DEPARTMENT OF MATHEMATICS

MADRAS CHRISTIAN COLLEGE

(AUTONOMOUS)

M.Sc. Mathematics

Curriculum & Syllabi

(with effect from 2014 – 2015)

M.Sc. Mathematics Curriculum

with effect from 2014 - 15

S. No.	Course	Hours	Marks			Credits
			CA	ESE	TOTAL	
	Semester I					
1	Algebra I	6	50	50	100	5
2	Real Analysis I	6	50	50	100	5
3	Ordinary and Partial Differential Equations	6	50	50	100	5
4	Mechanics	6	50	50	100	4
5	Graph Theory	6	50	50	100	4
	Total	**30**				**23**
	Semester II					
6	Algebra II	6	50	50	100	5
7	Real Analysis II	6	50	50	100	5
8	Number Theory and Cryptography	6	50	50	100	4
9	Java Programming	5	50	50	100	4
10	Elective 1	5	50	50	100	4
	Soft Skill Programme	2				4
	Total	**30**				**26**
	Internship					**2**
	Semester III					
11	Complex Analysis I	6	50	50	100	5
12	Topology	6	50	50	100	5
13	Formal Languages and Automata	6	50	50	100	4
14	Elective 2	5	50	50	100	4
15	Elective 3	5	50	50	100	4
	Soft Skill Programme	2				4
	Total	**30**				**26**
	Semester IV					
16	Complex Analysis II	6	50	50	100	5
17	Differential Geometry	6	50	50	100	5
18	Functional Analysis	6	50	50	100	5
19	Elective 4	5	50	50	100	4
20	Elective 5	5	50	50	100	4
	Seminar	2				
	Total	**30**				**23**
	Grand Total					**100**

Electives will be chosen from the following pool of papers

1. Operations Research
2. Graph Algorithms and Applications
3. Mathematical Statistics
4. Computational Geometry
5. Integral Equations and Calculus of Variations
6. Discrete Mathematics
7. Fluid Dynamics
8. Theory of Computation
9. Fixed Point Theory
10. Fuzzy Sets and Their Applications
11. Algebraic Topology
12. Wavelets
13. Commutative Algebra
14. Soft Computing
15. Computational Biology

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: I **Paper: 1**

Course Title: Algebra I **Course Code: 142MT1M01**

Credits: 5 **Hours / Cycle: 6**

Unit I

Another Counting Principle – Sylow's Theorems (for Theorem 2.12.1, first proof only).

Chapter 2: Sections 2.11, 2.12 (Section 2.12: Omit Lemma 2.12.5)

Unit II

Solvability by Radicals – Direct Products – Finite Abelian Groups – Modules.

Chapter 5: Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1 only)

Chapter 2: Sections 2.13, 2.14 (Section 2.14: Theorem 2.14.1 only)

Chapter 4: Section 4.5

Unit III

Canonical Forms: Triangular Form – Nilpotent Transformations.

Chapter 6: Sections 6.4, 6.5

Unit IV

Canonical Forms: Jordan Form – Rational Canonical Form.

Chapter 6: Sections 6.6, 6.7

Unit V

Trace and Transpose – Hermitian, Unitary and Normal Transformations – Real Quadratic Forms.

Chapter 6: Sections 6.8, 6.10, 6.11

Content and Treatment as in

I. N. Herstein, Topics in Algebra, Second Edition, Wiley India Pvt. Ltd., New Delhi, 2006

Books for Supplementary Reading and Reference

1. M. Artin, Algebra, Pearson - Prentice Hall, New Delhi, 2007
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second (Indian) Edition, Cambridge University Press, 1997
3. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Narosa Publishing House, New Delhi, 1996
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. II-Rings, Narosa Publishing House, New Delhi, 1999
5. D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill (International Edition), New York, 1997
6. N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman and co, USA 1980

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: I **Paper: 2**

Course Title: Real Analysis I **Course Code: 142MT1M02**

Credits: 5 **Hours / Cycle: 6**

Unit I

Infinite Series and Infinite Products: Absolute and Conditional Convergence – Dirichlet's Test and Abel's Test – Rearrangements of Series – Riemann's Theorem on Conditionally Convergent Series – Double Sequences – Double Series – Rearrangement Theorem for Double Series – A Sufficient Condition for Equality of Iterated Series – Multiplication of Series – Infinite Products.

Chapter 8: Sections 8.8, 8.15, 8.17, 8.18, 8.20, 8.21 - 8.24, 8.26

Unit II

Sequences of Functions: Pointwise Convergence of Sequences of Functions – Examples of Sequences of Real Valued Functions – Definition of Uniform Convergence – Uniform Convergence and Continuity – The Cauchy Condition for Uniform Convergence – Uniform Convergence of Infinite Series of Functions. Power Series: Multiplication of Power Series – The Taylor's Series Generated by a Function – Bernstein's Theorem – Abel's Limit Theorem – Tauber's Theorem.

Chapter 9: Sections 9.1 - 9.6, 9.14, 9.15, 9.19, 9.20, 9.22, 9.23

Unit III

Fourier Series and Fourier Integrals: Introduction – Orthogonal Systems of Functions – The Theorem on Best Approximation – The Fourier Series of a Function Relative to an Orthonormal System – Properties of the Fourier Coefficients – The Riesz-Fischer Theorem – The Convergence and Representation Problems for Trigonometric Series – The Riemann-Lebesgue Lemma – The Dirichlet Integrals – An Integral Representation for the Partial Sums of Fourier Series – Riemann's Localization Theorem – Sufficient Conditions for Convergence of a Fourier Series at a Particular Point.

Chapter 11: Sections 11.1 – 11.12

Unit IV

Multivariable Differential Calculus: Introduction – The Directional Derivative – Directional Derivatives and Continuity – The Total Derivative – The Total Derivative Expressed in terms of Partial Derivatives – An Application to Complex-Valued Functions - The Matrix of a Linear Function – The Jacobian Matrix – The Chain Rule – Matrix Form of the Chain Rule – The Mean Value Theorem for Differentiable Functions – A Sufficient Condition for Differentiability – A Sufficient Condition for Equality of Mixed Partial Derivatives.

Chapter 12: Section 12.1 – 12.13

Unit V

Implicit functions and Extremum Problems: Introduction – Functions with non-zero Jacobian Determinant – The Inverse Function Theorem – The Implicit Function Theorem – Extrema of Real-Valued Functions of One Variable – Extrema of Real-Valued Functions of Several Variables

Chapter 13: Sections 13.1 – 13.6

Content and Treatment as in

T.M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1985.

Books for Supplementary Reading and Reference

1. W. Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill Company, New York, 1976
2. S.C. Malik and S. Arora, Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991
3. S. Arora and B. Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991
4. B.R. Gelbaum and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964
5. R.G. Bartle, The Elements of Real Analysis, Second Edition, John Wiley and Sons Inc., USA 1976

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: I **Paper: 3**

Course Title: Ordinary and Partial Differential Equations **Course Code: 142MT1M03**

Credits: 5 **Hours / Cycle: 6**

Unit I

Linear Equations with Variable Coefficients: Introduction – Initial Value Problems for the Homogeneous Equation – Solutions of the Homogenous Equation – The Wronskian and Linear Independence – Reduction of the Order of a Homogenous Equation – The Non-Homogeneous Equation – Homogenous Equations with Analytic Coefficients – The Legendre Equation.

Chapter 3: Sections 1 – 8

Unit II

Linear Equations with Regular Singular Points: Introduction – The Euler Equation – Second Order Equations with Regular Singular Points – An Example – Second Order Equations with Regular Singular Points – The General Case – The Exceptional Cases – The Bessel Equation – The Bessel Equation (continued).

Chapter 4: Sections 1 – 4, 6 – 8

Unit III

Existence and Uniqueness of Solutions to First Order Equations: Introduction – Equations with Variables Separated – Exact Equations – The Method of Successive Approximations – The Lipschitz Condition – Convergence of the Successive Approximations.

Chapter 5: Sections 1 – 6

Content and Treatment as in
E.A. Coddington, An Introduction to Ordinary Differential Equations, Eastern Economy Edition, Prentice-Hall of India Ltd., New Delhi, 1987.

Unit IV

First order Partial Differential Equation: Introduction – Partial Differential Equations of First Order in Two Independent Variables – Formulation of First Order Partial Differential Equations – Compatibility of First Order Partial Differential Equations – Classification of the Solutions of First Order Partial Differential Equations – Solution of Non-Linear Partial Differential Equations of First Order: Charpit's Method – Jacobi's Method.

Second Order Partial Differential Equation: Origin of Second Order Partial Differential Equations – Linear Partial Differential Equation with Constant Coefficients – Classification of Second Order Partial Differential Equation: Canonical Forms.

Chapter1: Sections 1.1 – 1.3, 1.7 – 1.9 (Only 1.9.1 & 1.9.2)

Chapter2: Sections 2.1, 2.2, 2.4

Unit V

Elliptic Differential Equations: Occurrence of the Laplace and Poisson Equations – Boundary Value Problems – Separation of Variables Method.

Parabolic Differential Equations: Occurrence and Derivation of the Diffusion Equation – Boundary Conditions – Separation of Variables Method.

Hyperbolic Differential Equations: Occurrence of the Wave equation – Derivation of One-Dimensional Wave Equation – D'Alemberts Solution of One-Dimensional Wave Equation.

Chapter 3: Sections 3.1 - 3.3

Chapter 4: 4.1 - 4.3

Chapter 5: 5.1, 5.2, 5.4

Content and Treatment as in

J.N. Sharma and K. Singh, Partial Differential Equations for Engineers and Scientists, Second Edition, Narosa Publishing House, New Delhi, 2009

Books for Supplementary Reading and Reference

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1972
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, Fifteenth Revised Edition, S. Chand & Company Ltd., 2013
3. D. Somasundaram, Ordinary Differential Equations, Narosa Publishing House, 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: I **Paper: 4**

Course Title: Mechanics **Course Code: 142MT1M04**

Credits: 4 **Hours / Cycle: 6**

Unit I

Mechanical Systems: The Mechanical system – Generalised Coordinates – Constraints – Virtual Work – Energy and Momentum

Chapter 1: Sections 1.1 – 1.5

Unit II

Lagrange's Equations: Derivation of Lagrange's Equations – Examples.

Hamilton's Equations: Hamilton's Principle.

Chapter 2: Sections 2.1, 2.2

Chapter 4: Section 4.1

Unit III

Hamilton's Equations – Hamilton's Equation.

Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton Jacobi Equation.

Chapter 4: Section 4.2

Chapter 5: Sections 5.1, 5.2

Unit IV

Introduction to Relativity: Introduction– Relativistic Kinematics.

Chapter 7: Sections 7.1, 7.2

Unit V

Relativistic Dynamics, Accelerated Systems.

Chapter 7: Sections 7.3, 7.4

Content and Treatment as in

Donald T. Greenwood, Classical Dynamics, Prentice-Hall Inc, 1977.

Books for Supplementary Reading and Reference

1. H. Goldstein, Classical Mechanics, Second Edition, Narosa Publishing House, New Delhi, 2000
2. N.C. Rana and P.S. Joag, Classical Mechanics, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 1991

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: I **Paper: 5**

Course Title: Graph Theory **Course Code: 142MT1M05**

Credits: 4 **Hours / Cycle: 6**

Unit I

Graphs and Subgraphs: Graphs and Simple Graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection – Cycles.

Trees: Trees – Cut Edges and Bonds – Cut Vertices.

Chapter 1: Sections 1.1 – 1.7

Chapter 2: Sections 2.1 – 2.3

Unit II

Connectivity: Connectivity – Blocks.

Euler Tours and Hamilton Cycles: Euler Tours – Hamilton Cycles – The Chinese Postman Problem

Chapter 3: Sections 3.1, 3.2

Chapter 4: Sections 4.1 – 4.3

Unit III

Matchings: Matchings – Matchings and Coverings in Bipartite graphs.

Edge Colourings: Edge Chromatic number – Vizing's Theorem.

Chapter 5: Sections 5.1, 5.2

Chapter 6: Sections 6.1, 6.2

Unit IV

Independent Sets and Cliques: Independent Sets – Ramsey's Theorem.

Vertex Colorings: Chromatic Number – Brook's Theorem – Chromatic Polynomials.

Chapter 7: Sections 7.1, 7.2

Chapter 8: Sections 8.1, 8.2, 8.4

Unit V

Planar Graphs: Plane and Planar Graphs – Dual Graphs – Euler's Formula – The Five-Color Theorem and The Four-Color Conjecture.

Chapter 9: Sections 9.1 – 9.3, 9.6

Content and Treatment as in

J.A. Bondy and U.S.R Murthy, Graph Theory and Applications, Macmillan, London, 1976.

Books for Supplementary Reading and Reference

1. J. Clark and D.A. Holton, A First Look at Graph Theory, Allied Publishers, New Delhi, 1995
2. R. Gould, Graph Theory, Benjamin/Cummings. Menlo Park,1989
3. K.R. Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing Company Limited, 1994
4. S. Arumugam and S. Ramachandran, Invitation to Graph Theory, Scitech Publications (India) Pvt. Ltd., 2001
5. S.A. Choudum, A First Course in Graph Theory, Macmillan India Ltd., 1987
6. D.B. West, Introduction to Graph Theory, PHI Learning Private Ltd., New Delhi, 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 6**

Course Title: Algebra II **Course Code: 142MT2M01**

Credits: 5 **Hours / Cycle: 6**

Unit I

Extension Fields – The Transcendence of e.

Chapter 5: Sections 5.1, 5.2

Unit II

Roots of Polynomials – More About Roots.

Chapter 5: Sections 5.3, 5.5

Unit III

The Elements of Galois Theory.

Chapter 5: Section 5.6

Unit IV

Finite Fields – Wedderburn's Theorem on Finite Division Rings.

Chapter 7: Sections 7.1, 7.2 (Theorem 7.2.1 only)

Unit V

Solvability by Radicals – A Theorem of Frobenius – Integral Quaternions and the Four-Square Theorem.

Chapter 5: Section 5.7 (Omit Lemma 5.7.1 Lemma 5.7.2 and Theorem 5.7.1).

Chapter 7: Sections 7.3, 7.4

Content and Treatment as in

I. N. Herstein, Topics in Algebra, Second Edition, Wiley India Pvt. Ltd., New Delhi, 2006.

Books for Supplementary Reading and Reference

1. M. Artin, Algebra, Pearson - Prentice Hall, New Delhi, 2007
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second (Indian) Edition, Cambridge University Press, 1997
3. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Narosa Publishing House, New Delhi, 1996
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. II-Rings, Narosa Publishing House, New Delhi,1999
5. D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill (International Edition), New York. 1997
6. N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman and co, USA, 1980

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 7**

Course Title: Real Analysis II **Course Code: 142MT2M02**

Credits: 5 **Hours / Cycle: 6**

Unit I

Measure on the Real Line: Lebesgue Outer Measure – Measurable Sets – Regularity – Measurable Functions – Borel and Lebesgue Measurability.

Chapter 2: Sections 2.1 – 2.5

Unit II

Integration of Functions of a Real Variable: Integration of Non-Negative Functions – The General Integral – Integration of Series – Riemann and Lebesgue Integrals.

Chapter 3

Unit III

Abstract Measure Spaces: Measures and Outer measures – Extension of a Measure – Uniqueness of the Extension – Completion of a Measure – Measure Spaces – Integration with respect to a Measure.

Inequalities and the L^p Spaces: The L^p Spaces – The Inequalities of Holder and Minkowski (Statements only) – Completeness of $L^p(\mu)$.

Chapter 5, Chapter 6: Sections 6.1, 6.4, 6.5 (Section 6.4: Statements of Theorems 7 and 8 only)

Unit IV

Signed Measures and Their Derivatives: Signed Measure and Hahn Decomposition – The Jordan Decomposition – The Radon-Nikodym Theorem – Some Applications of the Radon-Nikodym Theorem.

Chapter 8: Sections 8.1 – 8.4

Unit V

Measure and Integration in a Product Space: Measurability in a Product Space – The Product Measure and Fubini's Theorem – Lebesgue Measure in Euclidean Space.

Chapter 10: Sections 10.1 – 10.3

Content and Treatment as in

G. de Barra, Measure Theory and Integration, New Age International Pvt. Ltd., Publishers, New Delhi, 1981

Books for Supplementary Reading and Reference

1. J.C, Bukill, The Lebesgue Integral, Cambridge University Press, 1951
2. M.E. Munroe, Measure and Integration. Addison Wesley Mass., 1971
3. H.L. Roydon, Real Analysis, Macmillan Publishing Company, New York,1988
4. W. Rudin, Principles of Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1979
5. S. Arora and B. Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 8**

Course Title: Number Theory and Cryptography **Course Code: 142MT2M03**

Credits: 5 **Hours / Cycle: 6**

Unit I

Some Topics in Elementary Number Theory: Time Estimates for Doing Arithmetic – Divisibility and Euclidean Algorithm – Congruences – Some Applications to Factoring.

Chapter I: Sections 1 – 4

Unit II

Finite Fields and Quadratic Residues: Finite Fields – Quadratic Residues and Reciprocity.

Chapter II: Sections 1, 2 (Section 2: Omit square roots modulo p)

Unit III

Cryptography: Some Simple Cryptosystems – Enciphering Matrices

Chapter III: Sections 1, 2

Unit IV

Public Key: The Idea of Public Key Cryptography – RSA – Discrete Log – Knapsack.

Chapter IV: Sections 1 – 4 (Section 3: Omit algorithms for finding discrete logs in finite fields and index-calculus algorithm for discrete logs)

Unit V

Primality: Pseudoprimes

Elliptic Curves: Basic Facts – Elliptic Curve Cryptosystems.

Chapter V: Sections 1 (Up to Proposition V.1.5)

Chapter VI: Sections 1, 2

Content and Treatment as in

N. Koblitz, A Course in Number Theory and Cryptography, Second Edition, Springer-Verlag, New York, 1994

Books for Supplementary Reading and Reference

1. I. Niven, S. Zuckermann and H.L Montgomery, An Introduction to Theory of Numbers, Fifth Edition, Wiley India Pvt. Ltd., New Delhi, 2012

2. D.M. Button, Elementary Number Theory, Seventh Edition, Tata McGraw-Hill Edition, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2012
3. W. Stallings, Cryptography and Network Security Principles and Applications, Sixth Edition, Pearson Education in South Asia, 2014
4. R. D. Stinson, Cryptography Theory and Practice, Discrete Mathematics and its Application Series, Third Edition, Special Indian Edition, 2011
5. S. Vaudenay, A Classical introduction to Cryptography Applications for Communication Security, Springer International Edition, 2009
6. J. Buchmann, Introduction to Cryptography, Undergraduate Text in Mathematics, Second Edition, Springer, 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 9**

Course Title: Java Programming **Course Code: 142MT2M04**

Credits: 4 **Hours / Cycle: 5**

Unit I

Constants, Variables and Data Types – Operators and Expressions.

Chapters: 4, 5

Unit II

Decision Making and Branching – Decision Making and Looping.

Chapters: 6, 7

Unit III

Classes, Objects and Methods – Arrays, Strings and Vectors – Multiple Inheritance.

Chapters: 8, 9, 10

Unit IV

Multithreaded Programming – Managing Errors and Exceptions.

Chapters: 12, 13

Unit V

Applet Programming.

Chapter: 14

Content and Treatment as in

E. Balagurusamy, Programming with Java – A Primer, Tata McGraw-Hill Education Private Ltd., New Delhi, 2010.

Books for Supplementary Reading and Reference

1. M. Waite and R. Lafore, Data Structures and Algorithms in Java, Techmedia (Indian Edition), New Delhi, 1999
2. A. Drozdek, Data Structures and Algorithms in Java, (Brown/Cole), Vikas Publishing House, New Delhi, 2001
3. H. Schildt, Java: The Complete Reference, Eight Edition, Tata McGraw-Hill Education Private Limited, 2011

Computer Laboratory Exercises

1. Design a class to represent a bank Account. Include the following members:

Data Members	Methods
(1) Name of the Depositor	(1) To Assign initial values.
(2) Account Number	(2) To deposit an amount.
(3) Type of account	(3) To withdraw an amount after checking the balance.
(4) Balance	(4) To display the name and balance.

   Write a Java program for handling 10 customers.

2. Java lacks a complex datatype. Write a complex class that represents a single Complex number and includes methods for all the usual operations, ie: addition, subtraction, multiplication, division.

3. Write a Java program to handle different types of exceptions using try, catch and finally statements

4. Write a Java program to implement the behavior of threads.
   (a) To create and run threads.
   (b) To suspend and stop threads.
   (c) To move a thread from one state to another.
   (d) By assigning a prioity for each thread.

5. Write an applet to draw the following shapes: a) Cone b)Cylinder c)Cube d) Square inside a circle e) Circle inside a square.

6. Creating a Java applet which finds palindromes in sentences. Your applet will have two input controls; One input will be a text field for entering sentences, the other input will be a text field or scroll bar for selecting the minimum length a palindrome to be shown. Your applet will output the first 10 palindromes it finds in the sentence.

7. Write a program which displays a text message coming down the screen by moving left to right and modify the above program instead of text moving from left to right it moves top to bottom.

8. Create a frame that contains 3 text fields and four buttons for basic arithmetic operations. You have to enter two numbers in first two text fields. On clicking the respective button that answer should be displayed in the last text filed.

9. Create a frame with check box group containing Rectangle, Circle, Triangle, Square. If the particular value is true then the corresponding shape should be displayed.

Madras Christian College
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Semester: III **Paper: 11**

Course Title: Complex Analysis I **Course Code: 142MT3M01**

Credits: 5 **Hours / Cycle: 6**

Unit I

Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

Local Properties of Analytic Functions: Removable Singularities – Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.

Chapter 4: Sections 2.1 – 2.3, 3.1 – 3.4

Unit II

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions.

The Calculus of Residues: The Residue Theorem – The Argument Principle.

Chapter 4: Sections 4.1 – 4.7, 5.1, 5.2

Unit III

Evaluation of Definite Integrals.

Harmonic Functions: Definition and Basic Properties – The Mean-Value Property – Poisson's Formula.

Chapter 4: Sections 5.3, 6.1 – 6.3

Unit IV

Schwarz's Theorem – The Reflection Principle.

Power Series Expansions: Weierstrass's Theorem – The Taylor Series – The Laurent Series.

Chapter 4: Sections 6.4, 6.5

Chapter 5: Sections 1.1 – 1.3

Unit V

Partial Fractions and Factorization: Partial Fractions – Infinite Products – Canonical Products – The Gamma Function.

Entire Functions: Jensen's Formula – Hadamard's Theorem.

Chapter 5: Sections 2.1 – 2.4, 3.1, 3.2

Content and Treatment as in

L. V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill Book Company, New Delhi, 1979

Books for Supplementary Reading and Reference

1. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa Publishing House, New Delhi, 1978
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing Company, 1995
3. R. Remmert, Theory of Complex Functions, Springer International Edition, 1991
4. T. W. Gamelin, Complex Analysis, Springer International Edition, Springer-Verlag, New York Inc., 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 12**

Course Title: Topology **Course Code: 142MT3M02**

Credits: 5 **Hours / Cycle: 6**

Unit I

Topological Spaces: Topological Spaces – Basis for a Topology – The Order Topology – The Product Topology on $X \times Y$ – The Subspace Topology – Closed Sets and Limit Points.

Chapter 2: Sections 12 – 17

Unit II

Continuous Functions: Continuous Functions – The Product Topology – The Metric Topology.

Chapter 2: Sections 18 – 21

Unit III

Connectedness: Connected Spaces – Connected Subspace of the Real Line – Components and Local Connectedness.

Chapter 3: Sections 23 – 25

Unit IV

Compactness: Compact Spaces – Compact Subspaces of the Real Line – Limit Point Compactness – Local Compactness.

Chapter 3: Sections 26 – 29

Unit V

Countability and Separation Axiom: The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietze Extension Theorem.

Chapter 4: Sections 30 – 35

Content and Treatment as in

J.R. Munkres, Topology, Second (Indian) Edition, PHI Learning Pvt. Ltd., New Delhi, 2000

Books for Supplementary Reading and Reference

1. J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1966
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 1963
3. J.L.R. Kelly, General Topology, Van Nostrand, Reinhold Co., New York, 1955
4. L. Steen and J. Seeback, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 13**

Course Title: Formal Languages and Automata **Course Code: 142MT3M03**

Credits: 4 **Hours / Cycle: 6**

Unit I

Introduction to the Theory of Computation: Three Basic Concepts.

Finite Automata: Deterministic Finite Accepters – Nondeterministic Finite Accepters – Equivalence of Deterministic and Nondeterministic Finite Accepters.

Regular Languages: Regular Expressions – Connection between Regular Expressions and Regular Languages.

Chapter 1: Section 1.2

Chapter 2: Sections 2.1 – 2.3

Chapter 3: Sections 3.1, 3.2

Unit II

Regular Grammars: Regular Grammars.

Properties of Regular Languages: Closure Properties of Regular Languages – Elementary Questions about Regular Languages – Identifying Nonregular Languages.

Chapter 3: Section 3.3

Chapter 4: Sections 4.1 – 4.3

Unit III

Context-Free Languages: Context-Free Grammars – Parsing and Ambiguity

Simplification of Context-Free Grammars and Normal Forms: Methods for Transforming Grammars – Two Important Normal Forms.

Chapter 5: Sections 5.1, 5.2

Chapter 6: Sections 6.1, 6.2

Unit IV

Pushdown Automata: Nondeterministic Pushdown Automata – Pushdown Automata and Context – Free Languages – Deterministic Pushdown Automata and Deterministic Context – Free Languages.

Chapter 7: Sections 7.1 – 7.3

Unit V

Properties of Context-Free Languages: Two Pumping Lemmas – Closure Properties and Decision Algorithms for Context – Free Languages.

Chapter 8

Content and Treatment as in

P. Linz, An Introduction to Formal Languages and Automata, Fourth Edition, Narosa Publishing House, New Delhi, 2007

Books for Supplementary Reading and Reference

1. J.E. Hopcroft and J.D. Ullman, Introduction to Automata Theory, Languages, and Computation, Narosa Publishing House, New Delhi, 1989
2. M. Sipser, Introduction to Theory of Computation, PWS Publishing Company, 1997
3. D. C. Kozen, Automata and Computability, Springer, New York, 1997
4. K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata Theory and Computation, Pearson, New Delhi, 2009

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 16**

Course Title: Complex Analysis II **Course Code: 142MT4M01**

Credits: 5 **Hours / Cycle: 6**

Unit I

Riemann Zeta Function: Product Development – Extension of $\varsigma(s)$ to the Whole Plane – The Functional Equation – The Zeros of the Zeta Function.

Normal Families: Equicontinuity – Normality and Compactness – Arzela's Theorem – Families of Analytic Functions – The Classical Definition.

Chapter 5: Sections 4, 5

Unit II

The Riemann Mapping Theorem: Statement and Proof – Boundary Behaviour – Use of the Reflection Principle.

Conformal Mapping of Polygons: The Behaviour at an Angle – The Schwarz-Christoffel Formula – Mapping on a Rectangle.

A Closer Look at Harmonic Functions: Functions with Mean-Value Property – Harnack's Principle.

Chapter 6: Sections 1, 2, 3 (Section 1: Omit 1.4, Section 2: Omit 2.4)

Unit III

Simply Periodic Functions: Representation by Exponentials – The Fourier Development – Functions of Finite Order.

Doubly Periodic Functions: The Period Module – Unimodular Transformations – The Canonical Basis – General Properties of Elliptic Functions.

Chapter 7: Sections 1, 2

Unit IV

Weierstrass Theory: The Weierstrass $\wp$-functions – The functions $\varsigma(z)$ and $\sigma(z)$ – The Differential Equation – The Modular Function $\lambda(\tau)$ – The Conformal Mapping by $\lambda(\tau)$.

Chapter 7: Section 3

Unit V

Analytic Continuation: The Weirstrass Theory – Germs and Sheaves – Sections and Riemann Surfaces – Analytic Continuations along Arcs – Homotopic Curves – The Monodromy Theorem – Branch Points.

Chapter 8: Section 1

Content and Treatment as in

L.V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill Book Company, New York, 1979

Books for Supplementary Reading and Reference

1. J.B. Conway, Functions of One Complex Variable, Second Edition, Springer-Verlag, International Student Edition, Narosa Publishing Co., 1973
2. T.W. Gamelin, Complex Analysis, Springer-Verlag, New York Inc., 2001
3. R. Remmert, Theory of Complex Functions, Springer International Edition, 1989

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 17**

Course Title: Differential Geometry **Course Code: 142MT4M02**

Credits: 5 **Hours / Cycle: 6**

Unit I

Curves: Curve – Arc-length – Reparametrization.

Curvature: Curvature – Plane Curves – Space Curves.

Chapter 1: Sections 1.1 – 1.3, Chapter 2: Sections 2.1 – 2.3

Unit II

Surfaces: Surface – Smooth Surfaces – Tangents, Normals and Orientability – Examples of Surfaces – Quadric Surfaces – Triply Orthogonal Systems.

Chapter 4: Sections 4.1 – 4.6

Unit III

First Fundamental Form: Lengths of Curves on Surfaces – Isometries of Surfaces – Conformal Mappings of Surfaces.

Chapter 5: Sections 5.1 – 5.4

Unit IV

Curvature of Surfaces: The Second Fundamental Form – The Curvature of Curves on Surfaces – The Normal and Principal Curvatures.

Chapter 6: Sections 6.1 – 6.4

Unit V

Gaussian Curvature: The Gaussian and Mean Curvatures.

Geodesics: Definition and Basic Properties – Geodesic Equations – Geodesics on Surfaces of Revolution.

Chapter 7: Section 7.1, Chapter 8: Sections 8.1 – 8.3

Content and treatment as in

Andrew Pressley, Elementary Differential Geometry, Springer Undergraduate Mathematics Series, Springer, 2001.

Books for supplement reading and reference:

1. T. J. Wilmore, An Introduction to Differential Geometry, Oxford University Press, New Delhi, 1959
2. W. Klingenberg, A Course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1978
3. J.A. Thorpe, Elementary Topics in Differential Geometry, Under Graduate Texts in Mathematics, Springer-Verlag 1979
4. D. Somasundaram, Differential Geometry – A First Course, Narosa Publishing House, 2005

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 18**

Course Title: Functional Analysis **Course Code: 142MT4M03**

Credits: 5 **Hours / Cycle: 6**

Unit I

Banach Spaces: The Definition and Some Examples – Continuous Linear Transformations – The Hahn-Banach Theorem – The Natural Embedding of N in N^{**}.

Chapter 9: Sections 46 – 49

Unit II

The Open Mapping Theorem – The Conjugate of an Operator.

Hilbert Spaces: The Definition and Simple Properties – Orthogonal Complements – Orthonormal Sets.

Chapter 9: Sections 50, 51

Chapter 10: Sections 52 – 54

Unit III

The Conjugate Space H^* – The Adjoint of an Operator – Self-Adjoint Operators – Normal and Unitary Operators – Projections.

Chapter 10: Sections 55 – 59

Unit IV

General Preliminaries on Banach Algebras: The Definition and some Examples – Regular and Singular Elements – Topological Divisors of Zero – The Spectrum – The Formula for Spectral Radius – The Radical and Semi-Simplicity.

Chapter 12: Sections 64 – 69

Unit V

The Structure of Commutative Banach Algebras: The Gelfand Mapping – Applications of the Formula $r(x) = lim\|x^n\|^{1/n}$ – Involutions in Banach Algebras **–** Gelfand-Neumark Theorem.

Chapter 13: Sections 70 – 73

Content and Treatment as in

G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Education Pvt. Ltd., New Delhi, 1963

Books for Supplementary Reading and Reference

1. B.V. Limaye, Functional Analysis, Second Edition, New Age International Pvt. Ltd., 1997
2. M. Thamban Nair, Functional Analysis, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2002
3. H.C. Goffman and G. Fedrick, First Course in Functional Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 1987
4. W. Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973
5. E. Kreyzig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978
6. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House Pvt. Ltd., New Delhi, 2002

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 5**

Course Title: ELECTIVE – 1, Operations Research **Course Code: 142MT2E05**

Credits: 4 **Hours / Cycle: 5**

Unit I

Duality in Linear Programming: Dual Simplex Method.

Linear Programming Problem – Advanced Techniques: Introduction – Revised Simplex Method – Simplex Method verses Revised Simplex Method.

Chapter 5: Section 5.9

Chapter 9: Sections 9.1 – 9.3

Unit II

Integer Programming: Introduction **–** Pure and Mixed Integer Linear Programming Problems – Gomory's All I.P.P. Method – Construction of Gomory's Constraints – Fractional Cut Method – All Integer Programming – Fractional Cut Method-Mixed Integer LPP – Branch and Bound Method.

Dynamic Programming: Introduction – The Recursive Equation Approach – Characteristic of Dynamic Programming – Dynamic Programming Algorithm – Solution of LPP by Dynamic Programming.

Chapters 7: Sections 7.1 – 7.7

Chapter 13: Sections 13.1 – 13.4, 13.7

Unit III

Inventory Control: Introduction – Types of Inventories – Reasons for Carrying Inventories – The Inventory Decisions – Objectives of Scientific Inventory Control – Costs Associated with Inventories – Factors Affecting Inventory Control – An Inventory Control Problem – The Concept of EOQ – Deterministic Inventory Problems with No Shortages – Deterministic Inventory Problems with Shortages.

Chapter 19: Sections 19.1 – 19.11

Unit IV

Queuing Theory: Introduction - Queuing System – Elements of a Queuing System – Operating Characteristics of a Queuing System – Deterministic Queuing System – Probability Distributions in Queuing Systems – Classification of Queuing Models – Definition of Transient and Steady States – Poisson Queuing Systems.

Chapter 21: Sections 21.1 – 21.9 (models VII, VIII and IX are not included)

Unit V

Non-Linear Programming: Introduction – General Non-Linear Programming Problem – Constrained Optimization with Equality Constraints – Constrained Optimization with Inequality Constraints.

Non-Linear Programming Methods: Introduction – Kuhn-Tucker Conditions with Non-Negative Constraints - Quadratic Programming – Wolfe's Modified Simplex Method – Beale's Method.

Chapters 27: Sections 27.1, 27.3 – 27.5 (problems involving mathematical formation are not included).

Chapter 28: Sections 28.1, 28.3 – 28.6

Content and Treatment as in

K. Swarup, P.K. Gupta and M. Mohan, Operations Research, Fifteenth Edition, Sultan Chand & Sons Educational Publishers, New Delhi, 2010

Books for Supplementary Reading and Reference

1 J.K. Sharma, Operations Research Theory and Applications, Second Edition, Macmillan (India) New Delhi, 2005

2 M. Mohan and P.K. Gupta, Problems in Operation Research, Twelfth Edition, Sultan Chand & Sons Educational Publishers, 2009

3 H.A. Taha, Operations Research, Seventh Edition, Prentice-Hall of India Private Limited, New Delhi, 1997

4 F.S. Hiller and J. Lieberman, Introduction to Operations Research, Seventh Edition, Tata McGraw-Hill Company, New Delhi, 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: II **Paper: 5**

Course Title: ELECTIVE – 1, Graph Algorithms and Applications **Course Code: 142MT2E05**

Credits: 4 **Hours / Cycle: 5**

Unit I

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort.

Chapter 22: Section 22.1 – 22.4

Unit II

Minimum Spanning Trees: Growing a Minimum Spanning Tree – The Algorithms of Kruskal and Prim.

Chapter 23: Sections 23.1 - 23.2

Unit III

Single-Source Shortest Paths: The Bellman-Ford Algorithm – Single-Source Shortest Paths in Directed Acyclic Graphs - Dijkstra's Algorithm.

Chapter 24: Sections 24.1 – 24.3

Unit IV

All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication - The Floyd-Warshall Algorithm – Johnson's Algorithm for Sparse Graphs.

Chapter 25: Sections 25.1 – 25.3

Unit V

Maximum Flow: Flow Networks – The Ford-Fulkerson Method - Maximum Bipartite Matching.

Chapter 26: Sections 26.1 – 26.3

Content and Treatment as in

T.H. Cormen, Charles E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2009

Books for Supplementary Reading and Reference

1. S. Dasgupta, C.H. Papadimitriou and U. Vazirani, Algorithms, First Edition, McGraw-Hill Education, 2006
2. U. Manber, Introduction to Algorithms: A Creative Approach, Addison-Wesley, 1989
3. A.V. Aho, J.E. Hopcroft and J.D. Ullman, Data Structures and Algorithms, Addison-Wesley, 1983

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 14**

Course Title: ELECTIVE – 2, Mathematical Statistics **Course Code: 142MT3E04**

Credits: 4 **Hours / Cycle: 5**

Unit I

Random Variables and Distribution Functions: Introduction – Distribution function – Discrete Random Variable – Continuous Random Variable.

Mathematical Expectation: Introduction – Mathematical Expectation of a Random Variable – Expected Value of Function of a Random Variable – Properties of Expectation – Properties of Variance – Covariance.

Chapter 5: Sections 5.1 – 5.4

Chapter 6: Sections 6.1 – 6.6

Unit II

Generating Functions and Law of Large Numbers: Moment Generating function – Cumulants – Characteristic Function – Some Important Theorems – Chebychev's Inequality – Convergence in Probability – Weak Law of Large Numbers – Borel Cantelli Lemma.

Probability Distributions: Rectangular Distribution – Gamma Distribution – Beta Distribution of First Kind – Beta Distribution of Second Kind – Exponential Distribution – Cauchy Distribution – Central Limit Theorems.

Chapter 7: Sections 7.1 – 7.8

Chapter 9: Sections 9.3, 9.5 - 9.8, 9.12, 9.13

Unit III

Large Sample Theory: Introduction – Types of Sampling – Parameter and Statistic – Test of Significance – Procedure for Testing of Hypothesis – Tests of Significance of Large Samples – Sampling of Attributes - Sampling of Variables.

Exact Sampling Distributions: Introduction – Derivation of Chi-Square Distribution – MGF of Chi-Square Distribution – Some Theorems on Chi-Square Distribution – Students' t-Distribution – F-Distribution.

Chapter 14

Chapter 15: Sections 15.1 – 15.4

Chapter 16: Sections 16.1, 16.2, 16.5

Unit IV

Theory of Estimation: Introduction – Characteristics of Estimators – Cramer Rao Inequality – Methods of Estimation – Confidence Interval and Confidence Limits.

Chapter 17: Sections 17.1 – 17.3, 17.6, 17.7

Unit V

Testing of Hypothesis: Introduction – Statistical Hypothesis – Steps in Solving Testing of Hypothesis Problem – Optimum Test under Different Situations – Neymann and Pearson Lemma – Likelihood Ratio Test.

Chapter 18: Sections 18.1 – 18.6

Content and Treatment as in

S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Eleventh Edition, Sultan Chand & Sons, New Delhi, June 2002

Books for Supplementary Reading and Reference

1. M. Fisz**,** Probability and Mathematical Statistics, John Wiley and Sons, New York, 1963
2. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988.
3. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Fifth Edition, Pearson Education Ltd., New Delhi, 2002
4. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, Third Edition, Mc-Graw Hill, Singapore, 1974
5. M.R. Spiegel and L.J. Stephens, Theory and Problems of Statistics (Schaum's Series), Third Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2000.

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 14**

Course Title: ELECTIVE – 2, Computational Geometry **Course Code: 142MT3E04**

Credits: 4 **Hours / Cycle: 5**

Unit I

Line Segment Intersection: An Example: Convex Hulls – Degeneracies and Robustness – Application Domains – Line Segment Intersection – The Doubly-Connected Edge List – Computing the Overlay of Two Subdivisions – Boolean Operations.

Chapter 1: Sections 1.1 – 1.3, Chapter 2: Sections 2.1 – 2.4

Unit II

Polygon Triangulation: Guarding and Triangulations – Partitioning a Polygon into Monotone Pieces – Triangulating a Monotone Polygon.

Chapter 3: Sections 3.1 – 3.3

Unit III

Voronoi Diagrams: Definition and Basic Properties – Computing the Voronoi Diagram – Voronoi Diagram of Line Segments.

Chapter 7: Sections 7.1 – 7.3

Unit IV

Delaunay Triangulations: Triangulations of Planar Point Sets – The Delaunay Triangulation – Computing the Delaunay Triangulation.

Chapter 9: Sections 9.1 – 9.3

Unit V

Quadtrees: Uniform and Non-Uniform Meshes – Quadtrees for Point Sets – From Quadtrees to Meshes.

Chapter 14: Sections 14.1 – 14.3

Content and Treatment as in

Mark de Berg, Otfried Cheong, Marc van Kreveld and Mark Overmars, Computational Geometry – Algorithms and Applications, Third Edition, Springer-Verlag, 2008

Books for Supplementary Reading and Reference

1. F.P. Preparata and M.I. Shamos, Computational Geometry – An Introduction, Springer International Edition, 1985
2. J. O'Rourke, Computational Geometry in C, Second Edition, Cambridge University Press, 1997

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 15**

Course Title: ELECTIVE – 3, Integral Equations and Calculus of Variations

Course Code: 142MT3E05

Credits: 4 **Hours / Cycle: 5**

Unit I

Integral Equations: Introduction – Definition – Regularity Conditions – Special Kinds of Kernels – Eigenvalues and Eigenfunctions – Convolution Integral – The Inner or Scalar Product of Two Functions.

Integral Equations with Separable Kernels: Reduction to a System of Algebraic Equations – Examples – Fredholm Alternative – Examples – An Approximate Method

Chapter 1: Sections 1.1 – 1.6

Chapter 2: Sections 2.1 – 2.5

Unit II

Method of Successive Approximations: Iterative Scheme – Examples – Volterra Integral Equation – Examples – Some Results about the Resolvent Kernel.

Classical Fredholm Theory: The Method of Solution of Fredholm – Fredholm's First Theorem – Examples – Fredholm's Second Theorem – Fredholm's Third Theorem

Chapter 3: Sections 3.1 – 3.5

Chapter 4: Sections 4.1 – 4.5

Unit III

Symmetric Kernels: Introduction – Fundamental Properties of Eigenvalues and Eigen functions for Symmetric Kernels – Expansion in Eigen functions and Bilinear Form – Hilbert-Schmidt Theorem and Some Immediate Consequences – Solution of a Symmetric Integral Equation – Examples.

Singular Integral Equations: The Abel Integral Equation – Examples – Cauchy Principal Value for Integrals – The Cauchy-Type Integrals – The Cauchy-Type Integral Equation on the Real Line.

Chapter 7: Sections 7.1 – 7.6

Chapter 8: Sections 8.1 – 8.5

Content and Treatment as in

R.P. Kanwal, Linear Integral Equations, Academic Press, New York, 1971

Unit IV

The Method of Variations in Problems with Fixed Boundaries: Variation and its Properties – Euler's Equation – Functionals of the form $\int F(x, y_1, y_2, \ldots y_n, y_1', y_2', \ldots y_n')dx$ – Functionals Dependent on Higher Order Derivatives – Functionals Dependent on the Functions of Several Independent Variables – Variational Problems in Parametric Form – Some Applications.

Chapter 6: Sections 1 – 7

Unit V

Variational Problems with Moving Boundaries and Certain Other Problems: An Elementary Problem with Moving Boundaries – The Moving Boundary Problem for a Functional of the form $\int f(x, y, z, y', z')dx$ – Extremals with Corners – One Sided Variations – Field of Extremals – The Function E(x, y, p. y′) – Transforming the Euler's Equations to the Canonical Form.

Chapter 7: Sections 1 – 4

Chapter 8: Sections 1 – 3

Content and Treatment as in

L. Elsgolts, Differential Equations and the Calculus of Variations, Mir Publishers, Moscow, 1973

Books for Supplementary Reading and Reference

1. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice-Hall Inc., New Jersey, 1963
2. A. Jeffrey, Integral Equations: A Short Course, International Textbook Company Ltd., Scotland, 1976

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: III **Paper: 15**

Course Title: **ELECTIVE – 3**, **Discrete Mathematics** **Course Code: 142MT3E05**

Credits: 4 **Hours / Cycle: 5**

Unit I

Mathematical Logic: Statements and Notation – Connectives – Normal Forms.

Chapter 1: Sections 1.1 – 1.3 (Section 1.2: Omit 1.2.5, 1.2.12 – 1.2.15)

Unit II

Mathematical Logic: The Theory of Inference for the Statement Calculus – The Predicate Calculus – Inference Theory of the Predicate Calculus.

Chapter 1: Sections 1.4 – 1.6

Unit III

Lattice and Boolean Algebra: Lattices as Partial Ordered Sets – Boolean Algebra – Boolean Functions.

Chapter 4: Sections 4.1 – 4.3

Content and Treatment as in

J.P. Tremblay, R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 1997.

Unit IV

Coding Theory: Error-Correcting Codes – Linear Codes.

Chapter 11: Section 11.1, 11.2

Unit V

Variable Length and Huffman Codes – Information Theory.

Chapter 11: Sections 11.3, 11.4

Content and Treatment as in

J. Truss, Discrete Mathematics for Computer Scientists, Second Edition, Pearson Education, 1998.

Books for Supplementary Reading and Reference

1. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw-Hill Computer Science Series, 2007
2. C.L. Liu, Elements of Discrete Mathematics, Second Edition, Tata McGraw-Hill Computer Science Series, 1986
3. M.K. Venkataraman, N. Sridharan and N. Chandrasekaran, Discrete Mathematics, The National Publishing Company, 2011

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 19**

Course Title: ELECTIVE – 4, Fluid Dynamics **Course Code: 142MT4E04**

Credits: 4 **Hours / Cycle: 5**

Unit I

Kinematics of Fluids in Motion: Real Fluids and Ideal Fluids – Velocity of a Fluid at a Point – Streamlines and Pathlines; Steady and Unsteady Flows – The Velocity Potential – The Vorticity Vector – Local and Particle Rates of Changes – The Equation of Continuity – Worked Examples – Acceleration of a Fluid – Conditions at a Rigid Boundary.

Chapter 2: Sections 2.1 – 2.10

Unit II

Equations of Motion of a Fluid: Pressure at a Point in a Fluid at Rest – Pressure at a Point in a Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's Equations of Motions – Bernoulli's Equation – Worked Examples – Discussion of the Case of Steady Motion under Conservative Body Forces – Some Flows Involving Axial symmetry – Some Further Aspects of Vortex Motion.

Chapter 3: Sections 3.1 – 3.7, 3.9, 3.12

Unit III

Some Three Dimensional Flows: Introduction – Sources, Sinks and Doublets – Images in a Rigid Infinite Plane – Axi-Symmetric Flows; Stokes's Stream Function.

Chapter 4: Sections 4.1 – 4.3, 4.5

Unit IV

Some Two Dimensional Flows: Meaning of Two-Dimensional Flow – Use of Cylindrical Polar Coordinates – The Stream Function – The Complex Potential for Two-Dimensional Irrotational, Incompressible Flow – Complex Velocity Potentials for Standard Two-Dimensional Flows – Some Worked Examples – The Milne-Thomson Circle Theorem – The Theorem of Blasius.

Chapter 5: Section 5.1 – 5.6, 5.8, 5.9

Unit V

Viscous Flow: Stress Components in a Real Fluid – Relations between Cartesian Components of Stress – Translational Motion of Fluid Element – The Rate of Strain Quadric and Principal Stresses – Some Further Properties of the Rate of Strain Quadric – Stress Analysis in Fluid Motion – Relations between Stress and Rate of Strain – Stress Analysis in Fluid Motion – Relations between Stress and Rate of Strain – The Coefficient of Viscosity and Laminar Flow – The Navier-Stokes Equations of Motion of a Viscous Fluid – Some Solvable Problems in Viscous Flow.

Chapter 8: Sections 8.1 – 8.10

Content and Treatment as in

F. Chorlton, Text book of Fluid Dynamics, CBS Publishers and Distributors, New Delhi, 1985.

Books for Supplementary Reading and Reference

1. S. Swarup, Fluid Dynamics, Krishna Prakashan Media Pvt. Ltd., Meerut, 1976.
2. R.K. Bansal, A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications Pvt. Ltd., New Delhi, 1983.

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 19**

Course Title: ELECTIVE – 4, Theory of Computation **Course Code: 142MT4E05**

Credits: 4 **Hours / Cycle: 5**

Unit I

Turing Machines: The Standard Turing Machine – Combining Turing Machines for Complicated Task – Turing's Thesis.

Other Models of Turing Machines: Minor Variations on the Turing Machine Theme.

Chapter 9

Chapter 10: Section 10.1

Unit II

Turing Machines with More Complex Storage – Non-Deterministic Turing Machines – A Universal Turing Machine – Linear Bounded Automata.

Chapter 10: Sections 10.2 – 10.5

Unit III

A Hierarchy of Formal Languages and Automata: Recursive and Recursively Enumerable Languages – Unrestricted Grammars – Context-Sensitive Grammars and Languages – The Chomsky Hierarchy.

Chapter 11

Unit IV

Limits of Algorithmic Computation: Some Problems that cannot be Solved by Turing Machines – Undecidable Problems for Recursively Enumerable Languages – The Post Correspondence Problem – Undecidable Problems for Context-Free Languages – A Question of Efficiency.

Chapter 12

Unit V

An Overview of Computational Complexity: Efficiency of Computation – Turing Machine Models and Complexity – Language Families and Complexity Classes – The Complexity Classes P and NP-Some NP Problems – Polynomial – Time Reduction-NP-Completeness and an Open Question.

Chapter 14

Content and Treatment as in

P. Linz, An Introduction to Formal Languages and Automata, Fourth Edition, Narosa Publishing House, 2007

Books for Supplementary Reading and Reference

1. J.E. Hopcroft and J.D. Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, 1989
2. M. Sipser, Introduction to Theory of Computation, PWS Publishing Company, 1997
3. D.C. Kozen, Automata and Computability, Springer, New York, 1997
4. K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata Theory and Computation, Pearson, New Delhi, 2009

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 20**

Course Title: ELECTIVE – 5, Fixed Point Theory **Course Code: 142MT4E06**

Credits: 4 **Hours / Cycle: 5**

Unit I

Metric Contraction Principles: Banach's Contraction Principle – Further Extensions of Banach's Contraction Principle – The Caristi-Ekeland Principle – Equivalents of Caristi – Ekeland Principle.

Chapter 3: Sections 3.1 – 3.4

Unit II

Hyperconvex Spaces: Introduction – Hyperconvexity – Properties of Hyperconvex spaces – A Fixed Point Theorem.

Chapter 4: Sections 4.1 – 4.4

Unit III

Normal Structures in Metric Spaces: A Fixed Point Theorem – Structure of the Fixed Point Set – Uniform Normal Structure – Uniform Relative Normal Structure.

Chapter 5: Sections 5.1 – 5.4

Unit IV

Continuous Mappings in Banach Spaces: Introduction – Brouwer's Theorem – Further Comments on Brouwer's Theorem – Schauder's Theorem.

Chapter 7: Sections 7.1 – 7.4

Unit V

Metric Fixed Point Theory: Contraction Mappings – Basic Theorems for Nonexpansive Mappings – A Closer Look at l_1 – Stability Results in Arbitrary Spaces.

Chapter 8: Sections 8.1 – 8.4

Content and Treatment as in

M.A. Khamsi and W.A. Kirk, An Introduction to Metric Spaces and Fixed Point Theory, John Wiley & Sons, INC, 2001

Books for Supplementary Reading and Reference

1. D.R. Smart, Fixed Point Theorems, Cambridge University Press, 1974
2. E. Zeidler, Nonlinear Functional Analysis and its Applications I: Fixed Point Theory, Springer-Verlag, Berlin, 1986
3. S. Singh, B. Watson and P. Srivastava, Fixed Point Theory and Best Approximations: The KKM – map Principle, Kluwer Academic Publishers, 1997
4. K. Goebel and W.A. Kirk, Topics in Metric Fixed Point Theory, Cambridge University Press, Cambridge, 1990

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: IV **Paper: 20**

Course Title: ELECTIVE – 5, Fuzzy Sets and Their Applications **Course Code: 142MT4E07**

Credits: 4 **Hours / Cycle: 5**

Unit I

Fundamental Notions: Introduction – Review of the Notion of Membership – The Concept of a Fuzzy Subset – Dominance Relations – Simple Operations on Fuzzy Subsets – Set of Fuzzy Subsets for E and M Finite – Properties of the Set of Fuzzy Subsets – Product and Algebraic Sum of Two Fuzzy Subsets.

Chapter I

Unit II

Fuzzy Graphs and Fuzzy Relations: Introduction – Fuzzy Graphs – Fuzzy Relations – Composition of Fuzzy Relations – Fuzzy Subsets Induced by a Mapping – Conditioned Fuzzy Subsets – Properties of Fuzzy Binary Relations – Transitive Closure of a Fuzzy Binary Relation – Paths in a Finite Fuzzy Graph.

Chapter II: Sections 10 – **18**

Unit III

Fuzzy Preorder Relations – Similitude Relations – Similitude Subrelations in a Fuzzy Preorder – Antisymmetry – Fuzzy Order Relations – Antisymmetric Relations without Loops, Ordinal Relations, Ordinal Functions in a Fuzzy Order Relations – Dissimilitude Relations – Resemblance Relations – Various Properties of Similitude and Resemblance – Various Properties of Fuzzy Perfect Order Relations – Ordinary Membership Functions.

Chapter II: Sections 19 – **30**

Unit IV

Fuzzy Logic: Introduction – Characteristic Function of a Fuzzy Subset. Fuzzy Variables – Polynomial Forms – Analysis of a Function of Fuzzy Variables. Method of Marinos – Logical Structure of a Function of Fuzzy Variables – Composition of Intervals – Fuzzy Propositions and their Functional Representations – The Theory of Fuzzy Subsets and Theory of Probability.

Chapter III: Sections 31 – 36, 39, 40

Unit V

The Laws of Fuzzy Composition: Introduction – Review of the Notion of a Law of Composition – Laws of Fuzzy Internal Composition. Fuzzy Groupoids – Principal Properties of Fuzzy Groupoids – Fuzzy Monoids – Fuzzy External Composition – Operations on Fuzzy Numbers.

Chapter IV

Content and Treatment as in

A. Kaufmann, Introduction to the Theory of Fuzzy Subsets, Vol. 1, Academic Press, New York, 1975

Books for Supplementary Reading and Reference

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic - Theory and Applications, Prentice Hall, New Delhi, 2001

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: ** **Paper: ****

Course Title: ELECTIVE – ** , Algebraic Topology **Course Code: 142MT*E****

Credits: 4 **Hours / Cycle: 5**

Unit I

The Fundamental Group: Homotopy of Paths – Fundamental Group – Covering Space – The Fundamental Group of the Circle – Retractions and Fixed Points.
Chapter 9: Sections 51 – 55

Unit II

The Fundamental Theorem of Algebra – Borsuk-Ulam Theorem – Deformation Retracts and Homotopy Type – The Fundamental Group of s^n – Fundamental Groups of Some Surfaces.
Chapter 9: Sections 56 – 60

Unit III

The Seifert-van Kampen Theory: Direct Dums of Abelian Groups – Free Products of Groups – Free Groups – The Seifert-van Kampen Theorem – The Fundamental Group of a Wedge of Circles.
Chapter 11: Sections 67 – 71

Unit IV

Classification of Surfaces: Fundamental Groups of Surfaces – Homology of Surfaces – Cutting and Pasting – The Classification Theorem – Constructing Compact Surfaces.
Chapter 12: Sections 74 – 78

Unit V

Classification of Covering Spaces: Equivalence of Covering Spaces – The Universal Covering Space – Covering Transformations – Existence of Covering Spaces
Chapter 13: Sections 79 – 82

Content and Treatment as in

J.R. Munkres, Topology, Second (Indian) Edition, PHI Learning Pvt. Ltd., New Delhi, 2000

Books for Supplementary Reading and Reference

1. M.K. Agoston, Algebraic topology – A First Course, Marcel Dekker, 1962.
2. S. Deo, Algebraic Topology , Hindustan Book Agency, New Delhi, 2003.
3. M. Greenberg and Harper, Algebraic Topology – A First course, Benjamin/Cummings, 1981.
4. C.F. Maunder, Algebraic topology, Van Nostrand, New York, 1970.
5. A. Hatcher, Algebraic Topology, Cambridge University Press, South Asian Edition 2002.
6. W.S. Massey, Algebrai Topology : An Introduction, Springer 1990

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: ** **Paper: ****

Course Title: ELECTIVE – ** , Wavelets **Course Code: 142MT*E****

Credits: 4 **Hours / Cycle: 5**

Unit I

The Discrete Fourier Transform: Basic Properties of the Discrete Fourier Transform – Translation-Invariant Linear Transformations – The Fast Fourier Transform.

Chapter 2: 2.1 to 2.3

Unit II

Wavelets on $\mathbb{Z}_n$: Construction of Wavelets on $\mathbb{Z}_n$: The First Stage – Construction of Wavelets on $\mathbb{Z}_n$: The Iteration Step – Examples and Applications

Chapter 3: 3.1 to 3.3

Unit III

Wavelets on $\mathbb{Z}$: $\ell^2(\mathbb{Z})$ – Complete Orthonormal Sets in Hilbert Spaces – $L^2[-\pi, \pi]$ and Fourier Series – The Fourier Transform and Convolution on $\ell^2(\mathbb{Z})$ – First-Stage Wavelets on $\mathbb{Z}$ – The Iteration Step for Wavelets on $\mathbb{Z}$ – Implementation and Examples

Chapter 4: 4.1 to 4.7

Unit IV

Wavelets on $\mathbb{R}$: $L_2(\mathbb{R})$ and Approximate Identities – The Fourier Transform on $\mathbb{R}$ – Multiresolution Analysis and Wavelets – Construction of Multiresolution Analyses – Wavelets with Compact Support and Their Computation

Chapter 5: 5.1 to 5.5

Unit V

Wavelets and Differential Equations: The Condition Number of a Matrix – Finite Difference Methods for Differential Equations – Wavelet-Galerkin Methods for Differential Equations

Chapter 6: 6.1 to 6.3

Content and Treatment as in

M.W. Frazier, An Introduction to Wavelets through Linear Algebra, Springer-Verlag, Berlin, 1999

Books for Supplementary Reading and Reference

1. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992
2. E. Hernandez and G.Weiss, A First Course in Wavelets, CRC Press, New York,1996
3. D.F. Walnut, Introduction to Wavelet Analysis, Birhauser, 2004

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: ** **Paper: ****

Course Title: ELECTIVE – ** , Commutative Algebra **Course Code: 142MT*E****

Credits: 4 **Hours / Cycle: 5**

Unit I

Rings and Ideals: Recollection and Preliminaries – Prime and Maximal Ideals – Sums, Products and Colons – Radicals – Zariski topology.
Modules and Algebras: Modules – Homomorphisms – Direct Products and Direct Sums – Free Modules.
Chapter 1: Sections 1.0 – 1.4, Chapter 2: Sections 2.1 – 2.4

Unit II

Exact Sequences – Algebras – Fractions – Graded Rings and Modules – Homogeneous Prime and Maximal Ideals.
Polynomial and Power Series Rings: Polynomial Rings – Power series Rings.
Chapter 2: Sections 2.5 – 2.9, Chapter 3

Unit III

Homological Tools: Categories and Functors – Exact Functors – The Functor Hom – Tensor product
Chapter 4: Sections 4.1 – 4.4

Unit IV

Base Change – Direct and Inverse limits – Injective, Projective and Flat Modules.
Tensor, Symmetric and Exterior Algebras: Tensor Product of Algebras – Tensor Algebras – Symmetric Algebra.
Chapter 4: Section 4.5 – 4.7, Chapter 5: Sections 5.1 – 5.3

Unit V

Exterior Algebras – Anticommutative and Alternating Algebras – Determinants.
Chapter 5: Sections 5.4 – 5.6

Content and Treatment as in

Balwant Singh, Basic Commutative Algebra, World Scientific, 2011

Books for supplementary reading and references

1. M.F. Atiyah and I.G. Macdonald, Introduction to Commutative Algebra, Addison- Wesley, Reading, 1969
2. H. Cartan and S. Eilenberg, Homological Algebra, Princeton University Press, Princeton, 1956
3. Gopalakrishnan. N.S, Commutative Algebra, Oxonian Press, New Delhi, 1984.
4. Zariski,O. and Samuel P, Commutative Algebra, Vols. I and II, Springer, New York, 1979.

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: ** **Paper: ****

Course Title: ELECTIVE – ** , Soft Computing **Course Code: 142MT*E****

Credits: 4 **Hours / Cycle: 5**

Unit I

Soft Computing and Neural Networks: Evolution of Computing – Soft Computing Constituents – From Conventional AI to Computational Intelligence – Machine Learning Basics

Unit II

Genetic Algorithms: Introduction to Genetic Algorithms (GA) – Applications of GA in Machine Learning – Machine Learning Approach to Knowledge Acquisition.

Unit III

Neural Networks: Machine Learning Using Neural Network, Adaptive Networks – Feed Forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in Neural Networks.

Unit IV

Fuzzy Logic: Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions-Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

Unit V

Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule based Structure Identification – Neuro-Fuzzy Control – Case Studies.

Content and Treatment as in

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun and Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice – Hall of India, 2003
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic – Theory and Applications, Prentice Hall, 1995
3. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education, 2003

Books for supplementary reading and references

1. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998
2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison Wesley, 1997
3. S. N. Sivanandam, S. Sumathi and S. N. Deepa, Introduction to Fuzzy Logic Using Matlab, Springer, 2007
4. S.N.Sivanandam and S.N.Deepa, Introduction to Genetic Algorithms, Springer, 2007

Madras Christian College
Department of Mathematics
M.Sc. Mathematics (with effect from 2014 – 15)

Semester: ** **Paper: ****

Course Title: ELECTIVE – ** , Computational Biology **Course Code: 142MT*E****

Credits: 4 **Hours / Cycle: 5**

Unit I

Introduction: Sequences in Space – Sequences in Time.

Optimal Pairwise Alignment: Alignment – Biological Interpretation – Scoring Alignment – Amino Acid Substitution Matrices – Number of Possible Alignment – Global Alignment – Shotgun Sequencing and Overlap Alignment – Local Alignment – Affine Gap Costs – Maximizing, Minimizing Scores – Example Applications.

Chapter 1: Sections 1.1, 1.2

Chapter 2: Sections 2.1 – 2.12

Unit II

Biological Sequences and Exact String Matching Problem: Exact String Matching – Naïve Pattern Matching – String Searching – Trees – Set Matching using Keyword Trees – Suffix Trees – Suffix Tree Construction – Suffix Arrays – Repetitive Sequences in Genomics – Detection of Repated and unique Substrings using Suffix Trees – Maximal Repeats – Generalized Suffix Tree – Longest Common Substring Problem – k-Mismatches – Power series Rings.

Chapter 3: Sections 3.1 – 3.14

Unit III

Genome Comparison and Database Searching and M: Global Alignment – Local Alignment – Database Composition – Heuristic, Optimal Alignment Methods – Determining Gene Families – Statistics of Local Alignments – Bit Scores.

Chapter 4: Section 4.1 – 4.7

Unit IV

Multiple Sequence Alignment: Scoring Multiple Alignments – Multiple Alignments by Dynamic Programming – Heuristic Multiple Alignments.

Sequence Profiles and Hidden Markov Models: Profile Analysis – Hidden Markov Models – Profile Hidden Markov Models.

Chapter 5: Sections 5.1 – 5.3

Chapter 6: Sections 6.1 – 6.3

Unit V

Gene Prediction: Gene – Computational Gene Finding – Measuring the Accuracy of Gene Predictions – *Ab initio* methods – Comparative Methods – Problems and Perspectives.

Chapter 7: Sections 7.1 – 7.6

Content and Treatment as in

B. Haubold and T. Wiehe, Introduction to Computational Biology – An Evolutionary Approach, Birkhauser Verlag, 2006.

Books for supplementary reading and references

1. A.M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2002
2. A. Baxevanis, B.F.Francis Quellette, Bioinformatics: A Practical Guide to Analysis of Genes and Proteins, John Wiley and Sons Inc. 1998
3. D. Gusfield. Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology, Cambridge University Press, 1997