Placed at the meeting of
Academic Council
held on 26.03.2018

APPENDIX - AY

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

M.Sc. Mathematics (Semester)
REVISED SYLLABUS

(With effect from the academic year 2018-19 onwards)

1. Introduction of the Programme

The M.Sc., Mathematics programme is expected to be highly beneficial to the student community. The progamme introduces new ideas slowly and carefully in such a manner so as to give the students a good institutive feeling for the subject and develops an interest in the subject to pursue their studies further. It would also prove to be a great asset for those preparing for NET, SET and other competitive exams. One of the amazing features of the twentieth century mathematics has been its recognition of the power of the abstract approach. This has given rise to a large body of new results for problems and has in fact led us to emerging trends in mathematics.

2. Eligibility for admission

A candidate with a pass in B.Sc., Mathematics degree or any other degree accepted by Madurai Kamaraj University as equivalent to B.Sc., Mathematics is eligible to join the course.

2.1 Duration of the Programme : 2 Years

2.2 Medium of Instructions : English

3. Objectives of the Programme

To develop knowledge in basic Mathematics and Mathematical theories so that the students are able to develop skills which enable them to apply mathematical techniques for solving problems and help them to appreciate the depth of mathematical ideas that are useful in other areas. Students undergoing this course will make them serve as good teachers at the U.G level and will also prepare them for pursuing research in areas related to Mathematical Science.

4. Outcome of the Programme

The syllabi for M.Sc., Mathematics have been designed in such a way that the students, when they go out, will be capable of facing the competitive situation prevailing now and getting placement with developed Mathematical Knowledge.

5. Core subject papers

M.Sc., Mathematics programme consists of number of Subjects. The following are the various categories of the courses suggested for the M. Sc., Mathematics programme:

Core Subjects (CS) – 16,

Elective Subjects (ES) – 4,

Non Major subject Elective (NMSE) – 3.(For other major students)

6. Subject Elective Papers

The University shall provide all information related to the Elective Subject in M.Sc., Mathematics to all the students so as to enablethem to choose their Elective Subjects in each semester. The list of elective Papers in each semester is displayed under the Programme structure.

7. Non – Major Elective Papers

The University shall provide all information relating to the Non-Major Elective Subjectwhich is related to competitive examinations in M.Sc., Mathematics, to all the students so as to enablethem to choose their Elective Subjects in third semester. The list of elective Papers of third semester is displayed under the Programme structure.

8. Unitization

Each subject contains five units which are interrelated each other. Not only core subjects, but elective and non-major elective also contain the same.

9. Pattern of semester exam

Internal	-	25 Marks
External	-	75 Marks
Total	-	**100 Marks**

10.Scheme for Internal Assessment

For the M. Sc., Mathematics Degree,the internal assessment marks will be given as below

Tests	-	10 Marks (average of the best two tests)
Assignment	-	5 Marks
Seminar / Group Discussion	-	5 Marks
Peer-Team-Teaching	-	5 Marks
Total	-	**25 Marks**

11. External Exam

- There shall be external examinations at the end of each semester, odd semesters in the month of October / November and even semesters in April / May.
- A candidate, who has not passed the examination, may be permitted to appear in such failed subjects in the subsequent examinations to be held in October / November or April / May. A candidate should get registered for the first semester examination. If registration is not possible, owing to shortage of attendance beyond condonation limit / regulation prescribed OR belated joining OR on medical grounds, the candidates are permitted to move to the next semester. Such candidates shall re-do the missed semester after the completion of the programme.
- Students must have earned 75% of attendance in each course for appearing for the examination. Students who have earned 74% to 70% of attendance have to apply for condonation in the prescribed form with the prescribed fee. Students who have earned 69% to 60% of attendance have to apply for condonation in the prescribed form with the prescribed fee alongwith the Medical Certificate.
- Students who have below 60% of attendance are not eligible to appear for the examination. They shall re-do the semester(s) after the completion of the programme.

- The results of all the examinations will be published through the controller of examination where the students underwent the course as well as through University Website. In the case of private candidates, the results will be published through the Controller of examination in which they took the examinations as well as University Website.

12. Question Paper Pattern

Part – A

Ten questions (No choice)
Two questions from each Unit (Objective type questions) — 10 x 1 = 10 marks

Part – B

Five questions (either or type)
One question from each unit — 5 x 7 = 35 marks

Part – C

Three questions out of five
One question from each unit — 3 x 10 = 30 marks

13. Scheme of Evaluation

The performance of a student in each course is evaluated in terms of percentage of marks with a provision of conversion to grade points. Evaluation of each course shall be done by a continuous internal assessment by the concerned Course Teacher as well as by an end semester examination and both will be consolidated at the end of the course.

A mark statement with

$$CCPA = \frac{\sum(Marks \times Credits)}{\sum(Credits)}$$

wherethe summations cover all the papers appeared up to the current semester.

14. Passing Minimum

A candidate passes the M. Sc., Mathematics by scoring a minimum of 50% (internal + external) in each paper of the course. No minimum marks for internal assessment. External minimum for external assessment is 45% and the external minimum is 34 out of 75.

14.1. Classification

S.No.	Range of CGPA	Class
1.	40 & above but below 50	III
2.	50 & above but below 60	II
3.	60 & above	I

15. Model Questions

One Model question paper is displayed at the end of the regulation.

16. TeachingMethodology

Each subject is designed with lectures/tutorials/seminar/Peer-Team-Teaching / PPT presentation/assignments etc., to meet the effective teaching and the learning requirements.

17. Text Books

List of all the text books is quoted at theend of the syllabus of each subject.

18. Reference Books

The list of all the reference books is followed by the list of text books. This list contains at least two books for each subject.

19. Retotaling and Revaluation Provision

Candidates may apply for retotaling and revaluation within ten days from the date of the result published in the university website along with the required forms and fees.

20. Transitory provision

The candidates of previous scheme may be permitted to write exams in their own schemes up to the examinations of April 2020 as a transitory provision.

Subjects and Paper related websites

All the subject details along with syllabus may be downloaded from the university website **www.mkuniversity.org**

SCHEME OF EXAMINATIONS

S. No	Title of the paper	Credits	Contact Hours	Duration of Exams (in hours)	Marks		
					External	Internal	Total
I	Groups and Rings	5	6	3	75	25	100
	Theory of Riemann Integrations	5	6	3	75	25	100
	Ordinary Differential Equations	4	6	3	75	25	100
	Differential Geometry	4	6	3	75	25	100
	Elective I / From list I	4	6	3	75	25	100
II	Linear Algebra	5	6	3	75	25	100
	Real Analysis	5	6	3	75	25	100
	Classical Mechanics	4	6	3	75	25	100
	Partial differential equations	4	6	3	75	25	100
	Elective II / From list II	4	6	3	75	25	100
III	Topology	5	6	3	75	25	100
	Measure Theory	5	6	3	75	25	100
	Graph Theory	5	6	3	75	25	100
	Probability and Statistics	4	6	3	75	25	100
	Non-Major Elective III / list IV	4	6	3	75	25	100
IV	Functional Analysis	5	6	3	75	25	100
	Number Theory and Cryptography	5	6	3	75	25	100
	Complex Analysis	5	6	3	75	25	100
	Operations Research	4	6	3	75	25	100
	Elective IV / From list III	4	6	3	75	25	100

Elective Subjects for M. Sc., Mathematics

Sem	S.No	Course Title	Credits
I List 1	1	Automata Theory	4
	2	Discrete Mathematics	4
	3	Calculus of Variations	4
II List II	4	Galois Theory	4
	5	Integral Transforms	4
	6	Numerical Methods	4
IV List IV	7	FluidDynamics	4
	8	Fuzzy Sets and Logic	4
	9	Financial Mathematics	4

Non-Major Elective Subjects for M. Sc., Mathematics

Sem	S.No	Course Title	Credits
III List III	1	Statistical Method	4
	2	Quantitative Aptitude	4
	3	Competitive Mathematics	4

Semester	Subject Code	Course Title	Credits
		Major Elective	
I		Automata Theory	4
		Discrete Mathematics	4
		Calculus of Variations	4
		Major Elective	
II		Galois Theory	4
		Integral Transforms	4
		Numerical Methods	4
		Non Major Elective	
III		Statistical Method	4
		Quantitative Aptitude	4
		Competitive Mathematics	4
		Major Elective	
IV		Fluid Dynamics	4
		Fuzzy Sets and Logic	4
		Financial Mathematics	4

FIRST YEAR / SEMESTER I
CORE SUBJECT 1
GROUPS AND RINGS – (5 Credits) / 90Hrs

Subject objective: To study the advance ideas in Group theory like fundamental theorem on finite Abelian groups and polynomial Rings in Ring theory.

Outcome of the subject: This subject helps the students to know about the algebraic structure, develops thinking and improves the mathematical ability.

Unit I :A Counting Principle - Normal subgroups and quotient groups – homomorphism – Automorphism – Cayley's theorem – permutation groups – another counting principle – Sylow's Theorem

Unit II: Direct Products – Finite Abelian Groups

Unit III: Ideals and Quotient Rings – More Ideals and Quotient Rings – The Field of Quotients of an Integral Domain

Unit IV : Euclidean Rings – A particular Euclidean Ring

Unit V: Polynomial Rings – Polynomials over the rational fields – Polynomial rings over commutative rings.

Text Book:

I.N. Herstein , Topics in Algebra - John wiley and sons, Second Edition (2013).

Reference Books:

1. Vijay K Khanna and S.K. BhambriVikas; A course in Abstract Algebra, Publishing House Pvt. Ltd., 3rd Edition, Reprint 2011.
2. Richard M. Foote and David S. Dummit; Abstract Algebra, John Wiley Publications, 2011.

CORE SUBJECT - 2
THEORY OF RIEMANN INTEGRATIONS –(5 Credits) /90Hrs

Subject objective: To make the students familiar with the concept of the construction of realnumber system, metric space and the analytical rudiments such ascontinuity, differentiability and Riemann integrations in the real line.

Outcome of the subject: Students willget a comprehensive idea about the underlying principles of real analysis and Riemann integrations.

Unit-I: Metric Spaces - Compact Sets - Perfect sets - Connected sets, Upper and lower limits – Some special sequences, – Addition and Multiplication of series - Rearrangements of series

Unit- II: Limits of Functions - Continuous Functions - Continuity and Compactness- Continuity and Connectedness - discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Unit- III: The Derivative of a Real Function - Mean Value Theorems – The Continuity of Derivatives – L-Hospital's Rule - Derivatives of Higher Order - Taylor's Theorem- Derivatives of Vector - valued Functions.

Unit- IV: The Riemann-Stieltjes Integral- Definition and Existence of the Integral- Properties of the Integral - Integration and Differentiation - Integration of Vector- valued functions - Rectifiable Curves

Unit V: Improper Riemann integrals - Functions of Bounded variation – Basic properties- Completeness of Metric Spaces - Nowhere dense sets - Construction of Cantor set-Cantor set is uncountable and nowhere dense- Baire Category Theorem- Sequence and Series of functions - Examples - Uniform convergence.

Text Book:
Walter Rudin, Principles of Mathematical Analysis - McGraw Hill International Editions, Mathematics series, Third Edition (1964).

Reference Books:

1. Patrick M. Fitzpatrick, Advanced Calculus, AMS, Pine and Applied UndergraduateTexts, Indian Edition, 2006
2. Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition, 1974

CORE SUBJECT - 3
ORDINARY DIFFERENTIAL EQUATIONS –(5 Credits) / 90Hrs

Subject objective: To provide knowledge of ODE"s, power series solution, special function,existence and uniqueness of solutions of ODE"s.

Outcome of the subject: Distinguish between linear, nonlinear, partial and ordinary differential equations and state the basic existence theorem for1st order ODE'sand use the theorem to determine a solution interval.

Unit I: Second order homogeneous equations, Initial Value Problems, Linear Dependence and Independence, Wronskian and a formula for Wronskian, Non- homogeneous equations of order two.

Unit II: Homogeneous and non-homogeneous equations of order n,Initial Value Problems, Annihilator method to solve non-homogeneous equations, Algebra of constant coefficient operators.

UNIT III: Initial Value Problems for the homogeneous equation, Solutions of the homogeneous equation, The Wronskian and linear independence, Reduction of the order of a homogeneous equation, The non-homogeneous equation, Homogeneous equations with analytic coefficients, The Legendre equation.

UNIT IV: The Euler equation, second order equations with regular singular points- an example, Second order equations with regular singular points – the general case, A convergence proof, The exceptional cases, The Bessel equation, The Bessel equation (continued).

UNIT V: Equations with variables separated, Exact Equations, The method of successive approximations, The Lipschitz condition, Convergence of the successive approximations, Non-local existence of solutions, Approximations and uniqueness of solutions.

Text Book:

E. A. Coddington,An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1987.

Reference Books:

1. G. F. Simmons, Differential Equations with Applications and Historical notes, Tata McGraw-Hill , 2006.
2. S.G. Deo and Raghavendra, Ordinary Differential Equations and Stability Theory, Tata McGraw Hill, 1980.

CORE SUBJECT- 4

DIFFERENTIAL GEOMETRY - (5Credits) / 90Hrs

Subject objective: To introduce the curve in space and to find curvature, torsion of acurve and various applications in differential geometry.

Outcome of the subject: Students willget new ideas and techniques which play a prominent role in current research in global differential geometry.

Unit I: Introductory remarks about space curves, Definition, Arc length, Tangent, Normal and binomial, Curvature and torsion of a curve given as the intersection of two surfaces, contact between curves and surfaces, Tangent surface, involutes and evaluates.

Unit II: Intrinsic equations, fundamental existence theorem for space curves, Helices and Definition of a surface, Curves on a surface, Surfaces of revolution, Helicoids.

Unit III: Metric - Direction coefficients, Families of curves, isometric correspondence, Intrinsic properties, Geodesics, canonical geodesic equations, Normal property of geodesics.

Unit IV: Existence theorems, geodesic parallels, Geodesic curvature, Gauss-Bonnet theorem Gaussian curvature, Surfaces of constant curvature.

Unit V: The Secondfundamental form, principal curvatures, Lines of curvature Developable, Developable associated with space curves, Developable associated with curves on surfaces, Minimal surfaces, Ruled surfaces.

Text Book:

T.G.Willmore, An Introduction to Differential Geometry , Oxford University Press 23rd Impression 2008.

Reference Book :

1. C. E. Weatherburn, Differential Geometry of Three Dimensions, The University Press 1998.
2. D. Somasundaram;Differential Geometry, Narosa Publishing House, 2008

FIRST YEAR / SEMESTER II
CORE SUBJECT - 5
LINEAR ALGEBRA – (5 Credits) / 90Hrs

Subject objective: To study the advance ideas in Vector Space, Linear Transformations and inner product space.

Outcome of the subject: Students will know more concepts in linear algebra and they will help them to develop thinking and improve mathematical ability.

Unit-I: Vector Spaces – Subspaces-Bases and Dimension-Coordinates -Linear transformations-The Algebra of Linear transformations.

Unit-II: Isomorphism-Representation of transformation by matrices-Linear functionals-Annihilators-The transpose of linear transformation.

Unit-III:Determinants-commutative rings-Determinant functions-Permutations and uniqueness of determinants-Properties of determinants.

Unit-IV: Characteristic values and characteristic vectors-Annihilating polynomials – Invariant subspaces.

Unit-V:Inner product-Inner product spaces-Linear functionals and adjoints, Modules.

Text Book:

I. N. Herstein: Topics in Algebra-second edition, John Wiley & Sons, New York, 1999.

Reference books:

1. Jin Ho Kwak and Sungpyo Hong, Linear Algebra, Birkhauser Boston, 1997
2. Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra,Prentice-Hail, 1989.
3. Kenneth Hoffman and Ray Kunze, Linear Algebra, Pearson Education, Second Edition first Indian reprint 2003.

CORE SUBJECT - 6

REAL ANALYSIS –(5 Credits) / 90Hrs

Subject objective: To make the students familiar with the concept of uniform convergence of sequence, double convergence and series, theorems of implicit functions, inverse function and stokes.

Outcome of the subject: Students will have enriched knowledge of the concepts of real analysis and they will get more knowledge in Weierstrauss theorem for algebraic polynomials.

Unit-I: Uniform convergence and Continuity - Uniform convergence and Integration – Uniform convergence and Differentiation - Double sequences and series - Iterated limits – Equicontinuous Families of Functions - Arzela – Ascoli Theorem

Unit- II: The Weierstrauss theorem for algebraic polynomials- The Stone - Weierstrauss Theorem – Power series - The Exponential and Logarithmic Functions - The Trigonometric Functions – Fourier Series - The Weierstrauss theorem for the Trigonometric polynomials- The Gamma Functions.

Unit- III: Functions of Several Variables - Linear Transformation - Differentiation - The Contraction Principle.

Unit- IV: The inverse function Theorem - The Implicit Function Theorem - The Rank Theorem – Determinants.

Unit V: Integrations of Differential forms- Primitive mappings – partition of unity- change of variables – differential forms, Simplexes and chains and Stoke's theorem.

Text Book:

Walter Rudin, Principles of Mathematical Analysis, McGraw Hill International Editions (1976)

Reference Books:

1. Patrick M. Fitzpatrick Advanced Calculus, Amer. Math. Soc. Pure and AppliedUndergraduate Texts, Indian Edition, 2006
2. Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition, 1974

CORE SUBJECT - 7
CLASSICAL MECHANICS (5 Credits) / 90 Hrs

Subject objective: To understand the basic concepts of Lagrangian andHamiltonian approaches to classical mechanics and to study different applications of theseconcepts in the mechanics.

Outcome of the subject: Thisconcept introduces the methods of solving partial differential equation. Students will become familiar with first order and second order linear partial differential equation. A selection of analytic techniques for solving some partial differential equation that frequently occur in applicationsand students will understand Bertrand theorem and Kepler problem in mechanics.

UNIT I: Mechanics of a particle, Mechanics of a system of particles, Constraints

UNIT II:D' Alembert's principle and Lagrange's equations, Velocity- dependent potentials and the dissipation function, Hamilton's principle, Some techniques of the calculus of variations.

UNIT III: Derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholomorphic systems, Advantage of a variational principle, formulation, conservation theorems and symmetry properties.

UNIT IV: Reduction to the equivalent one -body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The Viral theorem.

UNIT V: The differential equation for the orbit and integrable power –law potentials. Conditions for closed orbits (Bertrand's theorem). The Kepler problem: Inverse square law of force. The motion in time in the Kepler problem. The Laplace-Runge-Lenz vector.

Text Book:

H. Goldstein;Classical Mechanics, Second edition, Addison Wesley, New York, 1980.

Reference Books:

1. D. T. Greenwood;Classical Mechanics, Prentice Hall of India Pvt. Ltd. New Delhi, 1979.
2. D. Rutherford; Classical Mechanics, Oliver and Boyd, 1987.

CORE SUBJECT - 8

PARTIAL DIFFERENTIAL EQUATIONS – (5 Credits) / 90Hrs

Subject objective: To provide knowledge of PDE and its various kinds of solving methods.

Outcome of the subject: Students will be able to solve partial differential equations which arise in geometry, physics and applied mathematics.

Unit-I: Formation of PDEs – Solutions of PDEs of first order – Integral surfaces passing through a given curve – The Cauchy problem – Cauchy method of characteristics to first order nonlinear equations – Compatible systems of first order PDEs-Charpit's method.

Unit-II: Classification of second order PDEs into canonical forms-Adjoint Operators-Riemann's method – CF of homogeneous linear PDEs – Methods for finding PI.

Unit-III: Derivation of Laplace equation – The spherical mean-Maximum-Minimum principle – Separation of Variables – Driehlet problem for a rectangle – Neumann problem for a rectangle – Laplace equation in cylindrical coordinates – Laplace equation in spherical coordinates.

Unit-IV: Derivation of the diffusion equation – The elementary solution – Dirac delta function – Separation of Variables – Diffusion equation in cylindrical coordinates – Diffusion equation in spherical coordinates--Maximum-Minimum principle

Unit-V: Derivation of the one-dimensional wave equation – Solution of the one-dimensional wave equation in canonical form – D'Alemberts solution – Separation of Variables for vibrating string – Periodic solution of the wave equation in cylindrical coordinates – Periodic solution of the wave equation in spherical polar coordinates

TextBook :

K. SankaraRao; Introduction to Partial Differential Equations, Third Edition, PHILearning, New Delhi, 2011.

UNIT V: The differential equation for the orbit and integrable power –law potentials, Conditions for closed orbits (Bertrand's theorem), The Kepler problem: Inverse square law of force, The motion in time in the Kepler problem, The Laplace-Runge-Lenz vector.

Text Book:

H. Goldstein;Classical Mechanics, Second edition, Addison Wesley, New York, 1980.

Reference Books:

1. D. T. Greenwood;Classical Mechanics, Prentice Hall of India Pvt. Ltd. New Delhi, 1979.
2. D. Rutherford; Classical Mechanics, Oliver and Boyd, 1987.

CORE SUBJECT - 8

PARTIAL DIFFERENTIAL EQUATIONS – (5 Credits) / 90Hrs

Subject objective: To provide knowledge of PDE and its various kinds of solving methods.

Outcome of the subject: Students will be able to solve partial differential equations which arise in geometry, physics and applied mathematics.

Unit-I: Formation of PDEs – Solutions of PDEs of first order –Integral surfaces passing through a given curve – The Cauchy problem – Cauchy method of characteristics to first order nonlinear equations—Compatible systems of first order PDEs-Charpit's method.

Unit-II: Classification of second order PDEs into canonical forms-Adjoint Operators-Riemann's method—CF of homogeneous linear PDEs —Methods for finding PI.

Unit-III: Derivation of Laplace equation—The spherical mean-Maximum-Minimum principle—Separation of Variables—Drichlet problem for a rectangle—Neumann problem for a rectangle—Laplace equation in cylindrical coordinates—Laplace equation in spherical coordinates.

Unit-IV: Derivation of the diffusion equation—The elementary solution—Dirac delta function—Separation of Variables— Diffusion equation in cylindrical coordinates—Diffusion equation in spherical coordinates--Maximum-Minimum principle

Unit-V: Derivation of the one-dimensional wave equation— Solution of the one-dimensional wave equation in canonical form—D'Alemberts solution —Separation of Variables for vibrating string— Periodic solution of the wave equation in cylindrical coordinates—Periodic solution of the wave equation in spherical polar coordinates

TextBook :

K. SankaraRao; Introduction to Partial Differential Equations, Third Edition, PHILearning, New Delhi, 2011.

References:

1. Ian Sneddon; Elements of Partial Differential Equations, International Student Edition, McGraw-Hill, New Delhi, 1957.
2. W. E. Williams; Partial Differential Equations, Oxford Applied Mathematics and Computing Science Series, Clarendon Press, Oxford, 1980.
3. K. F. Riley and M. P. Hobson; Essential Mathematical Methods for the Physical Sciences, Cambridge University Press, Delhi, 2011.

SECOND YEAR / SEMESTER III

CORE SUBJECT -9

TOPOLOGY –(5 Credits) / 90Hrs

Subject objective: To study the concepts of topological space and the theorems ofUryshon's and Tychonoff.

Outcome of the subject: It will clear the extended concepts of Analysis andthe students will be able to enrich their knowledge of Topology and be able to apply for various areas of mathematics.

Unit I: Types of Topological Spaces and Examples – Basics for a topology – The order topology – The product topology on X x Y – The subspace topology – Closed sets and limits points – Continuous functions.

Unit II: The Product Topology - The metric topology – Connected spaces – Connected subspaces of the real line – Components.

Unit III: Compact spaces – Compact subspaces of the real line – Limit Point Compactness.

Unit IV: Countability axioms – The separation axioms – Normal spaces – The Uryshon's lemma.

Unit V: TheUrysohnmetrization Theorem – Tietz Extension Theorem. – The Tychonoff theorem.

Text Book:

James R.Munkres; Topology (Second Edition), Prentice – Hall of India, Private Ltd, New Delhi, 2006

References:

1. G.F.Simmons; Introduction to Topology and Modern Analysis, Tata McGraw-Hill Edition, New Delhi (2004).
2. S. T. Hu; Introduction to Topology, Tata-McGraw Hill, New Delhi, 1979.

CORE SUBJECT - 10

MEASURE THEORY –(5 Credits) / 90Hrs

Subject objective: To give the comprehensive idea about the underlying principles of Lebesgue measure and its property.

Outcome of the subject: Studentswill be enriched with Lebesgue outer measure, signed measure and its different types of decompositions.

Unit I: Lebesgue Outer Measure, Measurable Sets, Regularity, Measurable Functions, Borel and Lebesgue Measurability

Unit II: Integration of Non-negative functions, The General Integral, Integration of Series, Riemann and Lebesgue Integrals

Unit III: Abstract Measure Spaces, Measures and Outer Measures, Extension of a Measure, Uniqueness of Extension, Completion of a Measure

Unit IV: Measure Spaces, Integration with respect to a measure, The L^p spaces, The inequalities of Holder and Minkowski, Completeness of L^p (□)

Unit V: Signed Measures, Hahn decomposition, The Jordan decomposition, Measurability in a product space, The product measure and Fubini`s theorem

Text book:

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

Reference:

1. Inder K. Rana, An Introduction to Measure and Integration, Narosa, 2007.
2. H. L. Royden, P. M. Fitzpatrick, Real Analysis –Fourth edition, PHI, 2011.

CORE SUBJECT - 11

GRAPH THEORY–(5 Credits) / 90Hrs

Subject objective: To study the graph theoretical concepts and algorithms that help to model real life situations.

Outcome of the subject: Students will gather the graph theoretical knowledge and its application through algorithm.

Unit I: Graphs and simple graphs, Graph isomorphism - The incidence and adjacency matrices, Sub graphs, Vertex degrees, Paths and connectioncycles - The shortest problem, Sperner's lemma.

Unit II: Trees, cut edges and Bonds, Cut vertices, Cayley's formula - The connector problem, Connectivity, Blocks, Construction of Reliable Communication Networks.

Unit III: Euler tours, Hamiltonian cycles – The Chinese postman problem, The travelling salesman problem.

Unit IV: Matchings, Matchings and coverings in Bipartite graphs, Perfect matching – The personnel assignment problem, The optimal assignment problem.

Unit V: Chromatic number, Brook's theorem, Hajo's conjecture, chromatic polynomials, girth and chromatic number, Astorage problem.

Text Book:

J.A Bondy and U.S.R. Murthy, Graph theory with applications, North Holland, 1976.

References:

1. John Clark and D.Allan Holton; Graph Theory World Scientific Publishing Co. Pvt.Ltd, 1991.
2. NarsinghDeo; Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, 1974.

CORE SUBJECT -12

PROBABILITY AND STATISTICS–(5 Credits) / 90Hrs

Subject objective: To develop the skills of the students to understand more concepts in probability and statistics.

Outcome of the subject: Studentscan improve theirproblem solving skillsby using probability and statistics.

Unit I: Probability Set function - Conditional Probability and Independence - Random variables of Discrete type and continuous type - distribution function - its properties - Expectation of a random variable - moment generating function - Chebeshev's inequality.

Unit II: Two random variables - joint density - marginal probability density - conditional distribution, expectation and variance, Independence of two random variables mutual independence and pairwise independence.

Unit III: Discrete distribution Bernoulli, Binomial and related distribution Poisson distribution continuous distributions experimental, gamma and chi square normal bivariate normal distributions.

Unit IV: Sample statistic and parameter concepts Transformation of valuables of discrete and continuous types - methods of distribution function, change of variable (its extension).

Unit V: Order statistics - distributions of order statistic - distributions of X and S^2. expectation of function of random variables limiting distributions - convergence in

probability and in distribution - limiting MGF central limit theorem important results on limiting distribution

Text Book:

Robert V. Hogg and Allen T. Craig: Introduction to Mathematical Statistics, 5th edition, Pearson Education, 2002.

References:

1. I. Miller and M. Miller; Mathematical Statistics with Applications, Seventh Edition, Person Education, 2004.
2. Jun Shao; Mathematical Statistics – Second Edition, Springer; 2003.
3. Vijay K. Rohatgi, A.K. Md. EhsanesSaleh;An Introduction to Probability and Statistics - Second edition, Wiley, 2008.

SECOND YEAR / SEMESTER IV
CORE SUBJECT - 13

FUNCTIONAL ANALYSIS–(5 Credits) / 90Hrs

Subject objective: To study about the Banach space and Hilbert space with its properties.

Outcome of the subject: Students will obtain more skills in analyzingthe basic structure of normed spaces and get knowledge in using classes of functions rather than individual functions.

Unit I: Normed spaces – continuity of linear maps – Hahn Banach theorems

Unit II: Banach Spaces - Uniform boundedness principle – closed graph theorem – open mapping theorem.

Unit III: Bounded inverse theorem - Spectrum of a bounded operator – duals and transposes – duals of $L^p(a,b)$and$C[a,b]$.

Unit IV: Weak and weak* convergence – reflexivity - Compact linear maps – Spectrum of compact operator.

Unit V: Inner product spaces – orthogonal sets – Bounded operators and Adjoints – normal, unitary and self-adjoint operators.

Text Book:

B. V. Limaye; Functional Analysis, New Age International Limited Publishers, New Delhi ,(3rd edition) 2017.

Reference Books:

1. J.B. Conway;A Course in Functional Analysis, 2nd ed., Springer, Berlin, 1990.
2. C. Goffman and G. Pedrick;A First Course in Functional Analysis, Prentice-Hall, 1974.
3. E. Kreyzig; Introduction to Functional Analysis with Applications, John Wiley & Sons, New York, 1978.

CORE SUBJECT - 14

NUMBER THEORYAND CRYPTOGRAPHY–(5 Credits) / 90Hrs

Subject objective: To provide an introduction to analytic number theory and recent topics of cryptography with applications.

Outcome of the subject: The outgoing students will know more about numbers and enrich their knowledge for doing research in number theory.

Unit-I: Introduction-Well Ordering-Induction-Binomial Coefficients-Greatest integer functions-Divisibility-Greatest Common Divisor (GCD)-Euclid's algorithm-GCD via Euclid's algorithm-Least Common Multiple (LCM)-representation of integers.

Unit-II: Introduction-primes counting function-prime number theorem-test of primality-canonical factorization-fundamental theorem of arithmetic-Seive of Eratosthenes-determining canonical factorization of a natural number.

Unit-III: Congruences-equivalence relations-linear congruences-linear Diophantine equations-Chinese remainder theorem-polynomial congruences-modular arithmetic-Fermat's theorem-Wilson's theorem-Fermat number.

Unit-IV: Arithmetic functions-tau functions-Dirichlet product-quadratic residues-Legendre symbols-Gauss lemma-Law of reciprocity.

Unit-V: Cryptography: Introduction-RAS crypto system-encoding and decoding using Euler phi function (public key cryptography).

Text Book:

1. Neville Robbins; Beginning Number Theory, second Edition, Narosa, 2006.
2. Introduction to cryptography emphasis on public key cryptography, material from internet.

Reference Books

1. Tom. M. Apostol; Introduction to Analytic Number theory, Narosa Publishing House, 1998.

2. Ivan Nivan, H.S. Zuckerman and H.L.Montgomery; An Introduction to the theory of Numbers, 5th Ed paperback- International Edition, 1991.

CORE SUBJECT- 15

COMPLEX ANALYSIS – (5 Credits) / 90 Hrs

Subject objective: To provide the knowledge of Analytical functions, conformal mapping and related formulas.

Outcome of the subject: Students will get more ideas about analytic function, complex integration and Riemann mapping theorem.

UNIT I : Analytic functions - Cauchy's theorem for rectangle - Cauchy's theorem for disk - Integral formula - Local properties of analytic functions - Schwartz lemma - Maximum Modulus principle.

UNIT II: Homology - Homologous form of Cauchy's theorem - Calculus of Residues - Contour integration through residues.

UNIT III: Conformality - Normal family - Riemann mapping theorem.

UNIT IV: Properties - The mean-value property - Poisson's Formula - Schwarz's theorem - Harnack's principle.

UNIT V: Meromorphic functions –MittagLeffler's theorem - Partial fraction - Infinite product - Canonical Product - Gamma Functions - Jensen's formula - Order and Genus of an Entire function.

Text Book:

Lars V. Ahlfors; Complex Analysis, McGraw Hill International, Third Edition ,1979.

References:

1. Conway J.B.; Functions of one Complex variables, Springer International Student Edition, Second Edition, 2000.
2. Mathews J.H. and Howell R.W.; Complex Analysis for Mathematics and Engineering, Narosa Publishing House, Third Edition, 1998.
3. E.B. Staff, A.D.Snider; Fundamentals of Complex Analysis with applications to Engineering and Science, Pearson Education, Third Edition, 2008.

CORE SUBJECT -16

OPERATIONS RESEARCH–(5 Credits)/ 90Hrs

Subject objective: To study about the networking models andthe game theory with its solving methods.

Outcome of the subject: Students will be familiar with linear and non-linear programming concepts.

Unit I: Network Models – Minimal spanning tree algorithm – shortest route algorithms – maximal flow problems – critical path calculations – tree and total floats.

Unit II: Advanced Linear Programming, simplex method using the restricted basis – banded variables algorithm – revised simplex method.

Unit III: Game theory – Optimal solution of two-person zero sum games – solution of mixed strategy games – linear programming solution of games.

Unit IV: classical optimization theory – Jacobian method – Lagrangian method – The Newton Raphson – Kahn Tucker conditions

Unit V: Nonlinear Programming Algorithms – separable programming – quadratic programming – geometric programming.

Text Book:

H.A Taha, Operations Research 6th edition, Prentice Hall, New Delhi, 1998

References:

1. F.S. Hiller and G.J.Lieberman; An introduction to operations research, Holden – Day, Inc. San Fransisco, 1973
2. L. Cooper and D. Steiberg, Introduction to methods of optimization, W.B. Saunders company, Philedelphia, 1970

Major Elective List I

AUTOMATA THEORY (4 credits) / 90Hrs

Subject objective: To understand the notion of effective computability by studying Finite Automata, Grammars, Push Down Automata and Languages of PDA

Outcome of the subject: Students will be familiar with various applications of mathematics in practical situation.

Unit I: Why study Automata theory? Introduction to formal proof, Additional forms of proof, Inductive proofs, The central concepts of Automata theory

Unit II: An informal picture of finite automata, Deterministic finite automata, Non-deterministic finite automata, An application: text search, Finite automata with epsilon transitions.

Unit III: Regular expressions, Finite automata and regular expressions, Applications of regular expressions, Algebraic laws of regular expressions.

Unit IV: Proving languages are not regular, Closure properties of regular languages, Decision properties of regular languages, Equivalence and Minimization of automata.

Unit V: Context-free grammars, Parse trees, Applications of context – free grammar, Ambiguity in grammars and languages, Definitions of Push Down Automata, Languages of PDA, Equivalence of PDA's and CFG's, Deterministic PDA.

Text Book:

J.E.Hopcroft, R.Motwani and J.D.Ullman; Introduction to Automata Languages and Computation, II Edition , Pearson Edition, 2001.

Reference Book :

1. P.K.Srimani and S.F.B. Nasir; A text book on Automata theory, Cambridge University press, 2007.
2. J.P.Tremblay and R. Manohar; Discrete Mathematical structures with Applications to Computer Science, McGraw hill education (India) private Limited, 2017.

DISCRETE MATHEMATICS - (4 Credits) / 90 Hrs

Subject objective: To understand the basic foundation about permutation, relations and groups and dominating sets in graph theory.

Outcome of the subject: Students will gather the enumerators for permutation aspects in combinatorial theory, graph theoretical knowledge and its applications.

Unit I: The rules of sum and product – permutations – combinations – distributions of distinct objects – distributions of non-distinct objects – Stirling's formula.

Unit II: Generating functions of combinations – Enumerators for permutations – distributions of distinct objects into non-distinct cells – partitions of integers.

Unit III: Linear recurrence relations with constant coefficients – solution by the technique of generating functions – a special class of non-linear difference equations – recurrence relations with two indices.

Unit IV: Sets – relations and groups – equivalence classes of functions – weight and inventories of functions – Polya's fundamentals theorem.

Unit V: The principle of inclusion and exclusion – the general formula – dearrangements – permutations with restrictions on relative positions

Text Book:

C.L. Liu, Introduction to Combinatorial Mathematics, McGraw hill, 1968.

References:

1. Ralph P. Grimaldi, Discrete and Combinatorial Mathematics, Pearson Education 2011.
2. S. Lipschutz and M.L. Lipson; Discrete Mathematics, McGraw Hill Education (India) Private limited, revised third edition 2016.

CALCULUS OF VARIATIONS – (4 Credits) / 90 Hrs

Subject objective: To Acquire knowledge about Euler equations, functional dependent on higher order derivatives and variational problems in parametric form.

Outcome of the subject: Students will get more ideas about moving boundary value problems and their properties.

Unit I: Variations and its properties, Euler's Equations and functionals of the form $\int_{x_0}^{x_1} F(x, y_1, y_2, \dots, y_n, y_1', y_2', \dots, y_n')dx$

Unit II: Functionals dependent on higher-order derivatives and functions of several independent variables, variational problems in parametric form.

Unit III: Elementary problem with moving boundaries, Moving boundary problem for a functional of the form $\int_{x_0}^{x_1} F(x, y, z, y', z')dx$, extremals with corners, one-sided variations

Unit IV: Filed of extremals, the function $E(x,y,p,y')$, transforming the Euler equations to the canonical form

Unit V: Constraints of the forms $\phi(x, y_1, \dots, y_n) = 0$, and $\phi(x, y_1, \dots, y_n, y_1', \dots, y_n') = 0$, isoperimetric problems.

Text Book:

Lev Elsgolts; Differential equations of the calculus of variations, University Press of the Pacific, 2003.

Reference:

1. Robert Weinstock; Calculus of Variations with applications to Physics and Engineering. Dover Books on Mathematics, 1975.
2. Izrail M. Gelfand, S. V. Fomin; Calculus of Variations, Dover Books on Mathematics, 2003

Major Elective List II

GALOIS THEORY– (4 Credits) / 90 Hrs

Subject objective: To introduce the idea connected to Galois theory and its application.

Outcome of the subject: Students will get more ideas about field theory and extension fields.

Unit I: Conjugate classes, the class equation, Cauchy's and Sylow theorem, Application of Sylow's theorem, Direct Products, Finite Abelian groups.

Unit II: Polynomial rings, The ring of Gaussian integers, Polynomial Rings over the rational field, UFD.

Unit III: Extension fields, Transcendence of e.

Unit IV: Roots of polynomials and more about roots, solvable groups and Nilpotent groups

Unit V: Galois Theory (Section 5.6, 5.7 & 5.8)

Text Book:

I. N. Herstein: Topics in Algebra-second edition, John Wiley & Sons, New York, 1999.

References

1. David S.Dummit, Richard M.Foote;Abstract Algebra - Third edition, Wiley, 2011.
2. John B. Fraleigh; A Fist Course in Abstract Algebra - Seventh edition, Pearson Education; 2014
3. J. J. Gallian; Contemporary Abstract Algebra, Eighth edition, Cengage; 2013.

INTEGRAL TRANSFORMS–(4 Credits) / 90 Hrs

Subject objective: To provide the students an understanding of the basic properties of Laplace and Fourier Transforms.

Outcome of the subject: Students will getdifferent techniques to solve difficult integral problems using various transformation.

Unit I: Calculation of the Laplace transforms of some elementary functions—Rules of manipulation of the Laplace transform—Laplace transforms of derivatives—Periodic functions—The convolution of two functions

Unit II: The diffusion equation in a semi-infinite line—The wave equation in the semi-infinite strip.

Unit III: Fourier transforms–Fourier cosine transforms—Fourier sine transforms—Fourier transforms of derivatives

Unit IV: The calculation of the Fourier transforms of some simple functions (Lemma 1 and Lemma 2 are excluded)— TheFourier transforms of rational functions—The Convolution integral—Parseval's theorem for cosine and sine transforms.

Unit V: Laplace's equation in a half plane—Laplace's equation in an infinite strip—The linear diffusion equation on a semi-infinite line

TextBook:

Ian Sneddon; The uses of integral transforms, McGraw Hill, Delhi, 1972

References:

1. D. Zwillinger; Handbook of Differential Equations, Academic Press, Boston, 1997 (3rd edition).
2. LokenathDebnath and DambaruBhatta; Integral Transforms and Their Applications, Chapman and Hall/CRCChapman and Hall/CRC, Second Edition.

NUMERICAL METHODS– (4 Credits) / 90 Hrs

Subject objective: To develop the skills of solving algebraic,transcendental, differential and integral equations numerically.

Outcome of the subject: The outgoing students will know more about Eigen values and Eigen vectors, Lagrange and Newton Interpolation formula.

Unit I: Introduction- Bisection method - iteration methods based on first degree equation - iteration methods based on second degree equation -methods for complex roots - polynomial equations.

Unit II: Introduction - Direct methods - Error analysis for direct methods - iteration methods - Eigen values and Eigen vectors - Bounds on Eigen values.

Unit III: Introduction - Lagrange and Newton Interpolations - Finite difference operators - Interpolating polynomials using finite differences - Hermite interpolations - piecewise and spline interpolation.

Unit IV: Introduction - Numerical Differentiation - Extrapolation methods - partial Differentiation - Numerical integration - methods based on interpolation - Composite integration methods - Romberg method.

Unit V: Introduction - Difference equations - Numerical methods - Single step methods.

Text Book :

M.K.Jain, S.R.K.Iyengar and R.K.Jain; Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, Fourth Edition, 2013

Reference :

C.F.Gerald and P.O.Wheatly; Applied Numerical Analysis, Addison Wesley, Fifth Edition,1998.

Non-Major Elective Subject List III

Statistical Methods(4 Credits) / 90 Hrs

Subject Objective: To enable the students to learn statistical techniques and toapply statistical techniques to the data collected, analyze and interpret them.

Outcome of the Subject: Students will be able to understand important and various concepts in applied statistics. They will also be able to assess and articulate what type of statistical techniqueis appropriate for a given data and compose the findings from the methods applied for the data.

Unit I: Definition – Importance – Application – Collection of data – Primary and Secondary Data — Sampling design – Types of samples – Statistical errors – Classification of data – Tabulation – Presentation of data – Diagrams (15 hrs)
Unit II: Measures of Central tendency – Mean – Median – Mode – Geometric Mean – Harmonic Mean – Measures of dispersion – Range – Quartile deviation – Mean deviation – Standard deviation.

Unit III: Correlation – Meaning – Types – Scatter diagram – Karl Pearson's co-efficient of correlation– Rank correlation – Concurrent deviation method – Bi-variate frequency distribution. Regression analysis – Uses – Methods of studying regression – Regression lines.

Unit IV: Index numbers – Meaning – Construction of index numbers – Problems – Methods of construction – Test of consistency – Fixed base – Chain base –Base conversion and shifting – Consumer price index – Formula.

Unit V: Time series – Components – Moving average – Methods of least squares – Measurement of seasonal variations – Simple average, Ratio-to-trend method, Ratio-to-moving average method – Link relative method.

Text Book:

R. S. N. Pillai and Bagavathi; Statistics, Theory and Practice, published by S. Chand and Company New Delhi, 2010.

References:

1. Dr. S. P. Gupta; Statistical methods, published by S. Chand & sons, New Delhi, 2014
2. G. C. Beri; Business Statistics, Tata McGraw Hill Edition, 1978.

Quantitative Aptitude(4 Credits) / 90 Hrs

Subject objective: To enable the students to learn basic mathematical concepts required for quantitative aptitude and to solve a question in a fraction of minute by using short-cut methods.

Outcome of the Subject: Students will be able to solve questions asked in quantitative aptitude in a fraction of minute

Unit 1: HCF and LCM of Numbers

Unit 2: Problems on numbers

Unit 3: Problems on Ages

Unit 4: Percentage

Unit 5: Profit and Loss

Text Book:

Dr. R.S.Aggarwal Quantitative Aptitude S.Chand& Company Pvt. Ltd, 2015

References:

1. U. Mohan Rao, Quantitative Aptitude Scitech Publication (India) Pvt Ltd, 2016
2. Arun Sharma; How to prepare for Quantitative Aptitude for the CAT, McGraw Hill Education, 2014.

Competitive Mathematics(4 Credits) / 90 Hrs

Subject objective: To enable the students to learn basic mathematical concepts required for quantitative aptitude and to solve a question easily by using short-cut methods.

Outcome of the Subject: Students will be able to solve questions asked in quantitative aptitude in a fraction of minute and their Intelligent Quotient(IQ) of the students will be increased.

Unit 1: Time and distance

Unit 2: Problems on trains

Unit 3: Simple interest and compound interest

Unit 4: Area

Unit 5: Permutations and combinations

Text Book:

Dr. R.S.Aggarwal Quantitative Aptitude S.Chand& Company Pvt. Ltd, 2015

Reference Book:

1. U. Mohan Rao, Quantitative Aptitude Scitech Publication (India) Pvt Ltd, 2016
2. Arun Sharma; How to prepare for Quantitative Aptitude for the CAT, McGraw Hill Education, 2014.

Major Elective List IV

FLUID DYNAMICS(4 Credits) / 90 Hrs

Subject objective: Todevelop an appreciation for the properties of Newtonian fluids andto study analytical solutions for variety of simplified problems.

Outcome of the Subject: Students will get the knowledge of basic principles of fluid mechanics and they get the ability to analyze the fluid flow problems with the applicationof Bernoulli's theorem.

Unit I: Real fluids and Ideal fluids – velocity of a fluid at a point - Streamlines pathlines -Velocity potential – vorticity vector – equation of continuity – acceleration of a fluid.

Unit II: Equation of motion of a fluid: pressure at a point in a fluid at rest – pressure at a point in a moving fluid – Euler's equations of motion -Bernoulli's Equation, Bernoulli's theorem.

Unit III: Some two-dimensional flows: meaning of two-dimensional flow – stream function - two-dimensional image systems – Milne-Thomson circle theorem – theorem of Blasius

Unit IV: Elements of Thermodynamics: the equations of state of a substance – the first law of thermodynamics – internal energy of a gas – specific heats of a gas – function of state; Entropy – Maxwell's thermodynamics relation

Unit V: Shock waves: formation of shock waves – elementary analysis of normal shock waves – elementary analysis of oblique shock waves – the method of characteristics for two-dimensional, homentropic, irrational flow.

Text Book:

F. Chorlton; Text book of Fluid Dynamics, CBS publishers and Distributors Pvt. Limited, 2004.

References:

1. M. D. Raisinghania; Fluid Dynamics, published by S. Chand, 2003.
2. Michel Rieutord; Fluid Dynamics, Springer International Publishing, 2015.

FUZZY SETS AND FUZZY LOGIC APPLICATIONS(4 credits)

Subject objective: To introduce the concept of uncertainty and fuzziness in logic and to Study fuzzy arithmetic, fuzzy relations and construction of fuzzy sets.

Outcome of the Subject: Students will acquire the knowledge of basic ideas of fuzzy sets and fuzzy logic.

Unit I: Crisp sets and fuzzy sets: Overview of Classical Sets, Membership Function, Height of a fuzzy set – Normal and sub normal fuzzy sets – Support – Level sets, fuzzy points, α–cuts – Decomposition Theorems, Extension Principle.

Unit IIOperation on fuzzy sets: Standard fuzzy operations – Union, intersection and complement – properties De. Morgan's laws - α–Cuts of fuzzy operations.

Unit IIIFuzzy relations: Cartesian Product, Crisp relations – cardinality – operations and properties of Crisp and Fuzzy relations.Image and inverse image of fuzzy sets - Various definitions of fuzzy operations – Generalizations – Non interacting fuzzy sets, Tolerance and equivalence relations.

Unit IVDecision making in Fuzzy environments: General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making – fuzzy ranking methods – fuzzy linear programming.

Unit VApplications: Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.

Text Book:

George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, PHI Leaning Private Limited, New delhi, 2009.

Reference Books:

1. A. K. Bhargava; Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt. limited, 2013.
2. S.Rajasekaran&Y.A.VijaylakshmiPai, Neural Networks, Fuzzy logic and GeneticAlgorithms, Prentice Hall of India.

FINANCIAL MATHEMATICS – (4 Credits)

Subject objective: To impart the knowledge of active and practical use of mathematics which includes stochastical integrals, binomial model, Black-Scholes models and the multi-dimensional Black Scholes models.

Outcome of the Subject: Students will get more examples of asset pricing both from complete and incomplete models.

Unit I: Brownian motion, stochastic integrals, Ito process, Ito formula, Girsanov transformation and martingale representation theorem.

Unit II: Financial markets, derivatives, Binomial model, pricing European and American contingent claim.

Unit III: Definition of the finite market model, first and second fundamental theorems of asset pricing, pricing European contingent claims, incomplete markets, separating hyperplane theorem.

Unit IV: Black-Scholes model, equivalent martingale measure, European contingent claims, European contingent claims, pricing European contingent claims, European call options – Black-Scholes formula, American contingent claims, American call and put options.

Unit V: Multi-dimensional Black-Scholes model, first and second fundamental theorem of asset pricing, form of equivalent local martingale measures, pricing European contingent claims and incomplete markets.

Text Book:

R. J. Williams, Introduction to the Mathematics of Finance, American Mathematical Society, 2006.

Reference :

1. Stephen Garrett, An Introduction to the Mathematics of Finance: A Deterministic Approach, Butterworth-Heinemann Ltd; 2nd Revised edition, 2013.
2. S. M. Ross, An Elementary Introduction to Mathematical Finance, Cambridge University Press; 3rd edition, 2011.
3. MarekCapinski, .Tomasz Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer; 2nd edition 2011.

MODEL QUESTION PAPER

M.Sc. Mathematics

TOPOLOGY

Time : 3 hours

Maximum marks: 75

SECTION – A

Answer All questions **(10 x 1 = 10 Marks)**

1. Name the topology generated by B = $\{x : a < x < b\}$.

   (A) Usual topology (B) upper limit topology

   (C) lower limit topology (D) Digital topology

2. Which of the following subset is connected?

   (A) $A = \{(x, y) : | x^2 - y^2 | \geq 4\}$ of R^2

   (B) $A = \{a, d, e\}$ subset of a topological space (X, τ)

   where $X = \{a, b, c, d, e\}$.

   (C) Real line R with usual topology

   (D) $A = \{x \in R : | x | > 2\}$ as a subset of the real line with usual topology

3. If A is open set and B is closed set

   (A) A-B is open set (B) A-B is closed set

   (C) B-A is open set (D) B-A is not closed set

4. To include a picture in Latex the package used is

   (A) amssymb (B) graphicx

   (C) amsmath (D) amscd

5. The lower limit topology T' on real line R is

   (A) strictly finer than standard topology

   (B) inferior than the standard topology

   (C) finer than the standard topology

   (D) same as standard topology

6. If X is a topological space and f,g: $X \to R$ are continuous functions. Then,

(A) $f + g$ is continuous (B) $f - g$ is continuous

(C) $f.g$ is continuous (D) $\frac{f}{g}$ is continuous provided $g(x) \neq 0$, for all x.

7. If Y is a subspace of X, A is closed in Y and Y is closed in X then,

(A) A is semi-closed in X (B) A is not closed in X

(C) A is not open in X (D) None of the above.

8. Let $X = \{1,2,3,4,5\}, \tau = \{\emptyset, X, \{2\}, \{3,4\}, \{1,3,4\}, \{2,3,4\}, \{1,2,3,4\}\}$ then $Fr\{3\}$ is

(A) {2,3,4,5} (B) {1,2,3,4} (C) {1,3,4,5} (D){1,2,4,5}

9. Let A be a subset of a topological space X and A' be set of all limits. Then closure of A

(A) $\overline{A} = A \cup A'$ (B) $\overline{A} = A \cap A'$

(C) $\overline{A} = A - A'$ (D) $\overline{A} = A^c$

10. Let A be a connected subset of a topological space X. If $A \subset B \subset \overline{A}$, then B is

(A) Connected (B) disconnected

(C) Separable (D) Dense

SECTION : B

Answer all the questions **(5x7=35 Marks)**

11. (a) Prove that $\overline{A} = A \cup A'$

(or)

(b) Let X be a topological space and let $\mathcal{B}$ be basis for a topology on X. Prove that τ equals the collection of all union of elements of $\mathcal{B}$.

12. (a) State and prove Unifrom limit theorem.

(or)

(b) State and Prove The Pasting Lemma

13. (a) Prove that a topological space X is locally connected iff each component of each open subset of X is open .

(or)

(b) Prove that the union of a collection of connected subspaces of X have a point in common is connected.

14. (a) A subset of R is compact iff it is bounded and closed-Prove

(or)

(b) Prove that every metric space having the Balzano-Weiestrass proerty is sequentially compact.

15. (a) Prove that a closed subspace of a Lindeloff space is Lindeloff.

(or)

(b) Prove that the property of being regular is a heriditary property.

SECTION : C

Answer any Three **(3x10=30 marks)**

16. Let X and Y be topological spaces, let $f : X \to Y$. Prove that the following are equivalent:

    (a) f is continuous.

    (b) For every subset A of X, then $f(\overline{A}) \subset \overline{f(A)}$.

    (c) Inverse image of closed set is closed.

17. Prove that R is connected.

18. Show that every regular space with countable basis is normal.

19. (a) Prove that continuous image of a compact space is compct.
    (b) Prove that every compact subspace of Hausdorff space is closed.

20. State and prove Urysohn Lemma.