ANNAMALAI UNIVERSITY

MASTER OF SCIENCE

M.Sc. Mathematics

DEGREE COURSE

UNDER CBCS

(With effect from 2021-2022)

The Course of Study and the Scheme of Examination

Sl. No.	*Study Components* / *Course Title*		*ins. hrs / week*	*Credit*	*Title of the Paper*	*Maximum Marks*		
						CIA	*Uni. Exam*	*Total*
SEMESTER I								
1.	Core	Paper -1	6	5	Algebra-I	25	75	100
2.		Paper -2	6	5	Real Analysis –I	25	75	100
3.		Paper -3	6	4	Ordinary Differential Equations	25	75	100
Internal Elective for same major students (Choose any one)								
4.	Core Elective	Paper-1	6	3	(to choose one out of 3) A. Probability Theory B. Mechanics C. Graph Theory	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
5.	Open Elective	Paper-1	6	3	(to choose one out of 3) A. Basic Mathematics B. Mathematical Foundations C. Mathematical Modeling	25	75	100
			30	**20**		**125**	**375**	**500**
SEMESTER II						*CIA*	*Uni. Exam*	*Total*
6.	Core	Paper-4	6	5	Algebra-II	25	75	100
7.		Paper-5	6	5	Real Analysis –II	25	75	100
8.		Paper-6	6	4	Partial Differential Equations	25	75	100
Internal Elective for same major students (Choose any one)								
9.	Core Elective	Paper-2	5	3	(to choose one out of 3) A. Mathematical Statistics B. Fuzzy Set Theory C. Difference Equations	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
10.	Open Elective	Paper-2	5	3	(to choose one out of 3) A. Fundamentals of Insurance B. Numerical Methods C. Fundamentals of Business Statistics	25	75	100
11.	*Field Study		-	2		100	-	100

12.	Compulsory Paper		2	2	Human Rights & Duties	25	75	100
			30	**24**		**250**	**450**	**700**
SEMESTER III						***CIA***	***Uni. Exam***	***Total***
13.	Core	Paper-7	6	6	Complex Analysis –I	25	75	100
14.		Paper-8	6	5	Topology	25	75	100
15.		Paper-9	6	5	Differential Geometry	25	75	100
Internal Elective for same major students								
16.	Core Elective	Paper-3	6	3	(to choose one out of 3) A. LaTeX B. Discrete Mathematics C. Operations Research	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
17.	Open Elective	Paper-3	6	3	(to choose one out of 3) A. Mathematical Biology B. Quantitative Techniques C. SCILAB	25	75	100
18.	****MOOC Courses**		-	-				100
			30	**22**		**125**	**375**	**600**
SEMESTER IV						***CIA***	***Uni. Exam***	***Total***
19.	Core	Paper-10	5	4	Complex Analysis –II	25	75	100
20.		Paper-11	5	4	Fluid Dynamics	25	75	100
21.		Paper-12	5	5	Functional Analysis	25	75	100
22.	Core	Project	5	5	Project with *viva voce*	100 (75 Project +25 viva)		100
Internal Elective for same major students								
23.	Core Elective	Paper-4	5	3	**(to choose one out of 3)** A. Number Theory and Cryptography B. Advanced Numerical Analysis C. Calculus of Variations and Integral Equations	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
24.	Open Elective (Non-Major)	Paper-4	5	3	**(to choose one out of 3)** A. Mathematical Economics B. Entrepreneurial Development C. Programming in C++	25	75	100
			30	**24**		**125**	**375**	**600**
			120	**90**				**2400**

*** Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registred by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

(i). Head of the respective department

(ii). Mentor

(iii). One faculty from other department

****Mooc Courses**

Inclusion of the Massive Open Online Courses (MOOCs) with zero credits available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

ANNAMALAI UNIVERSITY

MASTER OF SCIENCE

M.Sc. MATHEMATICS

DEGREE COURSE

Syllabus

UNDER CBCS

(With effect from 2021-2022)

Name of the Course	**: Algebra-1**	**Credits**	**: 5**
Paper type	**: Core**	**Hours of teaching**	**: 90 hrs**

Course Objectives

The objectives of the course is to

- study and develop the concepts group action
- learn the importance of Sylow's theorems and its applications
- introducing structure theorem on abelian groups and studying its application
- learn the basic concepts and ideas of modules and its properties
- understand various canonical forms of transformations
- learn about the properties of matrix of transformations.

UNIT-1: Group Theory **18 hours**

Another counting principle - class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, Only First proof) (Chapter 2: Sections 2.11 and 2.12)

UNIT-2: Group Theory (Continuation) **18 hours**

Direct products - Finite abelian groups (Chapter 2: Sections 2.13 and 2.14 (Only Theorem 2.14.1)

UNIT-3:Ring Theory **18 hours**

Polynomial Rings – Polynomials over the Rational Field (Chapter 3: Sections 3.9 to 3.10)

UNIT-4: Modules and Linear Transformations **18 hours**

Modules –LinearTransformations: Nilpotent transformations - Jordan form - rational canonical form. (Chapter 4: Section 4.5, Chapter 6: Sections 6.5to 6.7)

UNIT-5: Linear Transformations **18 hours**

Hermitian, unitary, normal transformations, real quadratic form.

(Chapter 6: Sections 6.10 and 6.11)

Prescribed Book

I.N. Herstein, Topics in Algebra, 2nd Edition. Wiley.1975

Reference Books

1. D.S.Dummit and R.M.Foote. Abstract Algebra. Wiley 2003
2. M. Artin , Algebra, Prentice Hall of India, 1991
3. J.A. Gallian. Contemporary Abstract Algebra. 4th Edition. Narosa Publishing 2011
4. P.B.Battacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra(II Edition) Cambridge University Press, 1997.(Indian Edition)
5. I.S. Luther and I.B.S.Passi, Algebra, Vol.I – Groups(1996), Vol. II Rings, Narosa Publishing House, New Delhi, 1999.
6. L. Smith,Linear transformation: Example and Applications. In: Linear Algebra,Undergraduate texts in Mathematics, Springer, New york. NY, 1998.

E- Materials

1. https://nptel.ac.in/courses/111108098/
2. https://ocw.mit.edu/courses/Lecture-notes/
3. https://mathdoctorbob.org/Algebra.html/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- demonstrate ability to think group actions critically by Cayley's theorem and apply the Sylow's theorems to describe the structure of certain finite abelian groups
- know the internal and external direct product of groups. Also, apply the structure theorem on abelian groups to find the non-isomorphic abelian groups of certain orders.
- check the irreducibility of a given polynomial
- know about module and difference between the algebraic structures, Group, Ring and Module.
- know the Linear transformation in canonical forms. Also, the matrix form of linear transformation and its properties.

Annamalai University, Annamalainagar - 608002

Name of the Programme: M.Sc. Mathematics **Semester: I**
Name of the Course: Real Analysis I **Credits: 5**
Paper type: Core **Hours of teaching: 90hrs**

Course Objectives

The objectives of the course is to

- work comfortably with functions of bounded variation
- study the Riemann - StieltjesIntegration
- study the convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.

UNIT-1: Functions of Bounded Variation **18 hours**

Introduction - Properties of monotonic functions - Functions of bounded variation – Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation. (Chapter - 6 : Sections 6.1 to 6.8)

UNIT-2: The Riemann - Stieltjes Integral **18 hours**

Introduction - Notation - The definition of the Riemann - Stieltjes integral – Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral - Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition. (Chapter - 7 : Sections 7.1 to 7.13)

UNIT-3: The Riemann-Stieltjes Integral **18 hours**

Integrators of bounded variation-Sufficient conditions for the existence of Riemann Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus-Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral-Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign. (Chapter - 7: 7.15 to 7.24)

UNIT-4: Infinite Series and Infinite Products **18 hours**

Absolute and conditional convergence - Dirichlet's test and Abel's test – Rearrangement 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 - Cesarosummability – Infinite products.
(Chapter 8: Sections 8.8, 8.15, 8.17, 8.18, 8.20, 8.21 to 8.26)

UNIT-5: Sequence of Functions **18 hours**

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 - Uniform convergence and Riemann - Stieltjes integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.(Chapter - 9 Sec 9.1 to 9.6, 9.8, 9.10,9.11, 9.13)

Prescribed Book

Tom M. Apostol : Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, (1997).

Reference Books

1. R. G. Bartle, Real Analysis, (1976), John Wiley and sons Inc.
2. W. Rudin, Principle of Mathematical Analysis (1976), McGraw Hill Company, New York.
3. S. C. Malik and SavitaArora, Mathematical Analysis (1991), Wiley Eastern Limited. New Delhi.
4. Sanjay Arora and BansiLal, Introduction to Real Analysis (1991), SatyaPrakashan, New Delhi.
5. A.L. Gupta and N. R. Gupta, Principle of Real Analysis (2003),Pearson Education.

E-Materials

https://ocw.mit.edu/courses/mathematics/18-100a-introduction-to-analysis-fall-2012/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the concept of functions of bounded variation.
- Discuss the Riemann integration
  and to solve its related problems.
- Analyse the sequences and series of function and their limits
- Acquire the knowledge of Infinite Series and Infinite products
- have knowledge of uniform convergence of sequence and series

Annamalai University, Annamalainagar - 608002

Name of the Programme: M.Sc. Mathematics Semester: I

Name of the Course: Ordinary Differential Equations Credits: 4

Paper type: Core Hours of teaching: 90hrs

Course Objectives

The objectives of the course is to

- familiarize students to understand the theory and methods of Ordinary Differential Equations(ODEs).
- prepare students to apply and solve ODEs applications from various emerging technologies.
- introduce the concepts and solving methods of Second and n^{th}order linear differential equations.
- introduce the concepts and solving methods of differential equations with variable coefficients and regular singular point.
- examine the existence and uniqueness of solutions of differentialequations.

UNIT–1: Linear Equations with Constant Coefficients 18 hours

Second order homogeneous equations - Initial value problems for second order - Linear dependence and independence - A formula for the Wronskian -The non - homogeneous equation of order two. (Chapter -2: sections 1 to 6)

UNIT-2: Linear Equations with Constant Coefficients(Continuation) 18 hours

Homogeneous equations of order n - Initial value problems for order n - equations with real constants - Non-homogeneous equations of order n - Annihilator method - Algebra of constant coefficient operators. (Chapter - 2: sections 7 to 12)

UNIT–3: Linear Equations with Variable Coefficients 18 hours

Initial value problems - Existence and Uniqueness theorems - Solutions to solve a non-homogeneous equation – The Wronskian and linear independence - Reduction of the order of homogeneous equations - Homogeneous equation with analytic coefficients - The Legendre- Equation. (Chapter - 3: Sections 1 to 8)

UNIT–4: Linear Equations with Regular Singular Points 18 hours

Euler equation - Second order equations with regular singular points - general and exceptional cases - Bessel equation. (Chapter - 4 : Sections 1 to 4 and 6 to 8)

UNIT-5: Existence and Uniqueness of Solutions to First Order Equations 18 hours

Equation with variables separated - Exact equations - The method of successive approximations - The Lipschitz condition - Convergence of the successive approximations. (Chapter - 5: Sections 1 to 6)

Prescribed Book

Earl A.Coddington, An introduction to ordinary differential equations (Indian Reprint), Prentice- Hall of India Ltd., New Delhi, 2009.

Reference Books

1. Williams E. Boyce and Richard C. DI Prima, Elementary differentialequations and boundary value problems, John Wiley and sons, New York,1967.
2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi,1974.
3. W.T.Reid, Ordinary differential equations, John Wiley and sons, New York,1971.
4. M.D.Raisinghania, Advanced differential equations, S.Chand& Company Ltd. New Delhi,2001.
5. N.N.Lebedev,Specialfunctionsandtheirapplications,PrenticeHallofIndia, New Delhi,1965.

E-Materials:

1. https://www.coursera.org/learn/ordinary-differential-equations
2. https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
3. https://nptel.ac.in/courses/111108081/
4. https://ocw.mit.edu/courses/mathematics/18-034-honors-differential-equations-spring-2009/syllabus/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- solve Second order linear differential equations.
- solve n^{th}order differentialequations.
- solve differential equations with variablecoefficients.
- solve differential equations with regular singularpoints.
- examine the existence and uniqueness of solutions of differentialequations.
- apply ODE problems for real timeapplications.

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : I
Name of the Course : Probability Theory Credits : 3
Paper Type : Internal Elective Hours of Teaching : 90 hrs----------
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Course Objectives:
The objectives of the course is to

- introduce the basic notions of experiments, events, probability, random variables and probability distributions.
- give an insight about the various parameters and measures of the probability distributions.
- educate the characteristic functions and its properties.
- inculcate the special types of discrete and continuous probability distributions.
- indoctrinate the strong theoretical background about the limit theorems and its consequences.

Unit–1: Probability and Random Variables 18 Hours
Random Experiments – Sample Space – Random Events – Probability Axioms – Conditional Probability – Mutual Exclusive Events – Independent Events – Addition and Product Theorems on Probability – Theorem of Total Probability – Baye's Theorem – Random Variables – Probability Mass and Density Functions – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent Random Variables – Functions of Random Variables. (Chapter 1 – Sections: 1.1–1.7 and Chapter 2 – Sections: 2.1–2.9)

Unit–2: Parameters of the Distribution 18 Hours
Mathematical Expectation – Moments – The Chebyshev Inequality – Absolute Moments – Order Parameters – Moments of Random Vectors – Regression of the First and Second Types. (Chapter 3 – Sections: 3.1–3.8)

Unit–3: Characteristic Functions 18 Hours
Properties of Characteristic Functions – Characteristic Functions and Moments – Semi-Invariants – Characteristic Function of the Sum of the Independent Random Variables – Determination of Distribution Function by the Characteristic Function – Characteristic Function of Multidimensional Random Vectors – Probability Generating Functions. (Chapter 4 – Sections: 4.1–4.7)

Unit–4: Speical Probability Distributions 18 Hours
Discrete Probability Distributions: One Point – Two Point – Bernoulli Trails – Binomial – Poisson – Polya – Hypergeometric Distributions – Continuous Probability Distributions: Uniform – Normal – Gamma – Beta – Cauchy – Laplace Distributions.
(Chapter 5 – Sections: 5.1–5.10)

Unit–5: Limit Theorems **18 Hours**

Stochastic Convergence – Bernoulli Law of Large Numbers – Convergence of Sequence of Distribution Functions – Levy-Cramer Theorems – The deMoivre-Laplace Theorem – The Lindeberg-Levy Theorem – LapunovTheroem.

(Chapter 6 – Sections: 6.1–6.4 and 6.6–6.9)

Prescribed Book

M. Fisz, *Probability Theory and Mathematical Statistics*, 3rd Edition,John Wiley and Sons Inc., New York, 1963.

Reference Books:

1. R.B. Ash, *Real Analysis and Probability*, Academic Press, New York, 1972.
2. K.L. Chung, *A Course in Probability*, 2nd Edition, Academic Press, New York, 1974.
3. R. Durrett, *Probability: Theory and Examples*, 5th Edition, Cambridge University Press, New York, 2019.
4. V.K. Rohatgi and A.K.Md.E. Saleh, *An Introduction to Probability Theory and Mathematical Statistics*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1988.
5. B.R. Bhat, *Modern Probability Theory – An Introductory Textbook*, 4th Edition, New Age International Pvt. Ltd., New Delhi, 2014.

E-Materials:

1. https://ocw.mit.edu/resources/res-6-012-introduction-to-probability-spring-2018/
2. https://www.coursera.org/learn/introductiontoprobability
3. https://swayam.gov.in/nd1_noc20_ma18/preview

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- know the basic notions of experiments, events, probability, random variables and probability distributions.
- comprehend the various parameters and measures of the probability distributions.
- understand the characteristic functions and its properties.
- acquire the special types of discrete and continuous probability distributions.
- procure the strong theoretical background about the limit theorems and its consequences.

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : I
Name of the Course : Mechanics Credits : 3
Paper Type : Internal Elective Hours of Teaching: 90 hrs----------
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Objectives:

The objectives of the course is to

- study mechanical systems under generalized coordinate systems.
- study the details of virtual work.
- study energy and momentum.
- studythe concept of Hamilton, Lagrange.

UNIT-1 : Mechanical Systems **18 hours**

The Mechanical system - Generalized coordinates - Constraints - Virtual work – Energy and Momentum.(Chapter 1: Sections 1.1 to 1.5)

UNIT-2 : Lagrange's Equations **18 hours**

Derivation of Lagrange's equations- Examples - Integrals of motion.(Chapter 2: Sections 2.1 to 2.3)

UNIT-3: Hamilton's Equations **18 hours**

Hamilton's Principal - Hamilton's Equation - Other variational principle.
(Chapter 4: Sections 4.1 to 4.3)

UNIT-4: Hamilton-Jacobi Theory **18 hours**

Hamilton Principal function - Hamilton-Jacobi Equation - Separability
(Chapter 5: Sections 5.1 to 5.3)

UNIT-5: Canonical Transformation **18 hours**

Differential forms and generating functions - Lagrange and Poisson brackets. (Chapter 6: Sections 6.1 to 6.3 (Omit section 6.2))

Prescribed Book

D. T. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.

Reference Books:

1. H. Goldstein, *Classical Mechanics,* (2nd Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co., New York, 1970.

E-Materials:

https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- know mechanical systems under generalized coordinate systems.
- know the Derivation of Lagrange's equations.
- know the Hamilton's Principle.
- know the Hamilton-Jacobi Equation and separability.
- know the Lagrange and Poisson brackets.

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : I
Name of the Course : Graph Theory Credits : 3
Paper Type : Internal Elective Hours of Teaching: 90 hrs-----
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Course Objectives:

The objectives of the course is to

- study and develop the basic concepts of Graphs
- know the properties of graph theory
- understand various applications of certain topics of graph theory
- formulate and prove central theorems about trees, matching, connectivity, coloring and planarity of graphs.
- apply the graph theoretical approach to solve the problems that are modeled as graphs

UNIT-1: Graphs, Subgraphsand Trees 18 hours

Graphs - Graph Isomorphism - The Incidence and Adjacency Matrices - Subgraphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices- Cayley's formula- Application: The shortest path problem (Chapter 1: Section 1.1 - 1.8, Chapter 2: Section 2.1 - 2.4)

UNIT-2: Connectivity, Euler Tours and Hamilton Cycles 18 hours

Connectivity - Blocks - Euler tours - Hamilton Cycles. Application: The travelling Salesman Problem(Chapter 3: Section 3.1 - 3.3, Chapter 4: Section 4.1 - 4.2)

UNIT-3: Matchings, Edge Colourings 18 hours

Matchings - Matchings and Coverings in Bipartite Graphs –Perfect matchings- Edge Colourings: Edge Chromatic Number - Vizing's Theorem. Application: Optimal Assignment Problem. (Chapter 5: Section 5.1 – 5.3, 5.5,Chapter 6:Section 6.1 - 6.2)

Unit-4: Independent Sets and Cliques, Vertex Colourings 18 hours

Independent sets - Ramsey's Theorem – Vertex Colourings: Chromatic Number - Brooks' Theorem – Hajos Conjecture- Chromatic polynomial. (Chapter 7: Section 7.1 – 7.2 Chapter 8: Section 8.1 – 8.2, 8.4)

UNIT-V: Planar Graphs 18 hours

Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture- Directed graphs.

(Chapter 9:Section 9.1 - 9.6(Omit 9.4, 9.5) and Chapter 10: Section 10.1)

Prescribed Book

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

Reference Books:

1. NarsinghDeo, Graph Theory with applications to engineering and computer science, Prentice Hall of India, New Delhi,2001.
2. G.Chartrand and L.Lesniak, Graphs and Digraphs, Chapman and Hall, CRC, fourth edition, 2005.
3. R.J. Wilson, *Introduction to Graph Theory*, Pearson Education, 4th Edition, 2004, Indian Print. S
4. A. Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.
5. J. Clark and D.A. Holton ,*A First look at Graph Theory*, Allied Publishers, New Delhi, 1995.
6. A. Gibbons, *Algorithmic Graph Theory*, Cambridge University Press, Cambridge, 1989.

E- Materials

https://nptel.ac.in/courses/111106050/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- grasp features and properties of special graphs
- check the given graph is Eulerian or not. Also able to find the Eulerian circuit and Hamiltonian paths of the given graph.
- find the matching/perfect matching, connectivity of given graphs
- find independent sets and chromatic number of a given graph
- apply coloring and planarity of graphs in real life problems.

Annamalai University, Annamalainagar - 608002

Name of the Programme:MA/M.Sc/M.Com Semester : I
Name of the Course : Basic Mathematics Credits : 3 Paper Type : Non-Major Elective Hours of Teaching: 90hrs----------
----------Course Objectives:

The objectives of the course is to

- studyexponential and logarithmic series
- understandabout matrices and its applications
- formulate and solve the partial differential equations
- apply the results on Laplace transform
- learn the techniques on Fourier series.

Unit – 1: Exponential and Logarithmic series 18 hours

Exponential series – Logarithmic series (Chapter 1: Section 1.1 – 1.2)

Unit – 2: Matrices 18 hours

Determinant of a matrix – Characteristic equation of a matrix – Characteristic vectors of a matrix – Cayley-Hamilton Theorem – Inverse of a matrix. (Chapter 4: Section 4.1 – 4.5)

UNIT-3: Partial Differential Equations 18 hours

Elimination of arbitrary constants – Elimination of arbitrary functions – Standard forms – Lagrange's Equations. (Chapter 9: Section 9.1 – 9.4)

UNIT-4: Laplace transforms 18 hours

Properties of Laplace transform – Inverse Laplace transform – Partial Fractions. (Chapter 10: Section 10.1 – 10.3)

Unit-5: Fourier Series 18 hours

Properties of Integration – Odd and Even Functions – Half Range Fourier Series. (Chapter 11: Section 11.1 – 11.3)

Prescribed Book

G. Britto Antony Xavier, V. Balaji, S.U. Vasantha Kumar, B. Govindan, Mathematical Sciences, Jayalakshmi Publications, 2-e, 2015.

Reference Books:

1. P. Balasubramaniyam, K. G. Subramanian, Ancillary Mathematics, Volume – I, Tata McGraw – Hill publishing company limited, New Delhi, 1996.
2. P. DuraiPandian, S. UdayaBaskaran, Allied Mathematics, Volume – I, Muhil publishers, 1st Edition, Chennai, 1997.
3. P.Kandsamy and K. Thilagavathy, Allied Mathematics volume – I, Volume – II, S. Chand & Company, New Delhi, 2004.
4. Shanti Narayan, P.K.Mittal, Differential Calculus, S.Chand& Co, New Delhi, 2005.
5. A.Singaravelu, Allied Mathematics, Meenakshi Agency, Chennai, 2001.
6. P.R.Vittal, Allied Mathematics, Margham Publications, Chennai, 1999.

E- Materials

http://mathforum.org/library/drmath/sets/elem_2d

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- Acquire the knowledge ofexponential and logarithmic series
- understanding about matrices and its applications
- formulate and solve the partial differential equations
- apply the results on Laplace transform
- learn the techniques on Fourier series.

Annamalai University, Annamalainagar - 608002

Name of the Programme : MA/M.Sc/M.Com **Semester : I**
Name of the Course : Mathematical Foundations **Credits : 3**
Paper Type : Non-Major Elective **Hours of Teaching: 90hrs**------
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Course Objectives:

The objectives of the course is to

- make the students familiar in Mathematics which are essential for developing computer applications

Unit - 1: Symbolic Logic **18 hours**

Proposition, Logical operators, conjunction, disjunction, negation, conditional and bi – conditional operators, converse, inverse, contra positive, logically equivalent, tautology and contradiction, Arguments and validity of argument.

(Chapter 1: Sections 1.1 – 1.5)

Unit - 2: Set Theory **18 hours**

Set, Set operations, Venn diagram, Properties of sets, number of elements in a set, Cartesian product, relation & functions, Relation : Equivalence relation. Equivalence class, Partially and Totally ordered sets, Functions : Types of Functions, Composition of Functions.

(Chapter 2: Sections 2.1 – 2.8)

Unit - 3: Binary Operations **18 hours**

Types of Binary operations: Commutative, Associative, Distributive and identity, Boolean algebra: properties, Permutations and combinations.

(Chapter 3: Sections 3.1 – 3.3)

Unit - 4: Differentiation **18 hours**

Simple problem using standard limits, $\lim_{x\to a}\frac{x^n-a^n}{x-a}$,$\lim_{x\to 0}\frac{\sin x}{x}$, $\lim_{x\to 0}\frac{\tan x}{x}$,$\lim_{x\to 0}e^x$, $\lim_{n\to 0}(1+1/n)^n$ /n, $\lim_{n\to 0}(1+n)^{1\backslash n}$, Differentiation, successive differentiation, Leibnitz theorem, partial differentiation Applications of differentiation, Tangent and normal, angle between two curves, Maximum and minimum values [second derivative test], curvature and radius of curvature [Cartesian coordinates], Envelopes.

(Chapter 4**:** Sections 4.1 – 4.9)

Unit - 5: Two Dimensional Analytical Geometry **18 hours**

Straight lines – pair of straight lines – circles – System of Circles – Conics [parabola, Ellipse and Hyperbola].

(Chapter 5: Sections 5.1 – 5.5)

Prescribed Book

U. Rizwan, Mathematical Foundations Volume I, Nelliappar Publications, Chennai. 2017

Reference Books:

1. P.R Vittal, Mathematical Foundations, Margham Publication, Chennai.
2. V.Sundaram& others, Discrete Mathematical Foundations,A.P.Publication, Sirkali
3. P.Duraipandian& Others, Analytical Geometry of 2 and 3 Dimensions, Emerald Publication 1992 Reprint.

E- Materials

http://www.mathfoundation.com

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand mathematical logical operators.
- gain knowledge in set theory, binary operations with some problems.
- solve problems on applications of differentiation and two dimensional geometry.

Annamalai University, Annamalainagar - 608002

Name of the Programme :MA/M.Sc/M.Com **Semester : I**
Name of the Course : Mathematical Modeling **Credits : 3**
Paper Type : Non-Major Elective **Hours of Teaching:90 hrs**----------
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Course Objectives:

The objectives of the course is to

- provide an introduction to modelling and simulation
- solve and interpret real life problems using different Mathematical perspectives.

Unit- 1: Mathematical Modelling through Systems of Ordinary differential Equations of theFirst Order **18 hours**

Mathematical modelling in population dynamics, Mathematical modelling of epidemicsthrough systems of ordinary differential equations of first order – MathematicalModels in Medicine, Arms Race, Battles and international Trade in terms of Systemsof ordinary differential equations - Mathematical modelling in dynamics throughsystems of ordinary differential equations of first order.(Chapter 3: 3.1, 3.2, 3.5, and 3.6)

Unit -2: Mathematical Modelling through difference equations **18 hours**

The need for Mathematical modelling through difference equations - some simplemodels - Basic theory of linear difference equations with constant coefficients -Mathematical modelling through difference equations in economics and finance(Chapter 5: 5.1 to 5.3)

Unit-3: Mathematical Modelling through difference equations (contd.) **18 hours**

Mathematical modelling through difference equations in population dynamics andgenetics.Mathematical Modelling through difference equations in probability theory.Miscellaneous examples of Mathematical modelling through difference equations(Chapter 5: 5.4 to 5.6)

Unit -4: Mathematical modelling through Graphs **18 hours**

Situations that can be modeled through graphs - Mathematical models in terms ofdirected graphs - Mathematical models in terms of signed graphs – Mathematicalmodels in terms of weighted graphs.(Chapter 7: 7.1 to 7.4)

Unit- 5: Mathematical Modelling through calculus of Variations and Dynamic Programming **18 hours**

Optimization principles and techniques - Mathematical modelling through calculus ofvariations - Mathematical Modelling through dynamic programming.(Chapter 9: 9.1 to 9.3)

Prescribed Book

J. N. Kapur, Mathematical Modelling, Willey Eastern Limited, Reprint, 2000.

Reference Books:

1. D. J. G. James and J. J. Macdonald, Case studies in Mathematical Modelling, StanlyThames, Cheltonham.

2. M. Crossand A. O. Moscrcadini, The art of Mathematical Modelling, EllisHarwood and John Wiley.
3. C. Dyson, Elvery, Principles of Mathematical Modelling, Academic Press, NewYork.
4. D. N. Burghes, Modelling with Difference Equations, Ellis Harwood and JohnWiley.

E- Materials

http://www.mathfoundation.com

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand concept of modelling and simulation
- construct mathematical models of real world problems
- solve the mathematical models using mathematical techniques

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics **Semester : II**
Name of the Course : Algebra - II **Credits : 5**
Paper Type : Core **Hours of Teaching : 90hrs-----**

Course Objectives:

The objectives of the course is to

- attain depth knowledge about the algebraic structure of fields
- learn the concepts of fields, existence and properties of extension fields of polynomials
- provide the use of Galois Theory in discussing the existence of roots of the polynomials.
- learn about the finite fields and the important theorem related to division rings
- learn the Linear Algebra and apply them in various fields of Engineering and Technology.

Unit-1: Field Theory **18 hours**

Extension fields - Transcendence of e.(Chapter 5: Section 5.1 and 5.2)

Unit-2: Polynomials and Roots **18 hours**

Roots of Polynomials.- More about roots (Chapter 5: Sections 5.3 and 5.5)

Unit-3: Galois theory **18 hours**

Elements of Galois theory. (Chapter 5 : Section 5.6)

Unit-4: Finite Fields **18 hours**

Solvability by Radicals - Finite fields - Wedderburn's theorem on finite division rings.

(Chapter 5: Section 5.7, Chapter 7: Sections 7.1 and 7.2 (Only Theorem 7.2.1))

Unit-5: Solvability by Radicals **18 hours**

A theorem of Frobenius - Integral Quaternions and the Four -Square theorem.
(Chapter 7 : Sections 7.3 and 7.4)

Prescribed Book

I.N. Herstein, Topics in Algebra, 2nd Edition. Wiley.1975

Reference Books:

1. D.S.Dummit and R.M.Foote. *Abstract Algebra*. Wiley 2003
2. M. Artin ,*Algebra*, Prentice Hall of India, 1991J.A. Gallian. *Contemporary Abstract Algebra*. 4th Edition. Narosa Publishing 2011
3. P.B.Battacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra*(II Edition) Cambridge University Press, 1997.(Indian Edition)
4. I.S. Luther and I.B.S.Passi, *Algebra*, Vol.I – Groups(1996), Vol. II *Rings*, Narosa Publishing House, New Delhi, 1999.

5. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, Second Indian Reprint 2006, Springer Verlag, Newyork
6. L. Smith(1998). Linear transformation: Example and Applications. In: Linear Algebra, Undergraduate texts in Mathematics, Springer, New york. NY.

E- Materials

1. https://www.jmilne.org->FTe6
2. https://www.jmilne.org>math
3. www.math.iitb.ac.in->Lecnotes

E-Videos

1. https://nptel.ac.in/courses/111108098/
2. https://ocw.mit.edu/courses/Lecture-notes/
3. https://mathdoctorbob.org/Algebra.html/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- demonstrate ability to find the extension field of polynomials. Also, gets the clear understanding of algebraic extensions and algebraic closures.
- work with the consequences of Galois Theory such as insolubility of certain classes of equations.
- work with finite fields and certain important theorems related to Finite division ring
- use of Frobenius integral quaternions and the Four square theorem.

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : II
Name of the Course : Real Analysis - II Credits : 5 Paper Type : Core Hours of Teaching : 90hrs----------
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Course Objectives

The objectives of the course is to

- understand the concepts like measure on the real line, Lebesguemeasurability and integrability
- study Fourier Series and Integralsin depth
- study multivariable calculus.
- know the Lebesgue Integral

Unit–1:Fourier Series and Fourier Integrals 18 hours

Introduction – Orthogonal system of functions – The theorem on best approximation –The Fourier series of function relative to an orthonormal system – Properties of Fourier Coefficients– The Riesz-Fischer Theorem – The convergence and representation problems for trigonometric series – The Reimann-Lebesgue Lemma – The Dirichlet Integrals – An Integral representation for the partial sums of Fourier series –Reimann's localization theorem– Sufficient conditions for convergence of a Fourier Series at a particular point – Cesarosummability of Fourier series – Consequences of Fejes's theorem –The Weiestrass approximation theorem. (Textbook 1: Chapter 11**:** Sections 11.1 to 11.15)

Unit–2:Multivariable Differential Calculus 18 hours

Introduction – The Directional derivative – Directional derivative and continuity – The total derivative – The total derivative expressed in terms of partial derivatives –An Applications to Complex – Valued Functions -The matrix of linear function– The Jacobian matrix – The chain rule – Matrix form of chain rule – The mean-value theorem for differentiable functions – A sufficient condition for differentiability– A sufficient condition for equality of mixed partial derivatives – Taylor's theorem for functions of $R^n$to R^1.

(Textbook 1: Chapter 12**:** Sections 12.1 to12.14)

Unit–3: Implicit Functions and Extremum Problems 18 hours

Introduction- Functions with non-zero Jacobian determinants – The inverse function theorem –The Implicit function Theorem –Extrema of real valued functions of one variable and several variables –Extremum problems with side conditions. (Textbook 1: Chapter 13**:** Sections 13.1 to 13.7)

Unit-4: The Lebesgue Integral **18 hours**

Length of open sets and closed sets – Inner and outer measure : Measurable sets – Properties of measurable sets – Measurable functions – Definition and existence of the Lebesgue integral for bounded function.(Textbook 2: Chapter 11: Sections 11.1 to 11.5)

Unit -5: The Lebesgue Integral(Cont.) **18 hours**

Properties of the Lebesgue integral for bounded measurable functions – The Lebesque integral for unbounded functions – Some fundamental theorems – The metric space $L^2[a, b]$. (Textbook 2: Chapter 11: Sections 11.6 to 11.9)

Prescribed Books

1. Tom M. Apostol, Mathematical Analysis (Second Edition) (1981), Addison – Wesley Publishing Company Inc. New York, (for units I, II& III).
2. Richard R. Goldberg, Methods Of Real Analysis (1975), Oxford & IBH Publishing, New Delhi (for Unit IV & V).

Reference Books:

1. J. C. Burkill, TheLebesgue Integral (1951), Cambridge University Press.
2. M. E. Munroe, Measure And Integration (1971), Addison–Wiley.
3. H. L. Roydon, Real Analysis (1988), Macmillan Pub. Company, New York.
4. W. Rudin, Principles of Mathematical Analysis (1979), McGraw Hill Company, New York.
5. S. C. Malik and SavitaArora, Mathematical Analysis (1991), Wiley Eastern Limited, New Delhi.
6. Sanjay Arora and BansiLal, SatyaPrakashan, Introduction To Real Analysis, (1991), New Delhi.

E-Materials:

https://ocw.mit.edu/courses/mathematics/18-100b-analysis-i-fall-2010/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the concept of Fouier series and Fourier integrals
- analysethe functions of several variables.
- discuss the inverse function theorem and implicit function theorem
- acquire the knowledge of Lebesgue measure
- analyse the concept of inner and outer measure

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : II
Name of the Course: PartialDifferentialEquations Credits : 4 Paper Type : Core Hours of Teaching : 90hrs----------
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Course Objectives

The objectives of the course is to

- familiarize students to understand the theory and methods of PartialDifferential Equations (PDEs).
- prepare students to apply and solve PDEs applications from variousemerging technologies.
- introduce the concepts and solving methods of First and second orderpartial differentialequations.
- introduce the concepts and solving methods of Elliptical, paraboloid, hyperbolic differentialequations.
- examine the existence and uniqueness of solutions of differentialequations

Unit- 1: Partial Differential Equations of First Order 18 hours

Formation and solutions of first order PDE – Integral surfaces – The Cauchy problem for first order equation –Orthogonal surfaces – First order non-linear equations – characteristics – compatible systems of first order equations - Charpit's method. (Chapter -0: sections 0.4 to 0.11. (omit 0.11.1))

Unit -2: Fundementals of Second OrderPDE 18 hours

Introduction – classification of second order PDE – canonical forms – Adjoint operators. (Chapter - 1: sections 1.1 to 1.4)

Unit-3: Elliptic Differential Equations 18 hours

Derivation of Laplace and Poisson equations – Boundary value problem – Separation of variables – Dirichlet's and Newmann problems for a rectangle – Solution of Laplace equation in Cylindrical and sphericalcoordinates. (Chapter - 2 : Sections 2.1, 2.2, 2.5 to 2.7, 2.11 to 2.12)

Unit-4: Paraboloid Differential Equations 18 hours

Formation and elementary solution of diffusion equation with boundary conditions – Dirac-Delta function – Separation of variable method - Solution of diffusion equation in cylindrical and spherical coordinates.(Chapter - 3 : Sections 3.1 to 3.7)

Unit-5: Hyperbolic Differential Equations **18 hours**

Derivation and solution of 1-D wave equation by canonical reduction – Initial Value Problem ;D'Alembert's solution – IVP and BVP for 2-D wave equation – Periodic solution for 1-D wave equation in cylindrical and spherical coordinates systems –Uniqueness of the solution for 1-D wave equation – Duhamel's principle. (Chapter - 4: Sections 4.1 to 4.4, 4.7 to 4.9, 4.11 and 4.12)

Prescribed Book

K.SankaraRao, Introduction to Partial differential equations (Third edition), Prentice-Hall of India Ltd., New Delhi, 2016.

Reference Books:

1. I.N. Sneddon, Elements of partial differential equations, McGraw Hill bookcompany, Singapore,1957
2. R. Dennemeyer, Introduction to partial differential equations and boundary value problems, McGraw Hill, New York,1968.
3. R.C. McOwen, Partial differential equations, 2nd edition, Pearson education, New Delhi,2005.
4. M.D.Raisinghania, Advanced differential equations, S.Chand& Company Ltd.New Delhi,2001.
5. N.N. Lebedev, Special functions and their applications, Prentice Hall of India,New Delhi,1965.

E-Materials:

1. https://ocw.mit.edu/courses/mathematics/18-152-introduction-to-partial-differential- equations-fall-2011/
2. https://nptel.ac.in/courses/111103021/
3. https://ocw.mit.edu/courses/mathematics/18-306-advanced-partial-differential-equations- with-applications-fall-2009/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- formulate and solve Partial Differential Equations (PDE) and apply PDE problems for real timeapplications.
- solve partial differential equations of first and second order.
- classify the partial differential equations
- identify the canonical forms of the partial differentialequations.
- analyse the solution of Laplace, Diffusion and Wave equationsin Cylindrical and polar coordinates
- discuss the existence and uniqueness of solutions and Duhamel's principle

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : II
Name of the Course : Mathematical Statistics Credits : 3
Paper Type : Internal Elective Hours of Teaching : 75hrs-----
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Course Objectives:

The objectives of the course is to

- introduce the basic notions of sample, population, sample moments and their functions.
- give an insight about the parametric and non-parametric tests for small and large samples.
- educate the various measures of estimation theory.
- inculcate the concepts of ANOVA test and hypothesis testing.
- indoctrinate the strong background about the sequential analysis and its consequences.

Unit–1: Sample Moments and Their Functions 15 Hours

Notion of a Sample and a Statistic – Distribution of the Arithmetic Mean of Independent Normally Distributed Random Variables – The Chi-Square Distribution – The Distribution of the Statistics – Student's *t*-Distribution – Fisher's *Z*-Distribution – Snedecor's*F*-Distribution – Distribution of Sample Mean from Non-Normal Populations. (Chapter 9 – Sections: 9.1–9.8)

Unit–2: Significance Tests 15 Hours

Kolmogorov Theorem – Smirnov Theorem – The Concept of a Statistical Test – Parametric Tests for Small Samples and Large Samples – Chi-Square Test – Tests of Kolmogorov and Smirnov Type – The Wald-Wolfovitz and Wilcoxon-Mann-Whitney Tests – Independence Tests by Contingency Tables. (Chapter 10 – Sections: 10.11 and Chapter 12 – Sections: 12.1–12.7)

Unit–3: Estimation Theory 15 Hours

Preliminary Notion – Consistent Estimaties – Unbiased Estimates – Sufficiency of an Estimate – Efficiency of an Estimate – Asymptotically Most Efficient Estimates – Methods of Finding Estimates– Confidence Interval.(Chapter 13 – Sections: 13.1–13.8)

Unit–4: Analysis of Variance and Hypotheses Testing 15 Hours

ANOVA Test: One-Way Classification and Two-Way Classification. Hypotheses Testing: The Power Functions and OC Function – Most Powerful Test – Uniformly Most Powerful Test – Unbiased Test.(Chapter 15 – Sections: 15.1–15.2 and Chapter 16 – Sections: 16.1–16.5)

Unit–5: Elements of Sequential Analysis 15 Hours

SPRT – Auxiliary Theorem – Wald's Fundamental Identity – OC Function and SPRT – The Expected Value of $E(n)$ – Determination of A and B – Testing a Hypothesis Concerning p of Zero-One Distribution – Testing a Hypothesis Concerning the Expected Value m of a Normal Population. (Chapter 17 – Sections: 17.1–17.9)

Prescribed Book

M. Fisz, *Probability Theory and Mathematical Statistics*, 3rd Edition,John Wiley and Sons Inc., New York, 1963.

Reference Books:

1. V.K. Rohatgi and A.K.Md.E. Saleh, *An Introduction to Probability Theory and Mathematical Statistics*, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1988.
2. E.J. Dudewicz and S.N. Mishra, *Modern Mathematical Statistics*, John Wiley and Sons, New York, 1988.
3. G.G. Roussas, *A First Course in Mathematical Statistics*, 2nd Edition, Academic Press, USA, 1997.
4. B.L.V.D. Waerden, *Mathematical Statistics*, Springer-Verlag, New York, 1969.
5. R.E. Walpole, R.H. Myers, S.L. Mayers and K. Ye, *Probability and Statistics for Engineers and Scientists*, 9th Edition, Pearson Education Inc., 2012.

E-Materials:

1. https://ocw.mit.edu/courses/mathematics/18-655-mathematical-statistics-spring-2016/
2. https://www.coursera.org/learn/basic-statistics
3. https://swayam.gov.in/nd1_noc20_ma19/preview

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- know the basic notions of sample, population, sample moments and their functions.
- comprehend the parametric and non-parametric tests for small and large samples.
- understand the various measures of estimation theory.
- acquire the concepts of ANOVA test and hypothesis testing.
- procure the strong background about the sequential analysis and its consequences.

Annamalai University, Annamalainagar - 608002

Name of the Programme: M.Sc. Mathematics **Semester : II**
Name of the Course : Fuzzy Set Theory **Credits : 3**
Paper Type : Internal Elective **Hours of Teaching : 75hrs-----**

Course Objectives:

The objectives of the course is to

- introduce Fuzzy sets
- some operations on Fuzzy sets
- construction of Fuzzy sets

Unit-1: From Classical (Crisp) Sets to Fuzzy Sets 15 hours

Introduction – Crisp sets: An overview – Fuzzy sets – Basic types – Basic concepts – Characteristics – Significance of the paradigm shift. (Chapter 1: Sections 1.1 to 1.5)

Unit - 2: Fuzzy Sets Versus Crisp Sets 15 hours

Additional properties of α - Cuts – Representation of Fuzzy sets – Extension principle for Fuzzy sets. (Chapter 2: Sections 2.1 to 2.3)

Unit-3: Operations on Fuzzy Sets 15 hours

Types of Operation – Fuzzy complements – Fuzzy intersection – t-norms (Chapter 3: Sections 3.1 to 3.3)

Unit-4: Operations on Fuzzy Sets 15 hours

Fuzzy unions – t conorms – Combinations of operations – Aggregation operations.
(Chapter 3: Sections 3.4 to 3.6)

Unit-5: Fuzzy Arithmetic 15 hours

Fuzzy numbers – Linguistic Variables – Arithmetic operation on intervals – Arithmetic operation on Fuzzy numbers (Chapter 4: Sections 4.1 to 4.4)

Prescribed Book

G. J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic : Theory and Applications, PHI, New Delhi, 2005.

Reference Books:

1. H. J. Zimmerman, Fuzzy Set Theory and its Applications, Allied Publishers, 1996.
2. A. Kaufman, Introduction to the theory of Fuzzy Subsets, Academic Press, 1975.
3. V. Novak, Fuzzy Sets and their Applications, Adam Hilger, Bristol, 1969.

E-Materials:

http://nptel.ac.in/courses/105108081/module9/lecture36/lecture.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the basic concepts of Fuzzy Sets and the difference between the Fuzzy sets and crisp sets
- analyse the Fuzzy sets and additional properties of α cuts.

- discuss the operations on Fuzzy sets and Fuzzy complements
- acquire the knowledge of various noms on Fuzzy sets and combination of operations
- visualize the Fuzzy sets as Fuzzy numbers
- analysethe Linguistic Variables, Arithmetic operation on intervals, Arithmetic operation on Fuzzy numbers
- apply the concepts of Fuzzy mathematics in real life situation.

Annamalai University, Annamalainagar - 608002

Name of the Programme : M.Sc. Mathematics Semester : II
Name of the Course : Difference Equations Credits : 3
Paper Type : Internal Elective Hours of Teaching : 75hrs----------
----------Course Objectives:

The objectives of the course is to

- introduce the process of discretization, discrete version of Difference Equations
- study the oscillation and the asymptotic behaviour of solutions of certain class of difference equations.
- solvethe difference equations using Z-transforms.

Unit – I: Linear Difference Equations of Higher order 15 hours

Difference Calculus - General Theory of Linear Difference Equations - Linear Homogeneous Equations with Constant coefficients – Non-homogeneous equations: Method of Undetermined Coefficients, the method of variation of constants - Limiting behavior of Solutions. (Chapter 2, Sections: 2.1 to 2.5)

Unit – II: System of Linear Difference Equations 15 hours

Autonomous Systems - The Basic Theory - The Jordan form - Linear periodic systems. (Chapter 3, Sections: 3.1 to 3.4)

Unit – III: The Z-transform Method 15 hours

Definitions and Examples, Properties of Z-transform - The Inverse Z-transform and Solutions of Difference Equations: Power series method, partial fraction method, the inverse integral method - Volterra Difference Equation of convolution type - Volterra Systems. (Chapter 6, Sections: 6.1 to 6.3, 6.5)

Unit – IV: Oscillation Theory 15 hours

Three-term difference Equations – Self-Adjoint Second Order Equations - Nonlinear Difference Equations. (Chapter 7, Sections: 7.1 to 7.3)

Unit – V: Asymptotic Behaviour of Difference Equation 15 hours

Tools of Approximation - Poincare's Theorem - Asymptotically Diagonal Systems – High-Order Difference Equations - Second Order Difference Equations. (Chapter 8, Sections: 8.1 to 8.5)

Prescribed Book

Saber N. Elaydi, *An Introduction to Difference Equations*, Third Edition, Springer Verlag, New York, 2005 (First Indian Reprint 2008).

Reference Books:

1. Ronald E. Mickens, *Difference Equations Theory, Applications and Advanced Topics*,Third Edition, CRC Press, New York, 2015.
2. R. P. Agarwal., *Difference Equations and Inequalities*, Marcel Dekker, 1999.
3. S. Goldberg, *Introduction to Difference Equations*, Dover Publications, 1986

4. V. Lakshmikantham and Trigiante, *Theory of Difference Equations Numerical Methods and Applications*, Second Edition, Academic Press, New York, 1988.
5. Walter G. Kelly, Allan C. Peterson, *Difference Equations, An Introduction with Applications*, Academic Press, New York, 2001 (First Indian Reprint 2006).

E-Materials:

1. http://people.math.aau.dk/~matarne/11-imat/notes2011a.pdf,
2. http://pj.freefaculty.org/guides/stat/Math/DifferenceEquations/DifferenceEquations-guide.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- solve problems on Linear Difference Equations of Higher order
- understand the system of Linear Difference Equations
- apply Z-transform techniques in difference equations
- solve problems on Oscillation Theory and Asymptotic Behaviour of Difference Equation

Thiruvalluvar University, Vellore –632115

Name of the Programme : MA/M.Sc/M.Com Semester: II
Name of the Paper : Fundamentals of InsuranceCredits:3
Paper Type : Non-Major ElectiveHours of Teaching: 75hrs

Course Objectives:

The objectives of the course is to

- know about the different insurance sectors including life insurance
- provide the idea of time of maturity, revival and surrender of policies and claims
- study about the Marine and Fire insurance

UNIT – I15 hours

Introduction to Insurance-Meaning, Definition of insurance- General principles of insurance-Types ofinsurance life, fire and marine-Difference between life and other types of insurance, Growth & Developmentof Indian insurance industry- Regulations of insurance business and the emerging scenario.

UNIT-II15 hours

Life Insurance-Introduction to life insurance : Features of life insurance-Essentials of life insurance,Different types of life policies- Annuities, Formation of life insurance contracts-Assignment andnominations- Lapses and revivals of policies. Surrender value, paid up value, Loans-Claims- Procedure forclaims- Settlement of claims- Death and Maturity.

UNIT-III15 hours

Fire Insurance- Fire insurance contracts- Fire insurance coverage- Policies for stocks- Rate fixation in fireinsurance- Settlement of claims. **Marine Insurance-** Functions- Marine perils-Types of marine policiesClauses in general use-Warranties and conditions- proximate cause-subrogation and conciliation - Reinsurance- Double insurance-Types of marine losses.

UNIT-IV15 hours

Miscellaneous Insurance -Motor insurance - Employer's liability insurance- Personal accident and sicknessinsurance - Aviation insurance- Burglary insurance- Fidelity guarantee insurance- Engineering insurancecattle insurance- Crop insurance.

UNIT-V15 hours

Procedure for becoming an Agent- Pre-requisite for obtaining a license- Duration of license-Cancellation oflicense- Termination of agency - Code of Conduct- Functions of the Agent.

Prescribed Book

1. Fundamentals of Insurance - Dr. Periyasamy, Himalaya Publishing Pvt Ltd, Mumbai.

2. Insurance principles and practice - Moorthy. A ,Margham publications, Chennai.
3. Fundamentals of insurance - Dr. P. K. Guptha, Margham publications, Chennai

Reference Books:

1. Insurance principles and practice- Periasamy. P, Margham publications, Chennai
2. Insurance principles and practice - Mishra. M. N, Sultan Chand & Sons, NewDelhi
3. Insurance principles and practice- Balu. V. &Premilan, Margham publications, Chennai

E-Materials:

- https://ocw.mit.edu/courses/economics/14-73-the-challenge-of-world-poverty-spring-2011/video-lectures/lecture-15-risk-and-insurance/
- https://ocw.mit.edu/courses/economics/14-73-the-challenge-of-world-poverty-spring-2011/video-lectures/lecture-16-insurance/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the principles and regulations of Insurance
- analyse the benefits of life insurance policies
- discuss the marine insurance and its benefits
- discuss the fire insurance and its benefits
- analyse the various insurance sector
- understand the duties of an agent and procedure to get license.

Annamalai University, Annamalainagar - 608002

Name of the Programme :MA/M.Sc/M.Com Semester : II
Name of the Course : Numerical Methods Credits : 3 Paper Type : Non-Major Elective Hours of Teaching: 75hrs----------
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Course Objectives:

The objectives of the course is to

- understand the concept of interpolation
- study the various methods to obtain interpolation with equal and unequal intervals
- study the numerical integration
- find the roots of the system of equation
- solve the differential equations using various numerical methods
- fit a curve using the method of least squares.

Unit-115 hours

Solution of numerical algebraic and transcendental Equations:
Bisection method – Iteration Method –Newton-Raphson method
Solution of simultaneous linear algebraic equations:
Gauss elimination method – Gauss-Jordan elimination method –Gauss Jacobi method – Gauss Seidel method– Simple Problems.
Chapter 3: Sections 3.1, 3.1.1, 3.2, 3.4
Chapter 4: Sections 4.1, 4.2, 4.2.1, 4.8, 4.9.

Unit-215 hours

Interpolation:
Introduction – Newton's forward and backward formulae –Central differences– Gauss forward andbackward formulae – Stirlings formula–Divided differences – Properties– Relations between divided differences and forwarddifferences - Newton's divided differences formula – Lagrange's formula.
Chapter 6: Sections 6.1, 6.2, 6.3
Chapter 7: Sections 7.1, 7.3, 7.4, 7.5
Chapter 8: Sections 8.2, 8.3, 8.4, 8.5, 8.7

Unit-315 hours

Numerical Differentiation:
Newton's forward and backward formulae to compute the derivatives – Derivative using Stirlings formulae – to find maxima and minima of the function given the tabular values.
Chapter 9: Sections 9.2, 9.3, 9.4, 9.6

Unit-415 hours

Numerical Integration:
Newton – Cote's formula – Trapezoidal rule – Simpson's 1/3rd and 3/8th rules– Weddle rule.
Chapter 9: Sections 9.8, 9.9, 9.13, 9.14, 9.15

Unit-515 hours

Numerical solution of ordinary differential equations - Euler's method –Improved Euler's method - Modified Euler's method - Runge-Kutta method(Fourth order only).
Chapter 11: Sections 11.9, 11.10, 11.11, 11.12, 11.13.

Prescribed Book

Kandasamy. P, Thilagavathi. K and Gunavathi.K "Numerical methods" – S. Chand andCompany Ltd, New Delhi – Third Revised Edition 2016.

Reference Books:

1. Venkataraman M. K.,"Numerical Methods in Science and Engineering" National Publishing company V Edition 1999.
2. SankaraRao K., "Numerical Methods for Scientists and Engineers" 2nd Edition Prentice HallIndia 2004.
3. Gupta B.D., Numerical Analysis, Konark Publishers Pvt. Ltd.

E-Materials:

1. http://nptel.ac.in/courses/122102009/,
2. http://www.math.ust.hk/~machas/numerical-methods.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- solve the algebraic and transcendental equations
- understand the concept of interpolation with equal and unequal intervals
- analyse the properties of divided difference
- study the various methods for numerical differentiation
- discuss the various methods for numerical integration
- gain the knowledge of Euler's method,modified Euler's method and Runge-Kutta method.

Annamalai University, Annamalainagar - 608002

Name of the Programme:MA/M.Sc/M.Com Semester : II
Name of the Course : Fundamentals of Business Statistics Credits : 3
Paper Type : Non-Major Elective Hours of Teaching: 75 hrs----------
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Course Objectives:

The objectives of the course is to

- apply statistical techniques for interpreting and drawing conclusion for business problems.

Unit – I: Partial and Multiple Correlation 15 hours

Introduction - Partial Correlation – Multiple Correlation – Multiple Regression Analysis – Reliability of Estimates-Miscellaneous Illustrations (Volume – II: Chapter 9: Pages: 1109 to 1135)

Unit –II: Theory of Probability and Theoretical Distributions 15 hours

Introduction – Probability Defined – Importance of the Concept of Probability – Calculation of Probability – Theorems of Probability - Conditional Probability - Bayes' theorem – Probability Distribution – Binomial Distribution - Poisson Distribution. (Volume – II: Chapter 1: Pages: 751 to 770 and 774 to 788; Chapter 2: Pages: 806 to 823, 826 to 833 and 858 to 879)

Unit – III: Statistical Inference-Test of Hypothesis 15 hours

Introduction – Sampling Error and Sampling Distribution – Estimation – Test of Significance for Large Samples – Test of Significance for Small Samples - Miscellaneous Illustrations. (Volume – II: Chapter 3: Pages: 882 to 951)

Unit – IV: Chi square and Goodness of Fit 15 hours

Introduction - Chi square defined – Conditions of Additive Chi-Square Test – Yate's Corrections - Uses of Chi-Square Test – Additive Property of Chi-Square – Chi-Square Test for Specified Value of Population Variance – Miscellaneous Illustrations. (Volume – II: Chapter 4: Pages: 953 to 1003)

Unit– V: F-Test and Analysis of Variance 15 hours

The F Test or the Variance Ratio Test – Application F Test – Analysis of Variance – Assumptions In Analysis of Variance – Technique of Analysis of Variance – Coding data – Analysis of Variance in Two-Way Classification Model. (Volume – II: Chapter 5: Pages: 1006 to 1038)

Prescribed Book

S.P. Gupta, Statistical Methods, Volume I & Volume II, Sultan Chand & Sons, New Delhi, 2009.

Reference Books:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11-e, Sultan Chand & Sons, New Delhi, 2004.
2. S. P. Gupta & M. P. Gupta, Business Statistics, 14th enlarged edition, Sultan Chand & Sons, Educational publishers, New Delhi, reprint 2007.

3. Richard I Levin and David S. Rubit, Statistics for Management, Seventh edition, Pearson Education, New Delhi, 2002.
4. P.R. Vittal, Business Mathematics and Statistics, Margham Publications, Sixth revised edition, 2011.

E-Materials:

http://mathworld.wolfram.com

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- know about the Partial and Multiple Correlation
- understand the basics concepts of Probability and Theoretical Distributions
- identify the educated guess (hypothesis)
- analyse the statistical inferences-Test of Hypothesis, Chi square and Goodness of Fit and F-Test
- design and discuss the Analysis of Variance

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SEMESTER III
PAPER - 7

COMPLEX ANALYSIS - I

Course Objectives:

The objectives of the course is to

- introduce the notions of differentiability and analytic functions.
- discuss the elementary functions and complex integration.
- educate the conformal mappings and Mobius transformations.
- inculcate the concepts of Maximum Principle, Schwarz' Lemma And Liouville's Theorem.
- indoctrinate the applications of Classification of Singularities.

Unit – 1: Analytic Functions and Power Series **18 Hours**

Differentiability and Cauchy–Riemann Equations –Harmonic Functions –Power Series as an Analytic Function – Exponential and Trigonometric Functions – Logarithmic Functions – Inverse Functions. (Chapter 3, Sections: 3.1 to 3.6)

Unit – 2: Complex Integration **18 Hours**

Curves in the Complex Plane – Properties of Complex Line Integrals – Cauchy–Goursat Theorem – Consequence of Simply Connectivity – Winding Number or Index of a Curve – Cauchy Integral Formula – Taylor's Theorem – Zeros of Analytic Functions – Laurent Series. (Chapter 4, Sections: 4.1 to 4.5, 4.7, 4.10 to 4.12)

Unit – 3: Conformal Mappings and Mobius Transformations **18 Hours**

Principle of Conformal Mapping – Basic Properties of Mobius Maps – Fixed Points and Mobius Maps – Triples to Triples under Mobius Maps – The Cross-Ratio and its Invariance Property – Conformal Self-maps of Disks and Half-planes. (Chapter 5, Sections: 5.1 to 5.6)

Unit – 4: Maximum Principle, Schwarz' Lemma AndLiouville's Theorem **18 Hours**

Maximum Modulus Principle - Hadamard's Three Circles/Lines Theorems - Schwarz's Lemma and its Consequences - Liouville's Theorem - Doubly Periodic Entire Function - Fundamental Theorem of Algebra - Zeros of certain Polynomials (Chapter 6, Sections: 6.1 to 6.7)

Unit – V: Classification of Singularities

Isolated and Non-isolated Singularities – Removable Singularities – Poles – Further Illustrations through Laurent's Series – Isolated Singularities at Infinity – Meromorphic Functions – Essential Singularities and Picard's theorem. (Chapter 7, Sections: 7.1 to 7.7)

Prescribed Book

S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2012.

Reference Books:

1. Lars V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw-Hill Inc., New York, 1979.

2. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, 8th Edition, McGraw-Hill Higher Education, New York, 2009.
3. J.B. Conway, *Functions of One Complex Variable*, 2nd Edition, Narosa Publishing House, New Delhi, 1996.
4. V. Karunakaran, *Complex Analysis*, 2nd Edition, Narosa Publishing House, New Delhi, 2005.
5. H.A. Priestley, *Introduction to Complex Analysis*, 2nd Edition, Oxford University Press Inc., New York, 2005.

E-Materials:

1. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-variable-fall-2008/
2. https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-spring-2018/
3. https://www.coursera.org/learn/complex-analysis

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- Understand the differentiability and analytic functions.
- comprehend the elementary functions and complex integration.
- acquire the knowledge of conformal mappings and Mobius transformations
- discuss the Maximum Principle, Schwarz' Lemma And Liouville's Theorem.
- procure the applications of theClassification of Singularities.

PAPER - 8
TOPOLOGY

Course Objectives:

The objectives of the course is to

- introduce the mathematical analysis of open and closed sets and the significance of the topological spaces.
- give an insight about the continuous functions on topological spaces, product topology and topology induced by the metric.
- educate the connected spaces, connected subspaces, components and local connectedness.
- inculcate the notions of compactness, compact subspaces, limit point compactness and local compactness.
- indoctrinate the strong theoretical background about the countability axioms, the separation axioms and the consequences theorems.

Unit–1 :Topological Spaces **18 Hours**

Topological Spaces - Basis for a Topology - The Order Topology - The Product Topology on XxY - The Subspace Topology - Closed Sets and Limit Points.
(Chapter 2 - Sections: 12-17)

Unit–2 :Continuous Functions **18 Hours**

Continuous Functions - The Product Topology - The Metric Topology.
(Chapter 2 - Sections: 18-21)

Unit–3 :Connectedness **18 Hours**

Connected Spaces - Connected Subspaces of the Real Line - Components and Local Connectedness. (Chapter 3 - Sections: 23-25.)

Unit–4 :Compactness **18 Hours**

Compact Spaces - Compact Subspaces of the Real Line -Limit Point Compactness - Local Compactness. (Chapter 3 - Sections: 26-29.)

Unit–5 :Countability And Separation Axioms **18 Hours**

The Countability Axioms - The Separation Axioms - Normal Spaces - The Urysohn Lemma - The Urysohn Metrization Theorem - The Tietz Extension Theorem.
(Chapter 4 - Sections: 30-35)

Prescribed Book

James R. Munkres, *Topology*, 2nd Edition, Pearson Education Pvt. Ltd., Delhi, 2002.

Reference Books:

1. J. Dugundji, *Topology*, Prentice Hall of India Pvt. Ltd., New Delhi, 1975.
2. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Education, New York, 1963.

3. J.L. Kelley, *General Topology*, Van Nostrand Reinhold Company, New York, 1955.
4. L.A. Steen and J.A. Seebach, *Counterexamples in Topology*, Holt, Rinechart and Winston, New York, 1970.
5. S. Willard, *General Topology*, Addison–Wesley Publishing Company, USA, 1970.

E-Materials:

1. https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/index.htm
2. https://ocw.mit.edu/courses/mathematics/18-904-seminar-in-topology-spring-2011/index.htm
3. https://swayam.gov.in/nd2_cec20_ma12/preview

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- know the basics of open and closed sets and the significance of the topological spaces.
- comprehend the continuous functions on topological spaces, product topology and topology induced by the metric.
- understand the connected spaces, connected subspaces, components and local connectedness.
- acquire the notions of compactness, compact subspaces, limit point compactness and local compactness.
- understandthe various countability axioms and the separation axioms.

PAPER - 9

DIFFERENTIAL GEOMETRY

Course Objectives:

The objectives of the course is to

- introduces space curves and their intrinsic properties of a surface and geodesics.
- studythe non–intrinsic properties of a surface
- study the differential geometry of surfaces.

Unit-1: Space Curves **18 hours**

Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torsion – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – intrinsic equations – Fundamental existence theorem for space curve – Helices.
(Chapter 1: Sections 1 to 9)

Unit-2:Intrinsic Properties of a Surface **18 hours**

Definition of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties. (Chapter 2: Sections 1 to 9)

Unit-3: Geodesics **18 hours**Geodesics – Canonical geodesic equations – Normal properties of geodesics – Existence theorem – Geodesic parallels – Geodesic curvatures – Gauss Bonnet theorem – Gaussian curvature – Surface of constant curvature. (Chapter 2: Sections 10 to 18)

Unit-4: Non–Intrinsic Properties of a Surface **18 hours**
The second fundamental form – Principal curvature – Lines of curvature – Developable – Developable associated with space curves and with curves on surface – Minimal surfaces – Ruled surfaces. (Chapter 3: Sections 1 to 8)

Unit-5: Differential Geometry of Surfaces **18 hours**

Fundamental equations of surface theory – Fundamental existence theorem for surfaces – Compact surfaces whose points are umbilics– Hilbert's lemma – Compact surfaces of constant curvature – Complete surfaces.
(Chapter 3: Sections 9 to 11, Chapter 4: Sections 1 to 5)

Prescribed Book

T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)

Reference Books:

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963. 3. Wilhelm 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.

E-Materials:

http://www.math.ku.dk/noter/filer/geom1.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the characteristics of curves and surfaces in space and also the fundamental existence theorem for space curves.
- discussthe intrinsic properties of surface.
- analysethe geodesics and its normal properties and familiar with GaussBonnet Theorem.
- discussthe developable.
- understand Hilbert's Lemma and the fundamental existence theorem for surface theory.

CORE ELECTIVE
PAPER - 3
(to choose one out of 3)
A. LaTeX

Course Objectives:

The objectives of the course is to

- inculcatethe computer knowledge.
- introduce the LaTeXsoftware
- train in the Preparation of Project and dissertations using LaTex.
- educate the Latex coding.

Unit – I: Basic Document and Bibliography 18 hours

Whats is LATEX – Simple typesetting – Fonts Type size – Document class – page style – page numbering – Formatting lengths – parts of a document – Dividing the document – what next? – Introduction – natbib – The BIBTEX program – BIBTEX Style files – Creating a bibliographic database. (Chapter 1 to 4)

Unit - II: Contents, Index, Glossary, Text, Row and Column 18 hours

Table of contents – Index – Glossary. Borrowed words – Poetry in typing – Making lists – When order matters – Description and definitions. (Chapter 5 to 6)

Unit – III: Typesetting Equations and Theorems 18 hours

Keeping tabs – Tables – The basics – Custom commands – More on mathematics – mathematics miscellany – New operations– The many fact of mathematics – Symbols – Theory in LATEX – Designer theorem-the amsthm package – Housekeeping.
(Chapter 7 to 9)

Unit - IV: Several Kinds of boxes and Floats, 18 hours

LR boxes – Paragraph boxes – Paragraph boxes with specific height – Nested boxes – Role boxes – The figure environment – The table environment. (Chapter 10 to 11)

Unit – V: Cross References in LATEX, Footnotes, Marginpars and Endnotes 18 hours

Why cross reference? – Let LATEX do it – Pointing to a page-the package varioref – Pointing outside-the package xr – Lost the keys? Use lables.tex – Footnotes – Marginal notes – Endnotes. (Chapter 12 to 13)

Prescribed Book

A Primer, Latex Tutorials, Indian TEX users group, Trivandrum, India.

www.tug.org.in

Reference Books:

1. Peter Flynn, A beginner's introduction to typesetting with LATEX,Silmaril Consultants, Textual Therapy Division, 2003.
2. George Gratzer,More Math Into LATEX, 4th Edition, Springer Science (2007).
3. Frank Mittelbach,Michel Goossens,TheLaTex Companion, Second Edition, Addison-Wesley, 2004.

E-Materials:

1. https://www.latex-tutorial.com/tutorials/
2. https://www.latex-tutorial.com/
3. http://www.tug.org.in/tutorials.html

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- prepare the LaTeX document and the e-contents.
- Able to construct structures, tables inclusions, header and footer, bibliography management, etc.
- Understand about the mathematics document preparation.

CORE ELECTIVE
PAPER - 3
B. DISCRETE MATHEMATICS

Course Objectives:

The objectives of the course is to

- explore the topics like lattices and its applications in switchingcircuits
- study the finite fields, polynomials and coding theory.

Unit-1: Lattices **18 hours**

Properties and examples of Lattices - Distributive lattices - Boolean algebras - Boolean polynomials - Minimal Forms of Boolean Polynomials. (Chapter 1: 1 – 6).

Unit-2: Applications of Lattices **18 hours**

Switching Circuits- Applications of Switching Circuits (Chapter 2: 7 – 8)

Unit -3: Finite Fields and Polynomials **18 hours**

Finite fields (Chapter 3: 13 only)

Unit -4: Finite Fields and Polynomials **18 hours**

Irreducible Polynomials over Finite fields - Factorization of Polynomials over Finite fields (Chapter 3: 14 – 15)

Unit -5: Coding Theory **18 hours**

Linear Codes - Cyclic Codes(Chapter 4: 17 – 18)

Prescribed Book

Rudolf Lidl& Gunter Pilz. Applied Abstract Algebra, Second Indian Reprint 2006, Springer Verlag, NewYork, (2006).

Reference Books

1. A.Gill, Applied Algebra for Computer Science , Prentice Hall Inc., New Jersey.
2. J.L.Gersting, Mathematical Structures for Computer Science (3 rdEdn.), ComputerScience Press, New York.
3. S.Wiitala, Discrete Mathematics- A Unified Approach, McGraw Hill Book Co.

E-Materials:

1. http://archives.math.utk.edu/topics/discreteMath.html
2. http://www.discrete-math-hub.com/resources-and-help.html

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand about Lattices, applications of Lattices
- discuss the Boolean algebras and polynomials
- procure strong theoretical background on Finite Fields and Polynomials.
- analsye the concept of coding theory and factorization of polynomials
- identify the various types of codes

CORE ELECTIVE
PAPER - 3
C. OPERATIONS RESEARCH

Course Objectives:

The objectives of the course is to

- introduce decision theory and tree analysis
- study the project management of PERT and CPM
- study the deterministic and probabilistic inventory systems, queues, replacement and maintenance problems.

Unit-1: Decision Theory **18 hours**

Steps in Decision theory Approach – Types of Decision Making Environments –Decision Making Under Uncertainty – Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis– Decision Making with Utilities.
(**Chapter 11:** Sections 11.1 to 11.8)

Unit-2: Project Management: PERT And CPM **18 hours**

Basic Differences between PERT and CPM – Steps in PERT/ CPM Techniques – PERT / CPM Network Components and Precedence Relationships – Critical path Analysis – Probability in PERT Analysis – Project time –Cost Trade off – Updating the Project – Resource Allocation. (**Chapter 13:** Sections 13.1 to 13.7)

Unit-3: Deterministic Inventory Control Models **18 hours**

Meaning of Inventory control – Functional Classification – Advantage of Carrying Inventory – Features of Inventory System – Inventory Model building – Deterministic Inventory Models with no shortage – Deterministic Inventory with Shortages.
(**Chapter 14:** Sections 14.1 to 14.8)

Unit-4: Queueing Theory **18 hours**

Essential Features of Queuing System – Operating Characteristic of Queuing System – Probabilistic Distribution in Queuing Systems Classification of Queuing Models – Solution of Queuing Models – Probability Distribution of Arrivals and Departures –Erlangian Service time Distribution with k–phases.(**Chapter 16:** Sections 16.1 to 16.7,16.9.)

Unit-5: Replacement and Maintenance Models **18 hours**

Failure Mechanism of items– Replacement of Items Deteriorates with Time – Replacement of items that fail completely – other Replacement Problems
(**Chapter 17:** Sections 17.1 to 17.5)

Prescribed Book

J.K. Sharma, Operations Research (Second Edition), Macmillian (India), New Delhi, 2003.

Reference Books

1. F.S.Hillier and J.Lieberman, Introduction To Operations Research, (Eighth edition), Tata McGraw Hill Publishing Company, New Delhi, 2006.

2. C. Beightler, D.Phillips, and B. Wilde, Foundations of Optimization, (Second edition), Prentice Hall New York, 1979.
3. M.S. Bazaraa, J.J.Jarvis, and H.D.Sharall, John Wiley and sons, New York, 1990.
4. D. Gross and C.M. Harris, Fundamentals Of Queuing Theory [3rd Edition], Wiley and Sons, New York, 1998.
5. HamdyA.Taha, Operations Research, (Sixth edition), Prentice–Hall of India Private Limited, New Delhi.

E-Materials:

http://www2.math.umd.edu/~jmr/241/calc.htm

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- analyse various inventory control modules
- understand the concepts of network techniques
- discuss the maintenance models in replacements
- understand inventory control and functional role of inventory
- analyse various performance of queueing models

OPEN ELECTIVE
PAPER - 3
(to choose one out of 3)

1. MATHEMATICAL BIOLOGY

Course Objectives:

The objectives of the course is to

- understand and know the discrete population growth models.
- study the continuous growth models and qualitative behavior of populations
- know the mathematical models in epidemiology

Unit-1: Discrete Population Growth Models **18 hours**

Arithmetic Growth Model - Geometric Growth Model - Generalizations – AgeStructured Populations.(Chapter 2: 2.2 to 2.5)

Unit-2: Continuous Growth Models **18 hours**

The Linear Model - The Exponential Model - Model for the Distribution of drugs inthe body - Coalition Models.(Chapter 3: 3.2 to 3.5)

Unit-3: Continuous Growth Models (contd.) **18 hours**

Environmental Resistance - A Model for the Spread of Technological Innovations -The Gomertz Model - Bertalanffy Growth Model.(Chapter 3: 3.8 to 3.11)

Unit-4: Qualitative behavior of Populations **18 hours**

Autonomous Equations - Steady and Equilibrium State - Stability of Equilibrium State-Logistic Model with Harvesting - Fixed Points and their stability - The Logistic Map.(Chapter 5: 5.2 to 5.7)

Unit-5: Mathematical Models in Epidemiology **18 hours**

Plant Epidemics - Some features of Human Epidemics - A Simple Deterministic Epidemic Model - A more General Epidemic: SIR Disease.(Chapter 7: 7.2 to 7.5)

Prescribed Book

C. R. Ranganathan, A First Course in Mathematical Models of Population Growth (with MATLAB Program), Associated Publishing Company, New Delhi, 2006.

Reference Books:

1. Pundir, Bio Mathematics, APragati Edition, 2006.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd., New Delhi, 1985.
3. Nicolas F. Britton, Essential Mathematical Biology, Springer International Edition, First Indian reprint, 2004.
4. Murray, Mathematical Biology, Springer International Edition, First Indian reprint, 2004.

E-Materials:

1. https://www.smb.org/
2. https://web.archive.org/web/20080827161431/http://www.biostatsresearch.com/repository/

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- Formulate the mathematical models for real world problems
- understand the concepts of Discrete Population Growth Models
- discuss the Continuous Growth Models
- analyse the Qualitative behavior of Populations and Mathematical Models in Epidemiology

OPEN ELECTIVE
PAPER - 3

B. QUANTITATIVE TECHNIQUES

Course Objectives:

The objectives of the course is to

- study the linear programming problem
- understand the transportation problem and assignment problem
- know the inventory control and PERT and CPM.

Unit – I: Linear Programming Problem **18 hours**

Introduction – Graphical Solution Method – Some Exceptional Cases – General Linear Programming Problem – Fundamental Properties of Solution – The Computational Procedure - Simplex Method. (Chapter 3: Sections: 3.1 to 3.4 and Chapter 4: Sections: 4.1 to 4.3)

Unit –II: Transportation Problem **18 hours**

Introduction - L.P Formulation of the Transportation Problem – Existence of Solution in T.P – Transportation Table – Solution of a Transportation Problem – Finding Initial Basic Feasible Solution - Test for optimality – Economic Interpretation of u_j's and v_j's – Degeneracy in Transportation Problem – Transportation Algorithm (Modi Method) . (Chapter 10: Sections: 10.1 to 10.3, 10.5, 10.8 to 10.13)

Unit – III: Assignment Problem **18 hours**

Introduction - Mathematical Formulation of the Problem - Solution Methods of Assignment Problem – Special Cases in Assignment Problems – Travelling Salesman Problem. (Chapter 11: Sections: 11.1 to 11.4, 11.7)

Unit – IV: Inventory Control **18 hours**

Introduction – Types of Inventories – Reasons for Carrying Inventories – The Inventory Decisions – Objective of Scientific Inventory Control – Costs Associated with Inventories – Factors Affecting with Inventory Control – An inventory Control Problem - Deterministic Inventory problem with No shortages. (Chapter 19: Sections: 19.1 to 19.10)

Unit – V: Network scheduling by PERT and CPM **18 hours**

Introduction – Network: Basic Components – Logical Sequencing - Rules of Network Construction – Concurrent Activities – Critical Path Analysis – Probability Considerations in PERT- Distinction between PERT and CPM. (Chapter 25 only)

Prescribed Book

KantiSwarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand &Sons, New Delhi, 2008.

Reference Books

1. P.K. Gupta, Operations Research, 8-e, Krishna PrakasamMandir, Meerut, 1993.
2. P.K.Gupta and D.S. Hira, Operations Research, S. Chand & Company, New Delhi, 2000.
3. J.K.Sharma, Operations Research Theory and Applications, 2-e, Macmillian Business Books, 2003.
4. Hamdy A. Taha, Operations Research, Pearson Education, New Delhi, 2002.

E-Materials:

http://mathworld.wolfram.com

Course Learning Outcomes

After the successful completion of this course, the students will be able to:

- understand the linear programming problems(LPP)
- discuss the simplex method to solve LPP
- analyse the transportation and assignment problems
- acquire the knowledge of resource leveling
- study inventory control and functional role of inventory.
- learn PERT-CPM technique for project management

OPEN ELECTIVE
PAPER - 3

C. SCILAB

Course Objectives:

The objectives of the course is to

- acquire the practical knowledge of SCILAB
- solve the matrics, polynomials and differential equations.

Unit - I: **18 hours**

Login - Talking between Scilab and the Editor - Basic Commands - Linear Algebra - Loops and Conditionals - Help in Scilab. (Chapter 1: Sections 1.1 to 1.7).

Unit – II: **18 hours**

Matrices and Vectors - Solving Equations - Creating Matrices - Systems of Equations. (Chapter 2: Section 2.2).

Unit – III: **18 hours**

Plotting Lines and Data - Adding a Line - Hints for Good Graphs – Graphs - Function Plotting - Component Arithmetic - Printing Graphs - Saving Graphs. (Chapter 3: Sections 3.2, 3.3).

Unit – IV: **18 hours**

Evaluation of Polynomials – Polynomials - Linear Least Squares (Heath Computer Problem).(Chapter 6: Sections 6.2, 6.3, 6.4).

Unit – V: **18 hours**

Differential Equations - Scalar ODE's - Order 2 ODE's . (Chapter 8: Sections 8.2).

Prescribed Book

Graeme Chandler and Stephen Roberts, Scilab Tutorials for Computational Science, 2002.

Reference Books:

1. Scilab for very beginners, Scilab Enterprises, S.A.S, 143, bis rue Yves Le Coz – 78000 Versailles (France).
2. K. S. Surendran, SCILAB FOR DUMMIES, Version 2.6.
3. Some notes on SCILAB, Universit´e de Nice Sophia-Antipolis.

E-Materials:

https://www.scilab.org/

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- acquire the practical knowledge of SCILAB
- analyse the matrices, polynomials in SCILAB
- solve the solutions of differential equations
- visualize the mathematical objects in 2D and 3D

SEMESTER IV

PAPER - 10

COMPLEX ANALYSIS - II

Course Objectives:

The objectives of the course is to

- introduce the concept of residues.
- evaluate contour integrals.
- educate the analytic continuation and poisson integral formula.
- inculcate the concepts of meromorphic and entire functions.
- indoctrinate the applications of open mapping, Hurwitz and Riemann mapping theorems.

Unit – 1: Calculus of Residues **15 hours**

Residue at a Finite Point – Residue at the Point at Infinity – Residue Theorem – Number of Zeros and Poles – Rouche's Theorem. (Chapter 7, Sections: 7.1 to 7.6 and Chapter 8, Sections: 8.1 to 8.5)

Unit – 2: Evaluation of Certain Integrals **15 hours**

Integrals of three types - Singularities on the Real Axis - Integrals Involving Branch Points - Estimation of Sums (Chapter 9, Sections: 9.1 to 9.6)

Unit – 3: Analytic Continuation **15 hours**

Direct Analytic Continuation - Monodromy Theorem - Poisson Integral Formula - Analytic Continuation via Reflection (Chapter 10, Sections: 10.1 to 10.4)

Unit – 4: Representation of Meromorphic and Entire Functions **15 hours**

Infinite Sums and Meromorphic Functions - Infinite Product of Complex Numbers - Infinite Products of Analytic Functions - Factorization of Entire Functions - The Gamma Function - The Zeta Function - Jensen's Formula - The Order and the Genus of Entire Functions (Chapter 11, Sections: 11.1 to 11.8)

Unit –5: Mapping Theorems **15 hours**

Open Mapping Theorem and Hurwitz' Theorem - Basic Results on Univalent Functions - Normal Families - The Riemann Mapping Theorem - Bieberbach Conjecture - The Bloch-Landau Theorems - Picard's Theorem (Chapter 12, Sections: 12.1 to 12.7)

Prescribed Book

S. Ponnusamy, *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi, 2015.

Reference Books:

1. Lars V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw-Hill Inc., New York, 1979.
2. J.W. Brown and R.V. Churchill, *Complex Variables and Applications*, 8th Edition, McGraw-Hill Higher Education, New York, 2009.
3. J.B. Conway, *Functions of One Complex Variable*, 2nd Edition, Narosa Publishing House, New Delhi, 1996.
4. V. Karunakaran, *Complex Analysis*, 2nd Edition, Narosa Publishing House, New Delhi, 2005.

5. H.A. Priestley, *Introduction to Complex Analysis*, 2nd Edition, Oxford University Press Inc., New York, 2005.

E-Materials:

1. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-variable-fall-2008/
2. https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-spring-2018/
3. https://www.coursera.org/learn/complex-analysis

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- Understand the concepts of residues
- Evaluate the integrals using Cauchy residue theorem.
- comprehend the harmonic functions and its consequences.
- understand the conformal mappings, normal families and Riemann mapping theorem.
- acquire the concepts of entire and meromorphic functions.
- procure the applications of analyticity and special functions.

PAPER - 11

FLUID DYNAMICS

Course Objectives:

The objectives of the course is to

- discuss kinematics of fluids in motion
- derive the equations of motion of a fluid
- study the three dimensional flows, two dimensional flows and viscous flows.

Unit-1: Kinematics of Fluids In Motion 15 hours

Real fluids and ideal fluids – Velocity of a fluid at a point, Stream lines, path lines, steady and unsteady flows – Velocity potential – The vorticity vector – Local and particle rates of changes – Equations of continuity – Worked examples – Acceleration of a fluid – Conditions at a rigid boundary. (Chapter 2: Sections 2.1 to 2.10)

Unit-2: Equations of Motion of Fluid 15 hours

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 equation of motion – Discussion of the case of steady motion under conservative body forces. (Chapter 3: Sections 3.1 to 3.7)

Unit-3: Some Three Dimensional Flows 15 hours

Introduction – Sources, sinks and doublets – Images in a rigid infinite plane – Axis symmetric flows – Stokes stream function. (Chapter 4 : Sections 4.1, 4.2, 4.3, 4.5.)

Unit-4: Some Two Dimensional Flows 15 hours

Meaning of two dimensional flow – Use of Cylindrical polar coordinate – The stream function – The complex potential for two dimensional, irrational incompressible flow – Complex velocity potentials for standard two dimensional flows – Some worked examples – Two dimensional image systems – The Milne Thompson circle Theorem.

(Chapter 5 : Sections 5.1 to 5.8)

Unit-5: Viscous Flows 15 hours

Stress components in a real fluid – Relations between Cartesian components of stress – Translational motion of fluid elements – The rate of strain quadric and principal stresses – Some further properties of the rate of strain quadric – Stress analysis in fluid motion – Relation between stress and rate of strain – The co-efficient of viscosity and Laminar flow – The Navier – Stokes equations of motion of a Viscous fluid. (Chapter 8: Sections 8.1 to 8.9)

Prescribed Book

F. Chorlton, Text Book of Fluid Dynamics ,CBS Publications. Delhi ,1985.

Reference Books:

1. R.W.Fox and A.T.McDonald. Introduction to Fluid Mechanics, Wiley, 1985.
2. E.Krause, Fluid Mechanics with Problems and Solutions, Springer, 2005.
3. B.S.Massey, J.W.Smith and A.J.W.Smith, Mechanics of Fluids, Taylor and Francis, New York, 2005 4. P.Orlandi, Fluid Flow Phenomena, Kluwer, New Yor, 2002.
4. T.Petrila, Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics, Springer, berlin, 2004.

E-Materials:

http://web.mit.edu/1.63/www/lecnote.html

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- understand the concepts of kinematics of fluids in motions.
- analyse the examples related to the equation of continuity and acceleration of a fluid
- discuss two-dimensional flows, the stream function and the Milne Thompson Circle theorem.
- acquire the concept of three-dimensional flows and derive Stoke's stream function
- discuss the viscous flows and Navier – Stokes equations of motion of a Viscous fluid.

PAPER - 12

FUNCTIONAL ANALYSIS

Course Objectives:

The objectives of the course is to

- study the details of Banach algebraand Hilbert Spaces
- providethe concept of conjugate space H*, adjoint, self-adjoint, normal and unitary operators.
- study the regular, singular elements, radical and semi-simplicity.
- study the details of structure of commutative Banach algebras
- know about the relationship between algebraic structure of linear space and distance structure of a metric space.

UNIT-I :Banach Spaces **15 hours**

Definition - Some examples - Continuous Linear Transformations - The Hahn -Banach Theorem (Chapter 9: Sections 46 to 48)

UNIT-II :Banach Spaces And Hilbert Spaces **15 hours**

Open mapping theorem - conjugate of an operator - Definition and some simple properties - Orthogonal complements - Orthonormal (Chapter 9: Sections 50 and 51 ; Chapter 10 : Sections 52, 53 and 54)

UNIT-III : Hilbert Space **15 hours**

Conjugate space H* - Adjoint of an operator - Self-adjoint operator - Normal and Unitary Operators – Projections (Chapter 10: Sections 55, 56,57,58 and 59)

UNIT-IV :Preliminaries nnBanach Algebras **15 hours**

Definition and some examples - Regular and single elements - Topological divisors of zero - spectrum - the formula for the spectral radius - the radical and semi-simplicity.
(Chapter 12 : Sections 64 to 69)

UNIT-V: Structure of Commutative Banach Algebras **15 hours**

Gelfand mapping –Applications of the formula $r(x) = \lim \left\| x^n \right\|^{1/n}$ - Involutions in Banach Algebras - Gelfand-Neumark Theorem.(*Chapter 13 : Sections 70 to 73)*

Prescribed Book

G.F.Simmons ,*Introduction to topology and Modern Analysis*, McGraw Hill International Book Company, New York, 1963.

Reference Books:

1. W. Rudin*Functional Analysis*, Tata McGraw-Hill Publishing Company, New Delhi, 1973
2. G. Bachman &L.Narici, *Functional Analysis* Academic Press, New York, 1966.
3. H.C. Goffman and G.Fedrick, *First course in Functional Analysis*, Prentice Hall of India, New Delhi, 1987
4. E. Kreyszig*Introductory Functional Analysis with Applications*, John wiley& Sons, New York.,1978.
5. Balmohan V. Limaye, Linear Functional Analysis for Scientists and Engineers, Springer.

E-Materials

http://www.math.ucdavis.edu/~hunter/book/ch5.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- analyse the Banach space with examples
- understand the natural embedding N in N**
- discuss Banach spaces with the Hilbert spaces
- acquire the open mapping theorem, orthonormal complements and orthonormal sets
- derive Gelgand-Neumark theorem
- prove the structure theorems

CORE ELECTIVE

PAPER - 4

(to choose one out of 3)

A. NUMBER THEORY AND CRYPTOGRAPHY

Course Objectives:

The objectives of the course is to

- give elementary ideas from number theory which will have applications in cryptography.
- study the quadratic residues and reciprocity
- understand about public key and primality

UNIT–I Some Topics in Elementary Number Theory 15 hours

Time Estimates for doing arithmetic – Divisibility and Euclidean Algorithm – Congruence's – Some applications to Factoring. (Chapter I)

UNIT–II Cryptography 15 hours

Some simple cryptosystems – Enciphering matrices. (Chapter III)

UNIT–III Quadratic Residues 15 hours

Quadratics – Residues and reciprocity. (Chapter II)

UNIT–IV Public Key 15 hours

The idea of Public key Cryptography – RSA – Discrete Law – Knapsack – Zero–Knowledge.(Chapter IV : Sections 1 to 5)

UNIT–V Primalityand Factoring 15 hours

Pseudo–primes – The rho method – Fermat factorization and factor bases – The continued fraction method – The quadratic sieve method. (Chapter V: Sections 1 to 5)

Prescribed Book

Neal Koblitz, A Course in Number Theory And Cryptography, Springer–Verlag, New York,1987.

Reference Books:

1. Niven and Zuckerman, An Introduction to Theory of Numbers, Third Edition, Wiley Eastern Ltd, New Delhi,1976.
2. David M. Burton,Elementary Number Theory, Wm. C. Brown Publishers, Dubuque, Iowa, 1989.

3. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer–Verlag,1972.

E-Materials

http://mathworld.wolfram.com

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- discuss the elementary number theory
- understand the the quadratic, residues and reciprocity
- develop the idea of Public key cryptography, RSA and discrete law
- solve problems using the continued fraction method and the quadratic Sieve method
- analyseKnapsact, zero knowledge
- discuss Fermat factorization and factor bases.

CORE ELECTIVE

PAPER - 4

B. ADVANCED NUMERICAL ANALYSIS

Course Objectives:

The objectives of the course is to

- introduce the derivation of numerical methods with error analysis
- study the transcendental and polynomial equations
- study the system of linear algebraic equations
- understand the differentiation and integration
- solve problems on interpolation and ordinary differential equations

UNIT–I Transcendental and Polynomial Equations 15 hours

Iteration methods based on second degree equation –Rate of convergence – Iteration methods – Methods for complex roots – Polynomial equations.

(**Chapter 2:**Sections2.4 to 2.8)

UNIT–II System of Linear Algebraic Equations and Eigen Value Problems 15 hours

Direct methods –Triangularisation, Cholesky and Partition methods – Error analysis– Iteration methods – Eigen values and Eigenvectors – Jacobi's method, Given's method, Rutishaugher method and Power method. (**Chapter 3:** Sections 3.2 to 3.5)

UNIT–III Interpolation and Approximation 15 hours

Hermite Interpolations – Piecewise and Spline Interpolation – Bivariate interpolation – Approximation – Least Square approximation – Uniform approximation.

(**Chapter 4:**Sections4.5 to 4.10)

UNIT–IV Differentiation and Integration 15 hours

Numerical Differentiation – Partial Differentiation – Numerical Integration methods based on undetermined coefficients– Double integration.

(**Chapter 5:**Sections5.2, 5.5, 5.6, 5.8, 5.11)

UNIT–V ORDINARY DIFFERENTIAL EQUATIONS 15 hours

Numerical methods – Single step methods –Multistep methods –Predictor–Corrector methods.(**Chapter 6:**Sections6.2 to 6.5)

Prescribed Book

M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods For Scientific And Engineering Computation, 3rd Edition, New Age International, 1993.

Reference Books:

1. S. D. Corte and de Boor, Elementary Numerical Analysis – An Algorithmic approach, 3rd Edition, McGraw Hill International Book Company, 1980.
2. James B. Scarboraugh, Numerical Mathematical Analysis, Oxford& IBH Publishing Company, New Delhi.
3. F.B. Hildebrand, Introduction To Numerical Analysis, McGrawHill, New York, 1956.

E-Materials

1. https://www.math.upenn.edu/~wilf/DeturckWilf.pdf
2. https://web.archive.org/web/20120225082123/http://kr.cs.ait.ac.th/~radok/math/mat7/stepsa.htm
3. https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- compute the solutions of transcendental and polynomial equations
- understand the system of linear algebraic equations
- analyse interpolation and extrapolation
- derive numerical differentiation and integrations
- evaluate double integrals
- solve differential equations by single and multi step methods

CORE ELECTIVE

PAPER - 4

C. CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Course Objectives:

The aim of the course is to introduce to

- the concept of calculus of variation and its applications and to introduce various types of integral equations
- study the methods of successive approximations and fredholm theory
- acquire knowledge on applications to Ordinary Differential Equations.

Unit– I: Variational Problems with Fixed Boundaries 15 hours

The concept of Variation and its properties – Euler's equation – Variational problems for functionals of the form –Functionals dependent on higher order derivatives – Functionals dependent on Functions of several independent variables– Variational problem in parametric form – Some applications to problems of mechanics.
(Book – 1, Chapter 1, Sections: 1.1 to 1.7)

Unit–II: VariationalProblems with Moving Boundaries 15 hours

Variational problem with a Movable boundary for a functional dependent on two functions – One sided variations – Reflection and Refraction of extremals – Diffraction of light rays. (Book–1, Chapter 2, Sections: 2.2 to 2.5)

Unit– III: Integral Equations 15 hours

Introduction– Definition– Regularity conditions– Special kinds of Kernels– Eigen values and Eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples –Fredholmalternative – Examples – An approximation method. (Book–2, Chapter 1, Sections: 1.1 to 1.5; Chapter 2,Sections: 2.1 to 2.5)

Unit–IV: Method of Successive Approximations and Fredholm Theory 15 hours

Method of successive approximations – Iterative scheme – Examples – Volterra integral equations –Examples – Some results about the resolvent kernel – The method of solution of Fredholmequation –Fredholm first theorem – Examples. (Book–2, Chapter 3, Sections:3.1to 3.5; Chapter 4,Sections: 4.1 to 4.3)

Unit–V: Applications to Ordinary Differential Equations 15 hours

Initial value problems – Boundary value problems – Examples – Singular integral equations – The Abel integral equations - Examples.
(Book–2, Chapter 5, Sections: 5.1 to 5.3; Chapter8, Sections: 8.1 to 8.2)

Prescribed Book

1. A. S. Gupta, *Calculus of Variations with Applications*, PHI, New Delhi, 2005.
2. Ram P.Kanwal, *Linear Integral Equations*, Theory and Techniques, Academic Press, NewYork, 1971.

Reference Books:

1. M. D. Raisinghania, *Integral Equations and Boundary Value Problems*, S. Chand & Co., New Delhi, 2007.
2. Sudir K. Pundir and RimplePundir, *Integral Equations and Boundary Value Problems*, PragatiPrakasam, Meerut. 2005.

E –Materials

http://www.maths.ed.ac.uk/~jmf/Teaching/Lectures/CoV.pdf

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- understand theconcept of calculus of variation and its applications
- discuss the various types of integral equations
- analysethe methods of successive approximations and fredholm theory
- acquire knowledge on applications to Ordinary Differential Equations.

OPEN ELECTIVE

PAPER - 4

(to choose one out of 3)

A. MATHEMATICAL ECONOMICS

Course Objectives:
The aim of the course is to introduce to

- study the theory of FIRM and perfect competition
- understand about market equilibrium and welfare economics

Unit-1: The Theory of FIRM **15 hours**
Basic Concepts - Optimizing Behavior - Input Demands - Cost Functions – JointProducts - Generalization to m variables - (Chapter 4: Sections 4.1 to 4.6)

Unit-2: CES Production **15 hours**
Homogeneous Production functions – CESProduction Function.
(Chapter 5: Sections5.1 and 5.2)

Unit-3: Perfect Competition **15 hours**
Assumptions of Perfect Competition - Demand Functions - Supply Functions – Commodity - Market Equilibrium - An application to Taxation.
(Chapter 6: Sections 6.1 to 6.5)

Unit-4: Market Equilibrium **15 hours**
Factor-Market Equilibrium - Existence and Uniqueness of Equilibrium - Stability of Equilibrium - Dynamic Equilibrium with Lagged Adjustment.
(Chapter 6: Sections 6.6 to 6.9)

Unit-5:Welfare Economics **15 hours**
Pareto Optimality - the efficiency of Perfect competition - The efficiency of Imperfect competition - External Effects in consumption and Production - Taxes and Subsidies – Social Welfare functions - The theory of Second Best.
(Chapter 11 : Sections 11.1 to 11.7)

Prescribed Book

James M. Henderson and Richard E. Quandt, Micro Economic Theory
A Mathematical Approach, (3rd Edn.) Tata McGraw Hill, New Delhi, 2003.

Reference Books

1. William J. Baumol. Economic Theory and Operations Analysis, Prentice Hall ofIndia, New Delhi, 1978
2. A.C.Chiang, Fundamental Methods of Mathematical Economics, McGraw Hill, NewYork, 1984
3. Michael D. Intriligator, Mathematical Optimization and Economic Theory, PrenticeHall, New York, 1971.

4. A. Kautsoyiannis, Modern Microeconomics (2 ndedn) MacMillan, New York, 1979

E –Materials

1. https://curlie.org/Science/Math/Applications/Mathematical_Economics_and_Financial_Mathematics/
2. http://master-economics-qem.univ-paris1.fr/about/?no_cache=1

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- understand the knowledge of FIRM theory and perfect competition
- analyse the CES production
- acquire the knowledge of market equilibrium
- control the stability of equilibrium
- discuss the welfare economics, taxes and subsidies

OPEN ELECTIVE

PAPER - 4

B. ENTREPRENEURIAL DEVELOPMENT

Course Objectives:

The aim of the course is to

- provide an understanding of basic concept in the area of entrepreneurship
- expose students to the idea generation, creating awareness of business opportunities, and familiarizing them with formal practices in effective project formation.
- provide insights to students on entrepreneurial finance and role of various government agencies in assisting entrepreneurship.

Unit-1: Introduction **15 hours**

Entrepreneur and Entrepreneurship – Concept – Definition - Classification of Entrepreneur – Women Entrepreneur - Functions of an Entrepreneur - Traits of successful Entrepreneur - Entrepreneurs Vs Professional Managers – Role of an Entrepreneur in Economic Development - Future challenges.

Unit-2: Entrepreneurial Development **15 hours**

Entrepreneurial Development Programmes – Meaning - Evolution and Objectives of EDP - Institutional efforts to develop Entrepreneurship - National Skill Development Corporation (NSDC) - Role of Government in Organising EDPs - Operational Problem of EDPs.

Unit-3: Project Management and Idea Generation **15 hours**

Project Management - Project Identification - Project Formulation - Project Design and Network Analysis – Overview of Project Appraisal - Project Report - Identification and Selection of Business Opportunity – Idea Generation – Overview of Techniques used for Idea Generation. - Individual creativity.

Unit-4: Entrepreneurial Finance and Development Agencies **15 hours**

Sources of Finance – Commercial Banks and Development Banks - Role of Agencies in assisting Entrepreneurship - District Industries Centers (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB).

Unit-5: Government Policies and Benefits **15 hours**

Tax Benefits – Tax Holidays – Allowance for deducting Depreciation – Rehabilitation Allowance – Benefits available for MSMEs: PMEGP – NEEDS – UYEGP.

Prescribed Books

1. Dr. S.S. Khanka, Entrepreneurship Development - S. Chand & Co., New Delhi.
2. Jayashree Suresh, Entrepreneurial Development –Margham Publication, Chennai.
3. VasantDesa, Dynamics of Entrepreneurial Development –Himalaya Publication.
4. Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, Entrepreneurship - Tata McGraw Hill Publishing Company Limited, New Delhi.
5. Ravindranath V. Badi&Narayana, Entrepreneurship, Vrinda Publication (P) Ltd, New Delhi.

References Books:

1. Rabindra N. Kanungo, Entrepreneurship and Innovation, Sage Publications, New Delhi.
2. Holt D. H., Entrepreneurship New Venture Creation. New Delhi: Prentice Hall of India.
3. Hisrich R, and Peters, M., Entrepreneurship. New Delhi: Tata McGraw Hill.
4. Rajkonwar A.B., Entrepreneurship, Kalyani Publisher, Ludhiana.
5. Charantimath, Poornima, Entrepreneurship Development and Small Business Enterprises, Pearson Education, New Delhi.

E-Materials:

1. http://www.indcom.tn.gov.in/pmegp.html
2. http://www.indcom.tn.gov.in/needs.html
3. http://www.indcom.tn.gov.in/uyegp.html

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- understand the knowledge of entrepreneurship
- analyse the entrepreneurial finance and role of various government agencies
- develop the idea generation, creating awareness of business opportunities, and familiarizing them with formal practices
- discuss the Government policies and benefits.

OPEN ELECTIVE

PAPER – 4

C. PROGRAMMING IN C++

Course Objectives:

- This course introduces a higher level language C++ for hands on experience on computers.

Unit –1: Tokens Expressions and control Structures **15 hours**

Tokens – Keywords – Identifiers and constants – Basic data types – Uses defined data types – Derived data types – Symbolic – Operators in C++ – Scope resolution operator – Manipolators – Operator overloading – Control structures. (Chapter 3: Sections: 3.1 to 3.24)

Unit –2: Functions **15 hours**

Characteristic of OOP – Function prototype – Default arguments – Inline functions – Function overloading – Template functions (Chapter 4: Sections: 4.2, 4.3, 4.6, 4.7, 4.9)

Unit-3: Classes in C++ **15 hours**

Classes –Constructors and destructors – Friend functions – Template classes – New and delete operators – Operator overloading. (Chapter 5: Sections: 5.1 to 5.15; Chapter 6: Sections: 6.1 to 6.9, Chapter 7: Sections: 7.1 to 7.5)

Unit –4: Inheritance **15 hours**

Single inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Virtual functions (Chapter 8: Sections: 8.1 to 8.8)

Unit-5: **Polymorphism in C++** **15 hours**

Polymorphism. (Chapter 9: Sections: 9.6,9.7)

Prescribed Book

E.Balagurusamy, Object Oriented Programming with C++, 4-e, Tata McGraw Hill Pub.Co,New Delhi,2001

Reference Books

1. E.Balagurusamy, Numerical Methods, Tata McGraw Hill Publishing Company Ltd , New Delhi,1999.
2. John.H.Mathews, Numerical Methods for Mathematics, Science and Engineering, 2-e
   Prentice Hall India Pvt.,Ltd, 2003.
3. S.S.Sastry , Introductory to Numerical Methods , Prentice Hall India Pvt., Ltd, 2000
4. H.C.Saxena,Finite Differences and Numerical Analysis, S.Chand& Company Ltd, New Delhi, 2005.

E-Materials:

http:// en.wikipedia.org/wiki//c++/programme.

Course Learning Outcomes

After the successful completion of this course, the students will be able to

- understand the concept of Tokens Expressions and control Structures
- analyse the types of functions and classes used in C++
- discuss the inheritance and various types of inheritance
- acquire the knowledge of Polymorphism in C++

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