

Arrays: Introduction, Array declaration, Accessing values in an array, Initializing values in an array, Single and Two Dimensional Arrays, Initializing a 2-Dimensional Array, Array Multiplication. Pointers: Pointer declaration, Address operator \&", Indirection operator *", Pointer and arrays, Pointers and 2-Dimensional Arrays, Structures and Unions: Declaration of structures, Structure Initialization, Accessing structure members, Arrays of structure, Nested structures, Structure with pointers, Union. Files in C: Introduction, Opening and Closing les, Basic I/O operation on les.

Scope: Chapters 1-10 of (A).

Essential Textbooks

(A) Yashavant, P. Kanetkar, *Let us C,* BPB Publications.

Further Readings

1. C. Balaguruswami, *Programming with C Language,* Tata McGraw Hill.
2. Salaria, R.S, *Test Your Skills in C,* Salaria Publications.
3. Byron S. Gottfried, *Programming in C,* McGraw Hills Publishers, New York.
4. M.T. Somashekara, *Programming in C,* Prentice Hall of India.

Three dimensional space, Coordinates of a point in three dimensional space, Distance between two points, Section formaula.

[Scope: Chapter 12 of a Textbook- `Mathematics' for class XI, NCERT]

Essential Textbooks

(A) Mathematics, A Textbook for Class XI and XII, NCERT, 2003.

Further Readings

1. G. B. Thomas, M. D. Weir and J. R. Hass, *Thomas Calculus, (*12^{th} *Edition.),* Pearson, 2014.

MAT-GE2-BM: Calculus

Credits: 6

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

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

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MAT-GE3-BM: Matrices

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 familiarizes the students with the theory of matrices which are used in solving equations in mechanics and other streams used in Mathematics, Physics etc.

Unit-I

Symmetric and Skew symmetric, Hermitian and Skew Hermitian, Orthogonal and Unitary matrices (De nitions and examples only). Rank of a matrix, elementary transformations, reduction to normal form (methods only), elementary matrices, equivalence of matrices.

[Scope: Chapter 1,2,4 of Ref (A)]

Unit-II

Vector as n-tuples. Linear dependence and independence of vectors. Rank of a matrix. Row rank, Column Rank and Determinental Rank of a matrix. System of linear equations, consistency and inconsistency. Homogeneous and non-homogeneous equations. Gauss method of solving a system of equations

[Scope: Sections 5.1-5.8 , 6.1-6.6 of Ref (A)]

Unit-III

Characteristic equation of a square matrix. Characteristic roots and characteristic vectors. Nature of Characteristics roots of special matrices. Cayley-Hamilton Theorem (statement only). Orthogonal reduction of real symmetric matrices. (method only)

[Scope: Sections 11.1-11.4, 11.11, 12.1, 12.2 of Ref (A)]

Unit-IV

Unitary reduction of Hermitian matrices(method only). Similarity of matrices. Reduction to Diagonal form, diagonalizable matrices

[Scope: Sections 12.3-12.5, 13.1-13.4 of Ref (A)]

Essential Textbooks

(A) S. Narayan and P. K. Mittal, *A Text Book of Matrices, S. Chand & Co. Ltd,* Reprint 2002.

Further Readings

1. R. K. Jain & S. R. K. Iyengar *Advanced Engineering Mathematics,* (Narosa), 2nd edition, 2005.

MAT-GE4-BM: Vector Analysis, Di erential Equations and 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 aim of this course is to make the students acquire facility and con dence in the use of vectors and vector calculus so that they may employ the same in an e ective manner to various applications and to exhibit the techniques of solving ordinary and partial di erential equations.

Unit-I

Vector Valued Functions, P(F8 9.9626 Tf -203.5668 9.9A8(and)-356J/F34 9.962o99.9A86iTn3nuyro70n3nuyror7nctions,)-

(Scope: Sections 16.2, 16.3.1, 9.5.1, 9.5.2, 9.5.3, 9.5.4, 9.5.5 of (A)).

Essential Textbooks

(A) R. K. Jain & S. R. K. Iyengar, *Advanced Engineering Mathematics (2nd ed.),* Narosa, 2005.

(B) S. Narayan & P. K. Mittal, *A Text Book of Vector Analysis,* S. Chand & Co. Pvt. Ltd., 2003.

Further Readings

1. E. Kreyszig, *Advanced Engineering Mathematics (Revised Edition),* Wiley Eastern Ltd., 2003.
2.

MAT-GE1-PS: Advanced Calculus and 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: The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

Unit-I

Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradiant vectors and tangent planes, Double integrals. Fubini's Theorem without proof, Change of order of integration in double integrals, double integrals in polar form.

(Scope: Sections 11.1, 11.3,12.1-12.3, 12.7 , 13.1-13.3 of (A)).

Unit-II

Triple integrals in rectangular, spherical and cylindrical coordinates, substitution in multiple integrals.Line integrals vector elds. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only).

(Scope: Sections 13.4, 13.6, 13.7, 14.1, 14.3, 14.4, 14.5, 14.7 of (A)).

Unit-III

Transformation of axes, shifting of origin, re ection and rotation of axes, reduction of the equation $S = Ax^2 + Bxy + Cy^2 + Dx + Ey + f = 0$ into simpler forms by transformation of coordinate axes(without proof). Identi cation of curves represented by $S = 0$. Invariance of discriminant and trace t. Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

(Scope: Sections 2.4 - 2.7, 4.1 - 4.3 of (B)).

Unit-IV

Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

(Scope: Sections 1.1-1.6, 1.11-1.14 ,2.1-2.5, 2.12, 2.13,3.1-3.3 ,4.6, 4.7, 4.10, 4.11 of (B)).

Essential Textbooks

(A) G. B. Thomas and R. L. Finney, *Calculus and Analytical Geometry, (9th Edition),* Addison-Wesley Publishing Company, 2010.

(B) J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra, *New Pattern Vector Algebra and Geometry,* (New Edition), International Publishers, 2004.

Further Readings

1. Thomas, *Thomas' Calculus early transcendentals, (12th Edition.),* Addison-Wesley, 2014.
2. Shanti Narayan , *Analytic Solid Geometry* , S.Chand & Co., 2007.

MAT-GE2-PS: Linear 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: This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

Unit-I

Vector spaces over R and C, subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and determinantal rank of a matrix. Elementary row and column operations. Elemetary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only).

Unit-II

Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.

(Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7- 5.9) of (A)).

Unit-III

Cayley-Hamilton Theorem. Characteristic roots and characteristic vectors of a square matrix. Nature of roots of di erent types of matrices, Minimal polynomial of a matrix.

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Unit-IV

Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

(Scope as in 11(Sections 11.1-11.5, 11.11-11.13), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of (B)).

Essential Textbooks

MAT-GE3-PS: Di erential Equations and Fourier Series

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 the course is to enable the students to understand the basic concepts related to ordinary di erential, partial di erential equations and Fourier Series and their applications.

Unit-I

Exact First Order Di erential Equations, Linear second order equations. Homogeneous equation with constant coe cients, Characteristic equation and their wc4n-heous equation (equati0(thuati)-400(oruati0401(, -17.933 Td [(

Essential Textbooks

(A) R. K. Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics (5th Edition),* Narosa, 2016.

Further Readings

1. R. V. Churchill and J. W. Brown, *Complex Variables and Application (4nd ed.),* McGraw Hill, NY, 1984.
2. Erwin Kreyszig, *Advanced Engineering Mathematics (8th ed.),* Wiley Eastern Limited, 2006.
3. Sokolnikoff and Redheffer , *Mathematics for Physics and Engineering (2nd Edition),* McGraw-Hill, 1966.

MAT-GE4-PS: Integral Transforms 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 acquaint the students with the application of Laplace transforms to solve ordinary di erential equations. Moreover, basics of Complex Analysis are also included in this course.

Unit-I

Laplace Transforms: de nition, elementary transforms. Transforms of derivatives and integrals. Transforms of periodic functions. Convolution theorem. Inverse Laplace transforms. Application to ordinary di erential equations.

Unit-II

Complex numbers, absolute value, argument. Functions $exp(z)$, sin z, cos z, log z and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions and their conjugates.

Unit-III

Integration of complex functions, Cauchy's theorem (statement only), Cauchy's theorem for multiply connected domains (statement only). Cauchy's integral formula (statement only) and simple consequences.

Unit-IV

Expansion into Laurent series, singularities, Residues, Cauchy residue theorem (statement only). Evaluation of de nite integrals using contour integration.

Scope: Chapter 6, 13-16 of (A).

Essential Textbooks

(A) E. K rezyg, *Advanced Engineering Mathematics, 10th Ed.*, Wiley, 2015.

Further Readings

1. R. V. Churchill and J. W. Brown, *Complex Variables and Application, (4th ed.)*,1995.
2. R. K. Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics, 2nd Ed.* Narosa, 2004.
3. D Sokolnikoff and Redheffer, *Mathematics for Physics and Engineering 2nd Ed.*, 1996.
4. R. V. Churchill and J. W. Brown, *Complex Variables and Application, (4th ed.),* 1995.