Scheme and Syllabi of
M.Sc. Mathematics (Two Year) Course
Choice Based Credit System (w.e.f. 2020-2021)
Semester-I

Course Code	Title of the Course	External Marks	Internal Marks	Practical Marks	L:T:P	Credit	Total
Foundation Course							
MM-20-101	Office Automation Tools	30	20	50	2:0:6	5	100
Core Courses							
MM-20-102	Abstract Algebra-I	80	20	--	4:1:0	5	100
MM-20-103	Elementary Topology	80	20	--	4:1:0	5	100
MM-20-104	Real Analysis	80	20	--	4:1:0	5	100
Core Elective(Choose anyone Bouquet)							
Bouquet A (Any Two)							
MM-20-111	Number Theory	80	20	--	4:1:0	5	100
MM-20-112	Algebraic Coding Theory	80	20	--	4:1:0	5	100
MM-20-113	Design Theory	80	20	--	4:1:0	5	100
Bouquet B (Any Two)							
MM-20-121	Differential Geometry-I	80	20	---	4:1:0	5	100
MM-20-122	Mathematics for Finance and Insurance	80	20	--	4:1:0	5	100
MM-20-123	Difference Equations	80	20	--	4:1:0	5	100
Bouquet C (Any Two)							
MM-20-131	Probability Theory	80	20	--	4:1:0	5	100
MM-20-132	Statistical Methods	80	20	--	4:1:0	5	100
MM-20-133	Data Base Management System with SQL	30	20	50	2:0:6	5	100
	Total					30	600

29/10/2020

Semester-II

Course Code	Title of the Course	External Marks	Internal Marks	Practical Marks	L:T:P	Credit	Total
Foundation Course							
MM-20-201	Object Oriented Programming using C++	30	20	50	2:0:6	5	100
Core Courses							
MM-20-202	Abstract Algebra-II	80	20	--	4:1:0	5	100
MM-20-203	Ordinary Differential Equations-I	80	20	--	4:1:0	5	100
MM-20-204	Measure and Integration Theory	80	20	--	4:1:0	5	100
Core Elective (Choose anyone Bouquet)							
Bouquet A (Any Two)							
MM-20-211	Advanced Number Theory	80	20	--	4:1:0	5	100
MM-20-212	Algebraic Topology	80	20	--	4:1:0	5	100
MM-20-213	Fuzzy Set Theory	80	20	--	4:1:0	5	100
Bouquet B (Any Two)							
MM-20-221	Differential Geometry-II	80	20	---	4:1:0	5	100
MM-20-222	Advanced Numerical Analysis	80	20	--	4:1:0	5	100
MM-20-223	Classical Mechanics	80	20	--	4:1:0	5	100
Bouquet C (Any Two)							
MM-20-231	Probability Distribution	80	20	--	4:1:0	5	100
MM-20-232	Linear Programming	80	20	--	4:1:0	5	100
MM-20-233	Artificial Intelligence	80	20	--	4:1:0	5	100
Total						30	600

29/10/2020

Open Elective	
To be Chosen from the pool of open electives provided by the university (excluding the open elective prepared by the Department of Mathematics).	5

This courses will be taken as open elective by the students of other departments					
To be assigned by Examination Branch	Foundation of Mathematics	80	20	--	4:1:0

29/12/2020

Semester-III

Course Code	Title of the Course	External Marks	Internal Marks	Practical Marks	L:T:P	Credit	Total
Foundation Course							
MM-20-301	Functional Analysis	80	20	--	4:1:0	5	100
Core Courses							
MM-20-302	Complex Analysis	80	20	--	4:1:0	5	100
MM-20-303	Ordinary Differential Equations-II	80	20	--	4:1:0	5	100
MM-20-304	Project Work/Dissertation	160 (Evolution: 80Viva-voce:80)	40	--	10:0:0	10	200
Core Elective (Choose anyone Bouquet)							
Bouquet A (Any Two)							
MM-20-311	Algebraic Number Theory	80	20	--	4:1:0	5	100
MM-20-312	Lie Groups and Lie Algebra	80	20	--	4:1:0	5	100
MM-20-313	Advanced Fuzzy Set Theory	80	20	--	4:1:0	5	100
Bouquet B (Any Two)							
MM-20-321	Partial Differential Equations	80	20	---	4:1:0	5	100
MM-20-322	Fluid Dynamics	80	20	--	4:1:0	5	100
MM-20-323	Graph Theory	80	20	--	4:1:0	5	100
Bouquet C (Any Two)							
MM-20-331	Operations Research	80	20	--	4:1:0	5	100
MM-20-332	Parametric And Non Parametric Techniques	80	20	--	4:1:0	5	100
MM-20-333	Data Warehousing and Mining	30	20	50	2:0:6	5	100
Total						35	700

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Open Elective	
To be Chosen from the pool of open electives provided by the university (excluding the open elective prepared by the Department of Mathematics).	5

This courses will be taken as open elective by the students of other departments					
To be assigned by Examination Branch	Vedic Mathematics	80	20	--	4:1:0

29/10/2020

Semester-IV

Course Code	Title of the Course	External Marks	Internal Marks	Practical Marks	L:T:P	Credit	Total
Foundation Course							
MM-20-401	MATLAB	--	20	80	1:0:8	5	100
Core Courses							
MM-20-402	Integral Equations and Calculus of Variations	80	20	--	4:1:0	5	100
MM-20-403	Discrete Mathematics	80	20	--	4:1:0	5	100
MM-20-404	Wavelet Analysis	80	20	--	4:1:0	5	100
Core Elective (Choose anyone Bouquet)							
Bouquet A (Any Two)							
MM-20-411	Advanced Algebraic Coding & Number Theory	80	20	--	4:1:0	5	100
MM-20-412	Commutative Algebra	80	20	--	4:1:0	5	100
MM-20-413	Advanced Complex Analysis	80	20	--	4:1:0	5	100
Bouquet B (Any Two)							
MM-20-421	Elasticity	80	20	---	4:1:0	5	100
MM-20-422	Viscous Fluid Dynamics	80	20	--	4:1:0	5	100
MM-20-423	Mathematical Aspects of Seismology	80	20	--	4:1:0	5	100
Bouquet C (Any Two)							
MM-20-431	Econometrics	80	20	--	4:1:0	5	100
MM-20-432	Statistics through SPSS	--	20	80	1:0:8	5	100
MM-20-433	Big Data Analytics With R	30	20	50	2:0:6	5	100
	Total					30	600

Note: 1.Internal marks in each paper will be awarded by the concerned teacher on the basis of M.Sc. Mathematics Ordinance.

2. Size of Groups for all practicals and Viva-Voce examinations should not be more than twenty .

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contain two questions and the students shall be asked to attempt **one** question from each. Section - V shall be compulsory and contain **eight** short answer type questions without any internal choice covering the entire syllabus.

Note 3 : Elective courses can be offered subject to availability of requisite resources/ faculty.

(Prof. Khalid Ahmed) (Prof. Manju Pruthi) (Dr. Anupam Bhatia)

MM-20-101: Office Automation Tools

Maximum Marks : 100 **External: 30**
Time : 2 Hours **Internal: 20**
Practical: 50

Course Objectives:

1. To understand the important Application software used in office automation.
2. To provide the concepts word processing software for document writing.
3. To provide internet, multimedia and animation concepts.
4. To get familiar with Windows Operating System.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 4 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 6 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 6 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

UNIT-I

Word Processing: Starting Word Processing software, Creating and saving a document, Opening a document, Inserting, selecting, copying, moving, deleting and pasting, text, Undoing ,redoing, Applying bold, italic, underline style on text, changing size, color and font of text, using Format painter, aligning text, Formatting paragraphs: Line spacing, paragraph indents, space before and after paragraph, using bullets and numbering in paragraphs, Spelling and grammar, Autocorrect, inserting page number, page break, header and footer, border and shading, inserting picture, shapes and screenshot, using Mail merge.

UNIT-II

Spreadsheet Designing: Starting Excel, Workbook and Worksheet or Spreadsheet, Aligning and formatting data in cells, Cell range, Math, Trigonometric, Date and Time, Logical, Text and Statistical Functions, AutoSum, inserting/deleting rows, columns and cells, Merge and center, creating charts (column, line, pie, bar), changing column width and row height, using IF() function, Sorting data, Filtering data.

UNIT-III

Lookup and Reference Functions, Database Functions, Information Functions, Using conditional formatting with multiple cell rules, creating new rules and managing existing rules, Creating Pivot Table, Using Pivot Table Options, Changing and Updating Data Range, Formatting Pivot Table and making Dynamic Pivot Table, Creating Pivot Chart, Types of Pivot Charts and their usage, Formatting Pivot Charts and making Dynamic Pivot Charts.

UNIT-IV

Presentation Designing: Starting Presentation software, Creating New Presentation, adding slides, Entering/Editing Text in Slides, Formatting text and paragraph, inserting a picture, Clip Art and Screenshot, Inserting Chart, Shapes, Word Art, Text Box, Inserting table, PowerPoint Views, Slideshow, Slide Transition Effects, Animation, Inserting Video and Audio, Printing Presentation Slides

Suggested Readings:

1. Taxali , Ravi Kant, *"Computer Course"*, Mc Graw Hill Education, 2014.
2. Saxena , Sanjay, *"A First Course in Computers"*, Vikas Publishing House, 2015.
3. Balagurusami , E., *"Fundamentals of Computers"*, Mc Graw Hill, 2009.
4. Weverka, Peter, *"Office 2010 All-in-One for Dummies"*, Wiley Publishing, Inc , 2010.

MM-20-102: Abstract Algebra-I

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**
Course Objectives :-

1. To provide a first approach to the subject of algebra which is one of the basic pillars of modern mathematics.
2. To study of certain structure called solvable and nilpotent group with some related structure.
3. To study Fields in detail with a focus on Galois theory.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Symmetric group and centralizers in S_n, Normal and subnormal series, Composition series, Solvable series, Derived series, Solvable group, Solvability of S_n– the symmetric group of degree $n \geq 2$. Zassenhaus lemma and Jorden Holder Theorem.

Unit-II

Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Upper and lower central series, Sylow-p subgroups, Sylow theorems with simple applications. Description of group of order p and pq, where p and q are distinct primes (In general survey of groups upto order 15)

Unit-III

Recapitulation of Rings, Field theory, Extension of fields, algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions, Algebraically closed fields.

Unit-IV

Perfect fields, Finite fields, Automorphism of field extensions, Fixed fields, Galois extensions, Normal extensions and their properties, Fundamental theorem of Galois theory.

Suggested Readings:

1. P.M.Cohn,BasicAlgebra;Groups,Rings and Fields,Springer,2005.
2. D.S.Dummit and R.M.Foote,Abstract Algebra,3e,Wiley India Pvt.Ltd.,2011.
3. M.F.Atiyah and I.G.MacDonald,Introduction to Commutative Algebra,CRCPress,taylor&Francis,2018.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Combridge University Press, Indian Edition, 1997.
5. D.S. Malik, J.N. Mordenson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
6. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 4e,2018..
7. Charles Lanski, Concepts in Abstract Algebra, American Mathematical Society First Indian Edition, 2010.
8. M. Artin, "Algebra," Pearson Prentice-Hall of India, 2e,2011.
9. I.S. Luther and I.B.S. Passi, Algebra, Narosa Publishing House,2013.

MM-20-103:Elementary Topology

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. **To be familiar with the concepts of topological space and continuous functions.**
2. **To generate new topologies from a given set with bases.**
3. **To describe the concept of homeomorphism and topological invariants.**
4. **To have in-depth knowledge of separation axioms and their properties.**

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Definition and examples of topological spaces, Comparison of topologies on a set, Intersection and union of topologies on a set,Neighbourhoods, Neighbourhood system of a point and its properties,Interior point and interior of a set, interior as an operator and its properties,definition of a closed set as complement of an open set, limit point (accumulation point) of a set, derived set of a set, adherent point (Closure point) of a set, closure of a set, closure as an operator and its properties, boundary of a set.

Unit-II

Dense sets. Characterization of dense set.Base for a topology and its characterization, Base for Neighbourhood system, Sub-base for a topology. Relative (induced) Topology or subspace of a topological space.Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator.

Unit-III

First countable, Second countable and separable spaces, their relationships and hereditary property. About countability of a collection of disjoint open sets in a separable and a second countable space, Lindelof theorem.Definition, examples and characterisations of continuous functions, composition of continuous functions, Open and closed functions, Homeomorphism, embedding.

Unit-IV

Tychonoff product topology, projection maps, their continuity and openness, Characterization of product topology as the smallest topology with projections continuous. T0 , T1 , T2 , Regular and T3 Separation axioms, their characterization and basic properties i.e. hereditary and productive properties.Completely regular and Tychonoff (T 3 1/2), spaces, their hereditary and productive properties.

Suggested Readings:

1. C.W.Patty, Foundation of Topology, Jones &Bertlett, 2008.
2. Fred H. Croom, Principles of Topology, Cengage Learning, 2002.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGrawHill Book Company, 1963.
4. J. L. Kelly, General Topology, Springer Verlag, New York, 1991.
5. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
6. K. ChandrasekharaRao, Topology, Narosa Publishing House Delhi, 2017.
7. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, 2014.
8. Khalil Ahmad, Introduction to Topology, Narosa Publishing House, New Delhi, 2019.

MM-20-104:Real Analysis

Maximum Marks: 100
Time: 3 Hours **External: 80**
Course Objectives: **Internal: 20**

1. To understand Metric Space, Sequences in Metric spaces and convergence.
2. To learn about point wise and uniform convergence of sequence and series of functions
3. To be familiar with the chain rule, partial derivatives and concept of derivation in an open subset Rn
4. To learn about Compactness, functions continuous on compact sets.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Metric Space and examples, open sets, closed sets, neighbourhood, unitary space, Euclidean space, Sequences in Metric spaces and convergence, Cauchy sequences.

Unit-II

Complete metric spaces and examples, Continuity, spaces of continuous functions. Compactness functions continuous on compact sets, Bolzano-Weierstrass property.

Unit-III

Sequence and series of functions, Point wise and uniform convergence, Cauchy criterion for uniform convergence, WeierstrassMtest, Uniform convergence and continuity, Weierstrass approximation theorem

Unit-IV

Functions of several variables, Linear Transformations, Derivatives in an open subset R^n, Chain Rule, Partial derivatives, Young and Schwarz theorems, Taylor theorem, Explicit and implicit functions, Implicit function theorem, Inverse function theorem.

Suggested Readings:

1. Simmons, G. F. Introduction to Topology and Modern Analysis. McGraw-Hill Pvt. Ltd. 1963.
2. Apostol, T. M. Mathematical Analysis. Wesley Publishing Co.1985.
3. Kumaresan, S. Topology of Metric Spaces.Narosa Publishing House, 2011.
4. Walter, R. Principles of Mathematical Analysis. 3rd edition, McGraw-Hill, 1976.
5. Malik, S. C. and Arora, S. Mathematical Analysis.4thedition. New Age International Publishers, 2010.
6. Royden, H. L. Real Analysis, Macmillan Pub. Co., Inc. 4th edition, New York, 1993.
7. Jain P. K. and Ahmad K. Metric Spaces. 3rd Edition Narosa Publishing, New Delhi, 2019.

MM-20-111: Number Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand Well ordering principle, divisibility, division algorithm.
2. To learn about Linear Diophantine equation, Pythagorean triangles, assorted examples.
3. To be familiar with the Farey sequences, Farey sequence of order n. rational approximations, Hurwitz theorem.
4. To learn about Ternary quadratic forms, rational points on curves, Fermat numbers, Euler's function and its properties.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Well ordering principle, divisibility, division algorithm, G.C.D.(greatest common divisors), L.C.M.(least common multiple), Gauss theorem, primes, perfect number, Euclid's first theorem, Fundamental Theorem of Arithmetic or Unique Factorization theorem, Euclid's second theorem, congruences, basic properties of congruence, solutions of congruences.

Unit-II

Linear Diophantine equation i.e. equations of the type ax+by = c, the necessary and sufficient condition that the linear Diophantine equation has a solution in integers. examples of linear Diophantine equation. simultaneous linear equations, unimodular matrix and its equivalent properties. Pythagorean triples, assorted examples.

Unit-III

Farey sequences, Farey sequence of order n. rational approximations, Hurwitz theorem, irrational numbers, Geometry of Numbers, Minkowski's Convex body theorem, Lagrange's four square theorem.

Unit-IV

Ternary quadratic forms, rational points on curves, Fermat numbers, Fermat numbers are relatively prime, properties of Fermat numbers, Mersenne numbers, Fermat's theorem, Wilson's theorem, converse of Wilson's theorem, Euler's function and its properties, multiplicative function, Euler's generalization of Fermat's theorem.

Suggested Readings:

1. An Introduction to the Theory of Numbers Ivan Niven ,Herbert S. Zuckerman, Hugh L. Montgomery, John Wiley & Sons(Asia)Pte.Ltd. 1991.
2. Number Theory, An Introduction to Mathematics, Second edition, W.A. Coppel, Springer 2009.
3. G.H.Hardy and E.M. Wright,An introduction to the theory of Numbers,Oxford University Press,2008.

MM-20-112:Algebraic Coding Theory

Maximum Marks: 100 **External: 80**
Time:3Hours **Internal: 20**
Course Objectives:

1. To understand Block Codes, Minimum distance of a code, Group codes.
2. To learn about Polynomial codes, Weight of a code polynomial, Matrix code.
3. To be familiar with the Construction of finite fields, Primitive polynomials over finite fields.
4. To learn about Hamming codes, Cyclic codes, Generator polynomial of a cyclic code, Check polynomial of a cyclic code.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit–I

Block Codes, Minimum distance of a code, Decoding principle of maximum likelihood, Binary error detecting and error correcting codes, Group codes, Minimum distance of a group code (m, m+1) parity check code, Double and triple repetition code, Matrix codes, Generator and parity check matrices, Dual codes.

Unit-II

Definition of polynomial ring, Polynomial codes, Weight of a code polynomial, Exponent of a polynomial over the binary field, double error, Generator and parity check matrices- general case, Matrix code, Relation between polynomial code and matrix code.

Unit -III

Finite fields.Construction of finite fields.Primitive element of a finite field.Irreducibility of polynomials over finite fields.Irreducible polynomials over finite fields.Primitive polynomials over finite fields.The number of irreducible polynomials over a finite field.Generator polynomial of a Bose-Chaudhuri-Hocqhenghem codes (BCH codes) construction of BCH codes over finite fields.

Unit-IV

Binary representation of a number, Hamming codes, Procedure for forming a Hamming code, Minimum distance of a Hamming code. Cyclic codes, Generator polynomial of a cyclic code, Check polynomial of a cyclic code, Equivalent code and dual code of a cyclic code. Hamming and BCH codes as cyclic codes.Self dual binary cyclic codes.

Suggested Readings:

1.L.R. Vermani : Elements of Algebraic Coding Theory, Chapman and Hall Mathematics,1996.
2. Elwyn R.Berlekamp,Algebraic coding theory,River edge U.S.,2015.
3.Ron M.Roth,Introduction to Coding Theory,Cambidge University press,2006.

MM-20-113: Design Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand Incidence Matrices, Isomorphisms and Automorphisms.
2. To learn about Residual and Derived BIBDs, Projective Planes and Geometries.
3. To be familiar with Quadratic Residue Difference Sets, Singer Difference Sets.
4. To learn about Hadamard Matrices, An Equivalence Between Hadamard Matrices and BIBDs. Bent Functions.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Introduction to Balanced Incomplete Block Designs: What Is Design Theory? Basic Definitions and Properties, Incidence Matrices, Isomorphisms and Automorphisms, Constructing BIBDs with Specified Automorphisms, New BIBDs from Old, Fishers Inequality.

Unit-II

Symmetric BIBDs: An Intersection Property, Residual and Derived BIBDs, Projective Planes and Geometries, TheBruck-Ryser-Chowla Theorem. Finite affine and projective planes.

Unit-III

Difference Sets and Automorphisms: Difference Sets and Automorphisms, Quadratic Residue Difference Sets, Singer Difference Sets, The Multiplier Theorem, Multipliers of Difference Sets, The Group Ring,Proof of the Multiplier Theorem, Difference Families, A Construction for Difference Families.

Unit-IV

Hadamard Matrices and Designs: Hadamard Matrices, An Equivalence Between Hadamard Matrices and BIBDs, Conference Matrices and Hadamard Matrices, A Product Construction, Williamson's Method, Existence Results for Hadamard Matrices of Small Orders, Regular Hadamard Matrices, Excess of Hadamard Matrices, Bent Functions.

Suggested Readings:

1. D. R. Stinson, Combinatorial Designs: Constructions and Analysis, Springer, 2004.
2. W.D. Wallis, Introduction to Combinatorial Designs, (2nd Ed), Chapman & Hall, 2007.
3. D. R. Hughes and F. C. Piper, Design Theory, Cambridge University Press, Cambridge, 1988
4. T. Beth, D. Jungnickel and H. Lenz, Design Theory, Volume 2 (Second Edition), Cambridge University Press, Cambridge, 2011.

KAhmad

MM-20-121:Differential Geometry-I

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :

1. To apply the concepts of differential geometry of curves & surfaces.
2. To understand the curvature & torsion of a space curve.
3. To explain the concept of Tensors.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Tensors: Notations and summation Convention, Transformation law for vectors, Cartesian tensors, Algebra of Cartesian tensors, Algebra if Cartesian tensors Differentiation of Cartesian tensors Differentiation of Cartesian tensors The metric tensor

Unit-II

Transformation of curvilinear co-ordinates, General tensors, Contravariant, Covariant derivative of a vector, Physical components Christoffel symbol, Relation with the metric tensor, Covariant derivative of a tensor, Reimann- Christoffel curvature tensor

Unit-III

Curves with Torsion: Tangent, Principal normal, Curvature, Binormal, Torsion Serret – Frenet Formulae

Unit -IV

Locus of centre of curvature, Locus of centre of Spherical curvature, Locus of centre of Spherical Curvature, Surfaces, Tangent Plane, Normal, Envelope, Characteristics, Edge of regression.

Suggested Readings:

1. W.Kuhnel,Differential Geometry:Curves-Surfaces-manifolds,3e,American Mathematical Society,2013.
2. A.Pressely,Elementary Differential Geometry,Springer,India,2004.
3. J.A.thorpe,elementary Topics in Differential Geometry,Springer,India,2004
4. A.Mishchenko and A.Formentko,A Course of Differential Geometry and Topology,Mir Publisher Moscow,1988.

MM-20-122:Mathematics for Finance and Insurance

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :

1. To introduce & develop many of mathematical tools which are used in Finance and Insurance.
2. To understand Financial management.
3. To understand Insurance Fundamental and life insurance mathematics.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Financial Management – overview. Nature and scope of financial management. Goals and main decisions of financial management. Difference between risk, Speculation and gambling.

Time value of Money - Interest rate and discount rate. Present value and future value- discrete case as well as continuous compounding case. Annuities and its kinds.

Unit-II

Meaning of return. Return as Internal Rate of Return (IRR). Numerical methods like Newton Raphson method to calculate IRR. Measurement of returns under uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurements of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe Single Index Model- Systematic Risk and Unsystematic Risk.

Unit-III

Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds.

Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, Peril, Hazard, proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures- feature of a loss that is ideal for insurance.

Unit-IV

Life Insurance Mathematics – Construction of Morality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life. Determination of claims for General Insurance – Using Poisson Distribution and Negative Binomial Distribution –the Polya Case.

Determination of the amount of Claims of General Insurance – Compound Aggregate claim model and its properties. Claims of reinsurance. Calculation of a compound claim density function F, Recursive and approximate formulae for F.

Suggested Readings:

1. Aswath Damodaran, Corporate Finance - Theory and Practice, John Wiley & Sons, Inc.
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of India Private Ltd.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englwood Cliffs, New Jersey.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. Salih N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
7. Robert J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Sprigner-Verlag, New York Inc.

MM-20-123:Difference Equations

Maximum Marks : 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:-

1. To be familiar with the Difference Equation.
2. Derive and solve Difference Equations.
3. Apply the concept of stability of linear and non linear systems.
4. To get knowledge of phase plane analysis for linear systems.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Difference Calculus: Introduction, The Difference Operator, Summation, Generating functions and Approximate Summation.

Unit-II

Linear Difference Equations: First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can be Linearized, The z-Transform.

Unit-III

Stability Theory: Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior.

Unit-IV

Asymptotic Methods: Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations.

Suggested Readings:

1. Walter Kelley and Allan Peterson, Difference Equations, An Introduction with Applications, Academic Press.
2. Calvin Ahlbrant and Allan Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations, Kluwer1996.
3. Saber Elaydi, An Introduction to Difference Equations, Springer.

MM-20-131:Probability Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. The aim of the course is to understand concept of Random experiments and variables.
2. To explain moment generating function and modes of convergence.
3. To understand different form of weak law of convergence.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Random Experiment, Sample Space, Events – Simple, Composite, Mutually Exclusive and Exhaustive,Events, Various Definitions of Probability, Properties of probability function, Addition Theorem, Boole's and Bonferroni's Inequalities, Conditional Probability, Multiplication Theorem, Baye's Theorem,Independence of Events.

Unit-II

Random Variables and Distribution Functions, Probability Mass function, Probability density Function,Two Dimensional Random Variables- Joint , Marginal and Conditional Distributions, Independence of Random Variables.Moments of Random Variables – Expectation, Variance, Covariance, Conditional and Marginal,Expectation.

Unit-III

Probability and Moment Generating Function and their Properties, Characteristic Function and its properties, Continuity Theorem Inversion Theorem , Uniqueness Theorem of Characteristic Function, Moment Inequalities of Hölder, Minkowski, Jensen's , Cauchy- Schwartz and Lyapunov's

Unit-IV

Modes of Convergence -Convergence in Probability, almost surely, in the rth mean and in distribution, their relationship. Probability Inequalities of Chebychev and Markov , Weak Law of large numbers-Chebychev's, Bernoulli's and Khintchine's Weak Law of Large Numbers, necessary and sufficient conditions for the WLLN,
BorelCantelli Lemma, Kolmogorov inequality, Strong law of large numbers-Kolmogorov's theorem. Central Limit Theorem, Lindeberg - Levy and Demoivre- Laplace forms of CLT.

Suggested Readings:

1. P. L.Meyer ,Introductory Probability and Statistical Applications ,Addison Wesley
2. A.M.Goon,M.K.Gupta and B.Dasgupta,An Outline of StatisticalTheory, Vol. I,World Press
3. Freund J.E.Freund, Mathematical Statistics ,Prentice Hall
4. P.Mukhopadhya, Mathematical Statistics ,New Central Book Agency
5. V. K.Rohatgi and A.K.Saleh,An Introduction to Probability and Statistics, Second ed.,John Wiley
6. W.Feller, An Introduction to Probability Theory and its Applications,3rd ed.,Vol. I, John Wiley & Sons

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MM-20-132:Statistical Methods

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives:-

1. To familiarize the students with Statistics.
2. To present data in different ways.
3. To explain Measures of Dispersion and Charlier's check.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Introduction of Statistics: Origin, Development, Definition, Scope, Uses and Limitations. Types of Data: Qualitative and Quantitative Data, Nominal and Ordinal Data, Cross Sectional and Time Series Data, Discrete and Continuous Data, Frequency and Non-Frequency Data.Collection and Scrutiny of Data: Collection of Primary and Secondary Data-its Major Sources including Some Government Publications, Scrutiny of Data for Internal Consistency and Detection of Errors of Recording, Classification and Tabulation of Data.

Unit-II

Presentation of Data: Diagrammatic and Graphical Presentation of Grouped Data: Graphing the Data Constructing Histograms, Frequency Polygon, Frequency Curve and Ogives.Measures of Central Tendency and Location: Mean, Median, Mode, Geometric Mean, Harmonic Mean; Partition Values-Quartiles, Deciles, Percentiles and their Graphical Location.

Unit-III

Measures of Dispersion: Absolute and Relative Measures of Range, Quartile Deviation, Mean Deviation, Standard Deviation (σ). Root Mean Square Deviation(s), Relation between σ and S, Variance of the Combined Series, Coefficient of Variation.Moments, Skewness and Kurtosis: Moments about Mean and about any Point and Derivation of their Relationships, Effect of Change of Origin and Scale on Moments, Sheppard's Correction for moments (without derivation).

Unit-IV

Charlier's checks; concepts of Skewness, Kurtosis and their Measures/Coefficients.Theory of Attributes: Symbolic Notations, Dichotomy of Data, Class Frequencies, Order of Class Frequencies, Consistency of Data, Independence and Association of Attributes, Yule's Coefficient of Association and Coefficient of Colligation.

Suggested Readings:

1 .A.M.Goon.,M.K.Gupta, and B. Das Gupta. Fundamentals of Statistics, Vol-I.
2. P.Mukhopadhayaya, Mathematical Statistics.
3. R.V.Hogg& A.T. Craig, Introduction to Mathematical Statistics.

MM-20-133: Data Base Management System With SQL

Maximum Marks : 100 **External: 30**
Time : 2 Hours **Internal: 20**
Practical:50

Course Objectives :-

1. To understand the basic concept of DBMS.
2. To know about the Entity relationship model.
3. To get familiar Structured Query Language.
4. To acquire the knowledge of Transaction Processing Concepts of Relational Database.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 4 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 6 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 6 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

UNIT- I

Basic Concepts: Definition of Data Base and Data Base Management System, File Systems vs. DMBS, Characteristics of the Database Approach, Abstraction and Data Integration, Database users, Advantages and Disadvantages of DBMS. Database Systems Concepts and Architecture: Data Models, Schema and Instances, DBMS architecture, Data Independence, Database languages, DBMS functions.

UNIT - II

Entity Relationship Model: Purpose of ER Model, Entity Types, Entity Sets, Attributes, keys, Relationships, Roles and Structural Constraints, E-R Diagrams, Design of an ER Database Schema, Reduction of an ER schema to Tables. Relational Data Model: Relational Model Concepts, Integrity Constraints over Relations, Relational Algebra – Basic Operations.

UNIT - III

SQL: Data Definition and Data Types, DDL, DML, and DCL, Views & Queries in SQL, Specifying Constraints & Indexes in SQL. Relational Database Management System: ORACLE-Basic structure, Storage Management in ORACLE Database Structure & implementation in ORACLE, Programming ORACLE Applications. Conventional Data Models: Network and Hierarchical Data Models.

UNIT - IV

Relational Database Design: Functional Dependencies, Decomposition, Normal forms based on primary keys- (1NF, 2NF, 3NF, BCNF), Multi-valued Dependencies, 4 NF, Join dependencies, 5 NF. Transaction Processing Concepts: Introduction to Transaction, Properties of Transaction, Transaction Processing System Concepts, Schedules and Recoverability, Serializability of Schedules.

Suggested Readings:

1. Elmasri, R. and Navathe, S. B., *"Fundamentals of Database Systems"*, Pearson Education, 7th Edition, 2017.
2. Silberschatz, A., Korth, H. F., Sudarshan, S., *"Database System Concepts"*, McGraw Hill, 6th Edition, 2010.
3. Ramakrishnan, R., Gehrke, J., *"Database Management Systems"*, McGraw Hill, 3rd Edition, 2002
4. Bayross, Ivan, *"SQL, PL/SQL the Programming Language of Oracle"*, BPB Publication, 4th Edition, 2010.

MM-20-201:Object Oriented Programming using C++

Maximum Marks : 100 **External : 30**
Time : 2 Hours **Internal : 20**
Practical:50

Course Objectives :-

1. To understand the concept of mapping real objects into programming constructs.
2. To know about various Object oriented techniques like Inheritance, Polymorphism.
3. To get the idea of Templates.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 4 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 6 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 6 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

UNIT-I

Structure of C++ program: Data-types, Variables, Static Variables, Operators in C++, Arrays, Strings, Structure, Functions, Recursion, Control Statements.

Introduction to Class: Class Definition, Classes and Objects, Access Specifiers: Private, Public and Protected, Member functions of the class, Constructor and Destructor, Parameterized Constructor, Copy Constructors.

UNIT-II

Inheritance: Reusability, Types of Inheritance: Single inheritance, Multiple, Multilevel, Hybrid Inheritance, Public, Private, and Protected Derivations, Using derived class, Constructor and destructor in derived class, Object initialization and conversion, Nested classes(Container classes), Virtual Inheritance and Virtual base class.

UNIT-III

Polymorphism: Function Overloading, Static Class Members, Static Member Functions, Friend Functions, Operator Overloading: Unary and Binary Operator Overloading. Abstract class, Virtual function, Pure virtual function,Overloading vs. Overriding. Memory management: new,delete, object Creation at Run Time, This Pointer. Exception handling: Throwing, Catching, Re-throwing an exception, specifying exceptions, processing unexpected exceptions, Exceptions when handling exceptions, resource capture and release.

UNIT-IV

Templates: Introduction, Class templates and Function templates, Overloading of template function, namespaces. Introduction to STL: Standard Template Library: benefits of STL, containers, adapters, iterator, vector, list.

Suggested Readings:

1. Stroustrup Bjarne, *"The C++ Programming Language"*, Addison-Wesley Professional, 4th Edition.
2. Scildt Herbert, "*The Complete Reference C++* ", Tata McGraw-Hill, 4th Edition.
3. Lafore Robert, "*Object Oriented Programming in C++*", Pearson, 4th Edition
4. Lippman S.B., Lajoei J., Moo B.E., *"C++ Primer"*, Pearson, 4th Edition

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MM-20-202:Abstract Algebra-II

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :-

1. To provide the knowledge of modules and its properties.
2. To distinguish between free and semi simple modules.
3. Define and characterize Noetherian and Artinian modules.
4. To provide concepts of Canonical forms of Linear Transformations

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit- I

Modules,Cyclic modules, Simple and semi-simple modules, Schur's lemma, Free modules, Fundamental structure theorem of finitely generated module over principal ideal domain and its applications to finitely generated abelian groups.

Unit-II

Neotherian and Artininan modules and rings with simple properties and examples, Nil and Nilpotent ideals in Neotherian and Artinian rings, Hilbert Basis theorem.

Unit-III

$Hom_R(R,R)$, Opposite rings, Wedderburn – Artin theorem, Maschk's theorem, Equivalent statement for left Artinian rings having non-zero nilpotent ideals, Uniform modules, Primary modules .

Unit-IV

Canocnical forms : Similarity of linear transformations, Invariant subspaces, Reduction to triangular form, Nilpotent transformations, The primary decomposition theorem, Rational canonical forms, Jordan blocks and Jordan forms.

Suggested Readings:

1. N.Jacobson,BasicAlgebra,Volumes I&II,2e,Dover Publications,2009
2. D.S.Dummit and R.M.foote,Abstract Algebra,3e,Wiley India Ltd.,2011
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 2006.
4. P.B. Bhattacharys, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. M. Artin, Algebra, Prentice-Hall of India, 2011
6. P.M.Cohn,ClassicAlgebra,JohnWiley&Sons Ltd.,2000.
7. I.S. Luther and I.B.S. Passi, Algebra, Narosa Publishing House,2013.

MM-20-203: Ordinary Differential Equations-I

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand concept of Existence and uniqueness theory of solution of an ordinary differential equation.
2. To apply differential equations to variety of problems in diversified fields of life.
3. To learn use of differential equations for modeling and solving real life problems.
4. To Interpret the obtained solutions in terms of the physical quantities involved in the original problem under reference.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Initial value problem and equivalent integral equation, ε-approximate solution, Equicontinuous family of functions, Ascoli-Arzela theorem, Cauchy-Peano existence theorem.Uniqueness of solutions, Lipschitz condition.Differential inequalities and uniqueness.

Unit-II

Picard-Lindelof theorem for local existence and uniqueness of solutions, solution of initial-value problems by Picard method, Gronwall's inequality, Linear differential systems: Definitions and notations. Linear homogeneous systems, Fundamental matrix, Adjoint systems, reduction to smaller homogeneous systems.

Unit-III

Nonhomogeneous linear systems; variation of constants.Linear systems with constant coefficients.Linear systems with periodic coefficients, Floquet theory. Higher order equations: Linear differential equation (LDE) of order n; Linear combinations, Linear dependence and linear independence of solutions.

Unit-IV

Wronskian theory: Definition, necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE. Abel's Identity, Fundamental set.
More Wronskian theory.Reduction of order.Non-homogeneous LDE.Variation of parameters.Adjoint equations, Lagrange's Identity, Green's formula.Linear equation of order n with constant coefficients.

Suggested Readings:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons, 1980.
3. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
4. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
5. G.F. Simmons, Differential Equations, Tata McGraw-Hill, 1993
6. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
7. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub. 2001.
8. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 2006.

MM-20-204:Measure and Integration Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To describe the shortcomings of Riemann integral and benefits of Lebesgue integral.
2. To understand the fundamental concept of measure and Lebesgue measure.
3. To learn about the Lebesgue Integral of a bounded function over a set of finite measure and its properties.
4. To be familiar with Measurable functions as nearly continuous functions.

two alternatives

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of a set of real numbers, Algebra of measurable sets, Borel set.

Unit-II

Equivalent formulation of measurable sets in terms of open, Closed, F_σ and G_δ sets, Nonmeasurable sets. Measurable functions and their equivalent formulations Properties of measurable functions Approximation of a measurable function by a sequence of simple functions. Measurable functions as nearly continuous functions.

Unit-III

Egoroff theorem, Lusin theorem, Convergence in measure and F. Riesz theorem Almost uniform convergence Short comings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties Lebesgue integral as a generalization of Riemann integral.

Unit-IV

Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, Integral of non-negative functions, Fatou Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Suggested Readings:

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, International Student Edition, 1976.
2. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
3. P. K. Jain and V. P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986.
4. G.De Barra, Measure Theory and Integration, Wiley Eastern Ltd, 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.1976.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Ed, 2011.

MM-20-211:Advanced Number Theory

Maximum Marks: 100 **External:80**
Time:3Hours **Internal: 20**

Course Objectives:

1. To understand continued fraction, simple continued fraction, infinite continued fractions.
2. To learn about Periodic continued fractions, Pell's equation, Partitions, Ferrers Graphs.
3. To be familiar with the Euler's formula, divisibility property, Quadratic residues.
4. To learn about Division Algorithm of polynomials, factor theorem, generalization of factor theorem.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Euclidean algorithm, continued fraction, simple continued fraction, infinite continued fractions, irrational numbers, approximations to irrational numbers.

Unit-II

Best possible approximations, Hurwitz theorem, Periodic continued fractions, Pell's equation, Partitions, definition of Ferrers Graphs, Formal power series, generating functions and Euler's identity.

Unit-III

Euler's formula, bounds on P(n), Jacobi's formula, a divisibility property, Quadratic residues, Legendre symbols, Properties of Legendre symbol.

Unit-IV

Gauss lemma, Gauss Reciprocity law, Jacobi's symbol,Division Algorithm of polynomials, factor theorem, generalization of factor theorem, alternative proof of Wilson's theorem, definition of congruence of polynomials and equivalent polynomials, Chevelees theorem, Warning's theorem.

Suggested Readings:

1. An Introduction to the Theory of Numbers Ivan Niven ,Herbert S. Zuckerman, Hugh L. Montgomery, John Wiley & Sons(Asia)Pte.Ltd. 1991.
2. Number Theory, An Introduction to Mathematics, second edition, W.A. Coppel, Springer 2009.

MM-20-212 :Algebraic Topology

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand Homotopy, Path homotopy, The fundamental group.
2. To learn about Fundamental group of the projective space, Fundamental group of wedge of circles.
3. To be familiar with Equivalence of covering spaces, Universal covering space.
4. To learn aboutcomputation of simplicial Homology groups for S2, T2.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Homotopy.Path homotopy.The fundamental group.Simply connected spaces.Covering spaces.Path lifting and homotopy lifting lemma.Fundamental group of the circle.

Unit-II

Deformation retracts and homotopy types. Fundamental group of Sn. Fundamental group of the projective space. Brower fixed point theorem. Fundamental theorem of algebra.Borsuk-Ulam theorem. Seifert-Van Kampen Theorem (without proof). Fundamental group of wedge of circles.Fundamental group of the torus.

Unit-III

Equivalence of covering spaces.The lifting lemma.Universal covering space.Covering trans-formations and group actions.The classification of covering spaces.

Unit-IV

Δ-Complexes, Simplicial Homology, computation of simplicial Homology groups for S2, T2.

Suggested Readings:

1. James Munkres, Topology, Prentice Hall of India, 2000.
2. Alan Hatcher, Algebraic Topology, Cambridge University Press, 2002.
3. John Lee, Introduction to Topological Manifolds, Springer GTM, 2011.
4. James Munkres, Elements of Algebraic Topology, Addison Wesley, 1984.

MM-20-213:Fuzzy Set Theory

Maximum marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To be familiar with convex fuzzy sets, standard fuzzy set operations.
2. To understand the concept of decomposition theorems of fuzzy sets, Extension principle for fuzzy sets.
3. To learn about equilibrium of a fuzzy complement, algebraic product, bounded difference and drastic intersection.
4. To demonstrate the idea of conversion of decreasing generators and increasing generators to each other.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Fuzzy Sets: Basic definitions, a-cuts, strong a-cuts, level set of a fuzzy set, support of a fuzzy set, the core and height of a fuzzy set, normal and subnormal fuzzy sets, convex fuzzy sets, cutworthy property, strong cutworthy property, standard fuzzy set operations, standard complement, equilibrium points, standard intersection, standard union, fuzzy setinclusion, scalar cardinality of a fuzzy set, the degree of subsethood.

Unit-II

Additional properties of a-cuts involving the standard fuzzy set operators and the standard fuzzy set inclusion, Representation of fuzzy sets, three basic decomposition theorems of fuzzy sets, Extension principle for fuzzy sets, Images and inverse images of fuzzy sets, proof of the fact that the extension principle is strong cutworthybut not cutworthy.

Unit-III

Operators on fuzzy sets: types of operations, fuzzy complements, equilibrium of a fuzzy complement, equilibrium of a continuous fuzzy complement, first and second characterization theorems of fuzzy complements, fuzzy intersections (t-norms), standard fuzzy intersection as the only idempotent t-norm, standard intersection, algebraic product,
bounded difference and drastic intersection as examples of t-norms, decreasing generator, the Pseudo-inverse of a decreasing generator, increasing generators and their Pseudo-inverses.

Unit-IV

Convertion of decreasing generators and increasing generators to each other, characterization theorem of t-norms (statement only), Fuzzy unions (t-conorms), standard union, algebraic sum, bounded sum and drastic union as examples of t-conorms, characterization theorem of t-conorms (Statement only).
Fuzzy numbers, relation between fuzzy number and a convex fuzzy set, characterization of fuzzy numbers in terms of its membership functions as piecewise defined functions, fuzzy cardinality of a fuzzy set using fuzzy numbers, arithmetic operators on fuzzy numbers, extension of standard arithmetic operations on real numbers to fuzzy numbers.

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Suggested Readings:

1 .G. J. Klir and B. Yuan : Fuzzy Sets and Fuzzy Logic Theory and Appplications. Prentice Hall of India, New Delhi, 2008.

2 Dr.A.K.Bhargava,Fuzzy Set Theory Fuzzy Logic and there applications,S.Chand,2001.

3 H.J.Zimmermann,Fuzzy Set Theory and its applications,Springer Science-Business media,LLC,2014.

MM-20-221:Differential Geometry- II

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**
Course Objectives :

1. To apply the concepts of differential geometry of curves & surfaces.
2. To understand the Curvilinear coordinates.
3. To solve the equations of Gauss and Codazzi.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Curvilinear Coordinates,First order magnitudes,Directions on a surface,The normal,Second order magnitudes,Derivatives of unit normal.

Unit-II

Curves on a Surface: Principal directions and curvature,First and second curvature,Euler's theorem,Dupin theorem,Dupin'sindicotrix, Normal curvature, Mean curvature.

Unit-III

Equations of Gauss and of Codazzi: Gauss's formulae for 11,12,22,Gauss characteristic equation,Mainardi-Coadazzi relation, Bonnet's theorem.

Unit-IV

Geodesics: Geodesic property, Equation of geodesics,Surface of revolution, Torsion of geodesics,Central quadrics, Fundamental magnitudes, The fundamental theorem of surface theory, Liouville's equation.

Suggested Readings:

1. W.Kuhnel,Differential Geometry:Curves-Surfaces-manifolds,3e,American MathematicalSociety,2013.
2. A.Pressely,Elementary Differential Geometry,Springer,India,2004.
3. J.A. Thorpe,elementary Topics in Differential Geometry,Springer,India,2004
4. A.Mishchenko and A.Formentko,A Course of Differential Geometry and Topology, Mir PublisherMoscow 1988.

MM-20-222: Advanced Numerical Analysis

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand methods for getting complex roots and Eigen value problems.
2. To be familiar with the Fourier analysis and wavelet analysis.
3. To understand concept of difference equations and use of generating function.
4. To learn about Elliptic parabolic and Hyperbolic equation.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

General iterative method for the system: $x = g(x)$ and its sufficient condition for convergence. Chebychev method, Ramanujan's method, Methods for getting complex roots, Interpolation at irregular intervals, Hermite interpolation, Spline interpolation: B-splines, Eigen-value problems.

Unit-II

Review of finite difference operators, Difference equations, order of difference equation, degree of difference equation, Solution of difference equations, Use of generating function in the solution of difference equation.

Unit-III

Finite difference methods for PDEs, Elliptic parabolic, Hyperbolic equations: Implicit difference methods for wave equation solution of advection equation by finite difference method and Maccormack method, stability analysis, Lax, Wendroff explicit method on rectangular mesh for 1st order equations.

Unit-IV

Fourier analysis and Wavelet analysis .The Fourier transform and its applications. Wavelets, Haar Wavelets, continuous Wavelet transforms, discrete Wavelet transforms, multi resolutions Wavelet transforms, Algebra and geometry of Wavelet – matrices, one dimensional wavelet systems.

Suggested Readings:

1. Atkinson, K. and Han, W. Theoretical Numerical Analysis, Springer Science & Business Media, 2009.
2. Smith, G. D. Numerical solution of Partial Differential Equations: Finite Difference Methods, 3rd edition. New York: Oxford University Press, 2004.
3. Bradie, B. A friendly introduction to Numerical Analysis. Delhi: Pearson Education, 2006.
4. Reddy, J. N. An Introduction to Finite Element Methods. Delhi: McGraw-Hill, 2006.
5. Bazaraa, M.S., Sherali, H.D. and Shetty, C.M. Nonlinear Programming Theory and Algorithms. Delhi: John Wiley and Sons, 2006.

MM-20-223:Classical Mechanics

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :-

1. To familiarize the students with the basic concepts of moment of inertia.
2. To understand the representation of equations of motion for mechanical systems.
3. To understand the Lagrangian and Hamiltonian formulation of classical mechanics.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Free & constrained systems, constrained and their classification, holonomic and non-holonomic systems, degree of freedom and generalized coordinates, virtual displacement and virtual work, statement of principle of virtual work (PVW), possible velocity and possible acceleration, D' Alembert's principle, Lagrangian Formulation :Ideal constraints, general equation of dynamics for ideal constraints, Lagrange's equation of the first kind.

Unit-II

Independent coordinates and generalized forces, Lagrange's equations of the second kind, generalized velocities and accelerations. Uniqueness of solution, variation of total energy for conservative fields. Lagrange's variable and Lagrangian function L(t, qi), Lagrange's equations for potential forces, generalized momenta pi, Hamiltonian variable and Hamiltonian function H (t, qi, pi), Donkin's theorem, ignorable coordinates.

Unit-III

Hamilton canonical equations, Routh variables and Routh function R, Routh's equations, Poisson Brackets and their simple properties, Poisson's identity, Jacobi Poisson theorem. Hamilton action and Hamilton's principle, Poincare - Carton integral invariant, Whittaker's equations, Jacobi's equations, Lagrangian action and the principle of least action.

Unit-IV

Canonical transformation, necessary and sufficient condition for a canocial transformation, univalent Canonical transformation, free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, method of separation of 42 variables in HJ equation. Lagrange brackets, necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, conditions of canocnicity of a transformation in terms of Poison brackets, invariance of Poisson brackets under canonical transformation.

Suggested Readings:

1. F. Gantmacher,Lectures in Analytic Mechanics, MIR Publishers,Moscow, 1975.
2. P.V. Panat,Classical Mechanics,Narosa Publishing House, New Delhi, 2005.
3. N.C. Rana and P.S. Joag,Classical Mechanics,Tata McGraw- Hill,New Delhi, 1991.
4. Louis N. Hand and Janet D Finch,Analytical Mechanics, CUP, 1998.
5. M.R. Spiegal,Theoretical Mechanics, Schaum Outline Series.

K Ahmad

MM-20-231:Probability Distribution

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives:-

1. To explain Bernoulli and Poisson Distribution.
2. To solve the numerical problems based on Bernoulli and Poisson distribution.
3. To describe Normal and Gamma Distribution .

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Bernoulli Distribution and its Moments, Binominal Distribution: Moments, Recurrence Relation for the Moments. Mean Deviation about Mean, Mode, Moment Generating Function (m.g.f), Additive Property, Characteristic Function (c.f.), Cumulants, Recurrence Relation for Cumulants, Probability Generating Function (p.g.f.) and Recurrence Relation for the Probabilities of Binominal Distribution.Numerical problems of Bernoulli Distribution.

Unit-II

Poisson Distribution: Moments, Mode, Recurrence Relation for Moments, mgf, cfCumlants and p.g.f. of Poisson Distribution, Additive Property of Independent Poisson Variates. Negative Binominal Distribution: m.g.f. Cumulants and p.g.f. of Negative Binominal Distribution, Deduction of Moments of Negative Binominal Distribution from those of Binominal Distribution.Numerical Problems based onPoisson Distributions.

Unit-III

Discrete Uniform Distributions, Geometric Distribution: Lack of Memory, Moments and m.g.f. of Geometric Distribution. Mean and Variance of the Hypergeometric Distribution. Continuous Uniform Distribution. Moments, m.g.f., Characteristic Function and Mean Deviation of Uniform Distribution.

Unit-IV

Normal Distribution: Limiting Form of Binominal Distribution, Chief Characteristics, Mode, Median, mgf, cgf and Moments. Linear Combination of Independent Normal Variates, Points of Inflexion, Mean Deviation about Mean, Area Property of Normal Distribution and Related Numerical Problems, Importance and Fitting of Normal Distribution.Gamma Distribution: Moment Generating Function (m.g.f), Properties of Gamma Distribution, Beta Distribution of First and Second kind. Exponential Distribution.

Suggested Readings:

1.A.M.Gupta, Gupta, M.K.Gupta, and B. Das Gupta, Fundamentals of Statistics, Vol-I.
2. J.E.Freund, Mathematical Statistics ,Prentice Hall.
3R.V.Hogg& A.T. Craig, Introduction to Mathematical Statistics.

KAhmad

MM-20-232:Linear Programming

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :-

1. To understand the concept of Linear Programming.
2. To provide the knowledge of different methods of solving linear programming.
3. To explain Simplex method.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Simultaneous linear equations, Basic solutions, Linear transformations, Point sets, Lines and hyperplanes, Convex sets, Convex sets and hypeplanes, Convex cones, Restatement of the Linear programming problem, Slack and surplus variables, Preliminary remarks on the theory of the simplex method, Reduction of any feasible solution to a basic feasible solution, Definitions and notations regarding linear programming problems, Improving a basic feasible solution, Unbounded solutions, Optimality conditions, Alternative optima, Extreme points and basic feasible solutions.

Unit-II

The simplex method, Selection of the vector to enter the basis, Degeneracy and breaking ties. Further development of the transformation formulas. The initial basic feasible solution, artificial variables, Inconsistency and redundancy, Tableau format for simplex computations. Use of the tableau format, Conversion of a minimization problem to maximization problem, Review of the simplex method.
The two-phase method for artificial variables, Phase I, Phase II, Numerical examples of the two-phase methods, Requirement space, Solutions space, Determination of all optimal solutions, Unrestricted variables, Charne's perturbation method regarding the resolution of the degeneracy problem.

Unit-III

Selection of the vector to be removed, Definition of b (€). Order of vectors in b(€), Use of perturbation technique with simplex tableau format, Geometrical interpretation of the perturbation method. The generalized linear programming problem, The generalized simplex method, Examples pertaining to degeneracy, An example of cycling.

Revised simplex method: Standard Form I, Computational procedure for Standard Form I, Revised simplex method: Standard Form II, Computational procedure for Standard Form II, Initial identity matrix for Phase I, Comparison of the simplex and revised simplex methods, The product form of the inverse of a non-singular matrix. Alternative formulations of linear programming problems.

Unit-IV

Dual linear programming problems, Fundamental properties of dual problems, Other formulations of dual problems, Complementary slackness, Unbounded solution in the primal, Dual simplex algorithm, Alternative derivation of the dual simplex algorithm, Initial solution for dual simplex algorithm, The dual simplex algorithm; an example, geometric interpretations of the dual linear programming problem and

the dual simplex algorithm. A primal dual algorithm, Examples of the primal-dual algorithm , Transportation problem, its formulation and simple examples.

Suggested Readings:

1. G. Hadley ,Linear Programming , Narosa Publishing House ,1995.
2. S.I. Gauss, Linear Programming : Methods and Applications, 4e, McGraw Hill, New York ,1975.
3. J.K.Strayer, Linear Programming and its applications,Wiley publications, 2012.
4. H.Karloff, Linear Programming, Springer, 2008.

MM-20-233: Artificial Intelligence

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal:20**

Course Objectives :-

1. To understand the concept of Artificial Intelligence and Knowledge representation.
2. To get familiar with Search strategies.
3. To know about Production system and Expert System.
4. To understand the Genetic Algorithms and Natural Language Processing.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Introduction: Background, Overview of AI applications, The predicate calculus: Syntax and semantic for propositional logic and FOPL, Clausal form, inference rules, resolution and unification.
Knowledge representation: Network representation through Associative network & conceptual graphs, Structured representation- Frames & Scripts.

Unit-II

Search strategies: Strategies for state space search-data driven and goal driven search; Search algorithms-uninformed search (Depth first search, Breadth first search) and informed search (Hill climbing, Best first, A* algorithm, mini-max), computational complexity, Properties of search algorithms (Admissibility, Monotonicity, Optimality, Dominance).

Unit-III

Production system: Definition, Types of production system (Commutative, Non-commutative, Decomposable, Non-decomposable), Control of search in production systems. Expert System: Definition, Concept, Types of expert system, Rule based expert system: Architecture, Development, Managing uncertainty in expert systems - Bayesian probability theory, Stanford certainty factor algebra, Non-monotonic logic and reasoning with beliefs, Fuzzy logic, Dempster/Shaffer and other approaches to uncertainty.

Unit-IV

Knowledge acquisition: Definition of Knowledge, Types of learning (Learning by automata, Genetic algorithms, Intelligent editors, Learning by induction). Natural Language Processing (NLP): Problems in understanding natural languages, Different stages of language analysis, Chomsky Hierarchy of formal languages, Transition network parsers (TNP), Augmented Transition Network Parsers (ATNP).

Suggested Readings:

1. George F. Luger, "*Artificial Intelligence*", Pearson Education, 5th Edition.
2. Dan W. Patterson, "*Introduction to Artificial Intelligence and Expert system*", PHI, 1st Edition.
3. Ben Coppin, "*Artificial Intelligence Illuminated*", Narosa Publishing House, 1st Edition.
4. Eugene Charniak, Drew McDermott,"*Introduction to Artificial Intelligence*", Pearson Education, 2016.
5. Nils J. Nilsson,"*Principles of Artificial Intelligence*", Narosa Publishing House, 1st Edition.

Foundation of Mathematics

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand Sets and their representations, Union and Intersection of sets.
2. Difference of sets. Complement of a set.
3. To learn about relation, domain, co-domain and range of a relation.
4. To be familiar with Random experiments, probability.
5. To learn about matrix, types of matrices, Determinant.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Sets and their representations.Empty set.Finite and Infinite sets.Equal sets.Subsets.Subsets of a set of real numbers especially intervals (with notations). Power set. Universal set. Venn diagrams. Union and Intersection of sets.Difference of sets. Complement of a set. Ordered pairs.Cartesian product of sets.Number of elements in the Cartesian product of two finite sets.Cartesian product of the set of reals with itself (upto R x R x R).

Unit-II

Definition of relation, domain, co-domain and range of a relation.Function as a special type of relation. domain, co-domain and range of a function.Real valued functions, domain and range of these functions, constant, identity, polynomial, rational, modulus, signum, exponential, logarithmic and greatest integer functions, with their graphs. Sum, difference, product and quotients of functions.

Unit-III

Random experiments; outcomes, sample spaces (set representation). Events; occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events, Axiomatic (set theoretic) probability, connections with other theories of earlier classes. Probability of an event, probability of 'not', 'and' and 'or' events.

Unit-IV

Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication Invertible matrices.Determinant of a square matrix (up to 3 × 3 matrices), minors, cofactors Adjoint and inverse of a square matrix.

Suggested Readings:

1. H.S. Hall and S.R. Knight : Higher Algebra, H.M. Publication, 2017.
2. Shanti Narayan : A Text Books of Matrices, 2010.
3. Shanti Narayan : A Course in Mathematical Analysis, S.Chand and company, New Delhi, 2013.
4. M. Speigel, John Schiller, R. AluSrinivasan, Probability and Statistics, Schaum Outline Series, 2017.

MM-20-301:Functional Analysis

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To be familiar with the completeness in normed linear spaces.
2. To understand the concepts of bounded linear transformation, equivalent formulation of continuity and spaces of bounded linear transformations.
3. To understand Hilbert spaces, orthogonal complements and direct sums.
4. To learn about Conjugate spaces, Uniform boundedness principle and closed linear operator.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space,Banach spaces, subspace of a Banach space, Holder and Minkowski inequality, Completeness of quotient spaces of normed linear spaces, Completeness of Rn,Cn and C[a,b], Incomplete normed spaces.

Unit-II

Finite dimensional normed linear spaces and Subspaces, completeness and closeness of a subspace of a finite dimensional normed linear space, Equivalent norms, Equivalent norms on a finite dimensional normed space, F. Riesz's Lemma,Bounded linear transformation,Equivalent formulation of continuity, Spaces of bounded linear transformations, linear functional, bounded and Continuous linear functional.

Unit-III

Hilbert Spaces: Inner product spaces, Hilbert spaces, Pythagorean theorem, Schwarz inequality, triangle inequality, Hilbert space as normed linear space, continuity of inner product, subspace of a Hilbert space, orthogonal complements and direct sums, Convex sets in Hilbert spaces, Projection theorem, Orthonormal sets, Separability.

Unit-IV

Total Orthonormal sets, Bessel inequality, Parseval identity, Riesz representation theorem in Hilbert spaces. Conjugate spaces, Hahn-Banach extension theorem (Real and Complex form), adjoint operator, norm ofadjoint operator, Uniform boundness principle, closed linear operator, Closed Graph theorem.

Suggested Readings:

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley, 1989.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications, Anamaya Publishers, New Delhi, 2007.
5. K.C. Rao, Functional Analysis, Narosa Publishing House, Second edition, 2006.
6. P.K. Jain and O.P. Ahuja, New Age International (P) Ltd. Publishers, New Delhi, 2019.

Abhatia KAhood

MM-20-302:Complex Analysis

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To be familiar with complex numbers and their geometrical interpretations.
2. To understand the concept of complex numbers as an extension of the real numbers.
3. To represent the sum function of a power series as an analytic function.
4. To demonstrate the ideas of complex differentiation and integration for solving related problems and establishing theoretical results.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Function of a complex variable, Continuity, Differentiability, Analytic functions and theirproperties, Cauchy-Riemann equations in cartesian and polar coordinates,Power series,Radius of convergence, Differentiability of sum function of a power series.

Unit-II

Contour, Complex integration, Cauchy theorem, Cauchy integral formula,Extension of Cauchy integral formula for multiple connected domain, Poisson integralformula, Higher order derivatives, Complex integral as a function of its upper limit, Moreratheorem.

Unit-III

Cauchy inequality, Liouville theorem,Taylor theorem, Zeros of an analytic function, Laurent series, Isolated singularities, Cassorati-Weierstrasstheorem, Limit point of zeros and poles, Maximum modulus principle, $A = \pi r^2$Schwarz lemma.

Unit-IV

Meromorphic functions, Argument principle, Rouche theorem, Fundamental theorem ofalgebra, Calculus of residues, Cauchy residue theorem.

Evaluation ofintegrals ofthetypes $\int f(\cos\theta, \sin\theta)d\theta$, within limit 0 to 2π, $\int_{-\infty}^{\infty} f(x)dx$,

$\int_0^{\infty} f(x)\sin mx\,dx$, $\int_0^{\infty} f(x)\cos mx\,dx$.

Suggested Readings:

1.H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford,1990.
2. J.B. Conway, Functions of One Complex Variable, Springer-Verlag, Internationalstudent-Edition, Narosa Publishing House, 2000.
3. Liang-Shin Hann&Bernand Epstein, Classical Complex Analysis, Jones and BartlettPublishersInternational, London, 1996.
4. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications,McGraw-Hill Publishing Company, 1990.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 2011.

MM-20-303: Ordinary Differential Equations- II

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To learn about Riccati's equation, zero of a solution, Pruffer transformation, Abel's formula.
2. To be familiar with the eigen value and eigen function, Green's function, Nonlinear differential systems.
3. To learn use of differential equations for modeling and solving real life problems.
4. To Interpret the obtained solutions in terms of the physical quantities involved in the original problem under reference.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Linear second order equations: Preliminaries, self adjoint equation of second order, Basic facts, superposition principle, Riccati's equation, Pruffer transformation, zero of a solution, Oscillatory and non-oscillatory equations. Abel's formula.Common zeros of solutions and their linear dependence.

Unit-II

Common zeros of solutions and their linear dependence. Sturm theory: Sturm separation theorem, Sturm fundamental comparison theorem. Elementary linear oscillations.
Second order boundary value problems(BVP): Linear problems; periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP.

Unit-III

Sturm-Liouville BVP: definitions, eigen value and eigen function. Orthogonality of functions, orthogonality of eigen functions corresponding to distinct eigen values. Green's function. Applications of boundary value problems.

Unit-IV

Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical points, Path approaching a critical point, Path entering a critical point, Types of critical points- Center, Saddle points, Spiral points, Node points, Stability of critical points, Asymptotically stable points, Unstable points, Critical points and paths of linear systems.

Suggested Readings:

1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 2000.
2. S.L. Ross, Differential Equations, John Wiley & Sons, 1980.
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 2006.
4. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
5. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
6. G.F. Simmons, Differential Equations, Tata McGraw-Hill 1993.
7. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
8. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub. 2001.

MM-20-304 Project Work/Dissertation

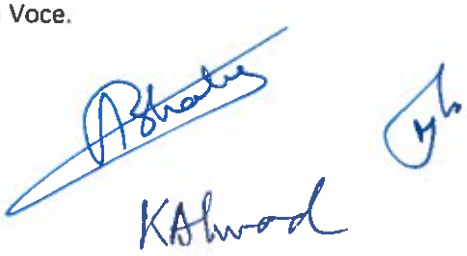
External:160
(Evalution:80
Viva-Voce:80)
Internal:40

The Project Work/Dissertation based on the specialization available in the Department.

Guidelines :

1. Project Work will be supervised by Faculty Members of Department of Mathematics.
2. Supervisor of Project Work will be allotted by Staff Council in 2nd Semester.
3. Title of Project Work will be approved by Staff Council, Department of Mathematics.
4. Student will prepare Synopsis of Project Work just after completion of Examination of 2nd Semester.
5. Student will present Synopsis before Staff Council, Meeting of Staff Council for the purpose will be held within 15 days of Commencement of 3rd Semester.

The Project Work will be evaluated jointly by Internal and External Examiner on basis of Project Report Submitted and Viva Voce.



MM-20-311:Algebraic Number Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To understand Gaussian Integers and Eisenstein Integers, Algebraic numbers and algebraic integers.
2. Tolearn about Minimal polynomial of an algebraic integer, Characterization of algebraic integers.
3. Tobe familiar withBilinear form on algebraic number field K, Ideals in the ring of algebraic number field K.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Definition of Gaussian Integers and Eisenstein Integers, Algebraic numbers and algebraic integers.Transcendental Numbers.Liouville's Theorem for real Algebraic numbers.Thue Theorem and Roth's theorem (statement only). Algebraic number field K. Theorem of Primitive elements.

Unit-II

Liouville's Theorem for complex algebraic numbers.Minimal polynomial of an algebraic integer.Characterization of algebraic integers. Primitive m-th roots of unity. Cyclotomic Polynomials.Eisenstein's criterion for irreducibility.Norm and trace of algebraic numbers and algebraic integers.

Unit-III

Bilinear form on algebraic number field K. Integral basis and discriminant of an algebraic number field. Index of an element of K. Ring Ok of algebraic integers of an algebraic number field K. Ideals in the ring of algebraic number field K.

Unit-IV

Integrally closed domains.Dedekind domains.Fractional ideals of Ok.Factorization of ideals as a product of prime ideals in the ring of algebraic integers of an algebraic number field K. G.C.D. and L.C.M. of ideals in Ok.Chinese Remainder theorem.

Suggested Readings:

1. Jody Esmonde and M.RamMurty Problems in Algebraic Number Theory (Springer Verlag) 1998.
2. Paulo Ribenboim Algebraic Numbers 2013.
3. R. Narasimhan Algebraic Number Theory and S. RaghavanMathematical Pamphlets-4. Tata Institute of Fundamental Research 1966.

KAhmad

MM-20-312:Lie Groups and Lie Algebra

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To understand matrix Lie group, Examples of matrix Lie groups.
2. To learn about the matrix Logarithm, The Lie algebra of matrix Lie group.
3. To be familiar with the Baker-Campbell-Housdorff formula for the Heisenberg group.
4. To learn about the Weyl group, Weight diagrams, Complete reducibility and semisimple Lie Algebras.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Definition of a matrix Lie group, Examples of matrix Lie groups, Compactness, connectedness, simple connectedness, The polar decomposition for SL(n, R) and SL(n,C), Lie groups.

Unit-II

The matrix exponential, The matrix Logarithm, The Lie algebra of matrix Lie group,Properties of Lie Algebra, The complexification of Real Lie algebra.

Unit-III

The Baker-Campbell-Housdorff formula for the Heisenberg group, The general Baker-Campbell-Housdorff formula, The derivative of the exponential mapping, Group versus Lie algebra homomorphism, covering groups, subgroup and subalgebras.

Unit-IV

The representations of SU(3), weights and roots, The theorem of the highest weight, The Weyl group, Weight diagrams, Complete reducibility and semisimple Lie Algebras, Cartansubalgebras, Roots and root spaces, Inner products of roots and co-roots, Positive root.

Suggested Readings:

1. B. C. Hall, Lie groups, Lie Algebras and representations: An elementary introduction, Springer, 2015.
2. J. E. Humphreys, Introduction to Lie Algebras and representation theory, Springer Verlag, 1973.
3. S. C. Bagchi, S. Madan, A. Sitaram and U. B.T iwari, A first course on representation theory and linear Lie groups, University Press, 2000

MM-20-313:Advanced Fuzzy Set Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To be familiar with the Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations.
2. To apply the concepts of Fuzzy measures, continuity from below and above, semicontinuous fuzzy measures.
3. To understand the concept of fuzzy sets and possibility theory, degree of compatibility, degree of possibility.
4. To learn about Fuzzy propositions, classification, canonical forms, relation with possibility distribution function.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Fuzzy Relations: Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, domain, range and height of a fuzzy relation, membership matrices, sagittal diagram, inverse of a fuzzy relation, composition of fuzzy relations, standard composition, max-min composition, relational join, binary relations on a single set, directed graphs, reflexive irreflexive, antireflexive, symmetric, asymmetric,antisymmetric, transitive (max-min transtitive), non transitive, antitransitive fuzzy relations.

Unit-II

Fuzzy equivalence relations, fuzzy compatibility relations, a-compatibility class, maximal a-compatibles, complete a-cover, reflexive undirected graphs, fuzzy ordering relations, fuzzy upper bound, fuzzy pre ordering, fuzzy weak ordering, fuzzy strict ordering, fuzzy morphisms.

Fuzzy measures, continuity from below and above, semicontinuous fuzzy measures, examples and simple properties; Evidence Theory, belief measure, superadditivity, monotonicity, plausibility measure, subadditivity, basic assignment, its relation with belief measure and plausibility measure, focal element of basic assignment, body of evidence, total ignorance, Dempster's rule of combination.

Unit-III

Possibility Theory, necessity measure, possibility measure, implications, possibility distribution function, lattice of possibility distributions, joint possibility distribution. Fuzzy sets and possibility theory, degree of compatibility, degree of possibility, relation with possibility distribution function and possibility measure, example of possibility distribution for fuzzy proposition.

Unit-IV

Fuzzy Logic: An overview of classical logic, about logic functions of two variables, Multivalued logics, about three-valued logic, n-valued logic, degrees of truth, definition of primitives, Fuzzy propositions, classification, canonical forms, relation with possibility distribution function, Fuzzy Quantifiers, their two kinds, relation with possibilitydistribution function, Linguistic hedges, as a unary operation and modifiers, properties, Inference from conditional fuzzy propositions, relations with characteristic and membership functions, Compositional rule of inference, modus ponens and tollens, hypothetical syllogism.

K Ahmad

Suggested Readings:

1 G. J. Klir and B. Yuan : Fuzzy Sets and Fuzzy Logic Theory and Appplications, Prentice Hall of India, New Delhi, 2008.

2 Dr.A.K.Bhargava,Fuzzy Set Theory Fuzzy Logic and there applications,S.Chand,2001.

3 H.J.Zimmermann,Fuzzy Set Theory and its applications,Springer Science-Business media,LLC,2014.

MM-20-321:Partial Differential Equations

Maximum marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To establish a fundamental familiarity with partial differential equations and their applications.
2. To distinguish between linear and nonlinear partial differential equations.
3. To learn about Separation of variables, Potential functions, Hodograph and Legendre transforms.
4. To use Green's function method to solve partial differential equations.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

PDE of kth order: Definition, examples and classifications. Initial value problems. Transport equations homogeneous and non-homogeneous, Radial solution of Laplace's Equation: Fundamental solutions, harmonic functions and their properties, Mean value Formulas. Poisson,s equation and its solution.

Unit-II

Strong maximum principle, uniqueness, local estimates for harmonic functions, Liouville,s theorem, Harnack's inequality. Green's function and its derivation, representation formula using Green's function, symmetry of Green's function, Green's function for a half space and for a ball. Drichlet's principle.

Unit-III

Non-linear first order PDE – Complete integrals, Envelopes, Characteristics, Hamilton Jacobi equations (Calculus of variations, Hamilton ODE, Legendre transform, Hopf-Lax formula, Weak solutions, Uniqueness).

Unit-IV

Representation of Solutions- Separation of variables, Similarity solutions (Plane and traveling waves, solitones, similarity under Scaling). Fourier Transform, Laplace Transform, Converting non linear into linear PDE, Cole-Hop Transform, Potential functions, Hodograph and Legendre transforms.

Suggested Readings:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, New York, 1986.
2. Peter V. O'Neil, Advanced Engineering Mathematics, ITP. 2011.
3. L.C. Evans, Partial Differential Equations: Second Edition (Graduate Studies in Mathematics) 2nd Edition, American Mathematical Society, 2014.
4. H.F. Weinberger, A First Course in Partial Differential Equations, John Wiley & Sons, 1965.
5. M.D. Raisinghania, Advanced Differential equations, S. Chand & Co. 1988.

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MM-20-322: Fluid Dynamics

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :-

1.To understand the concept of the flow properties of ideal fluid.

2. To give fundamental knowledge fluid and its properties.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Kinematics - Velocity at a point of a fluid. Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vorticity and circulation. Equation of continuity. Boundary surfaces. Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes.

Unit-II

Pressure at a point of a moving fluid. Euler equation of motion. Equations of motion in cylindrical and spherical polar co-ordinates.

Bernoulli equation. Impulsive motion. Kelvincirculation theorem. Vorticity equation. Energy equation for incompressible flow. Kinetic energy of irrotational flow. Kelvin minimum energy theorem. Kinetic energy of infinite fluid. Uniqueness theorems.

Unit-III

Axially symmetric flows. Liquid streaming part a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. Kinetic energy generated by impulsive motion. Motion of two concentric spheres.

Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Unit-IV

Two-dimensional motion; Use of cylindrical polar co-ordinates. Stream function. Axisymmetric flow. Stoke-stream function. Stoke- stream function of basic flows.

Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem.

Suggested Readings:

1. Edward B.Mcleod, Introduction to Fluid Dynamics, Dover publications, 2016.
2. G.K.Batchelor, H.K. Moffatt, M.G.Worster, Perspectives in Fluid Dynamics,Cambridge University Press, 2002.
3. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
4. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.
5. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
6. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

MM-20-323:Graph Theory

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To Model real world problems and solve them using basic Graph Theory.
2. To Understand graph, subgraphs, connected and disconnected graphs etc.
3. To Differentiate between Hamiltonian and Eulerian graphs.
4. To Solve problems involving vertex, edge connectivity, planarity and edge coloring.
5. To Apply tree and graph algorithms to solve problems.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Definition and types of graphs, Walks, Paths and Circuits, Connected and Disconnectedgraphs, Applications of graphs, operations on Graphs, Graph Representation, Isomorphismof Graphs.

Unit-II

Eulerian and Hamiltonian paths, Shortest Path in a Weighted Graph, The Travelling Salesperson Problem, Planar Graphs, Detection of Planarity and Kuratowski Theorem, Graph Colouring.

Unit-III

Directed Graphs, Trees, Tree Terminology, Rooted Labeled Trees, Prefix Code, Binary Search Tree, Tree Traversal.

Unit-IV

Spanning Trees and Cut Sets, Minimum Spanning Trees, Kruskal Algorithm, Prim Algorithm, Decision Trees, Sorting Methods.

Suggested Readings:

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice – Hall of India Pvt. Ltd. 2004.
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. G. Chartrand and P. Zhang. Introduction to Graph Theory, Tata McGraw-Hill, 2006.
4. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw Hill, Fourth Edition, 1999.
5. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York, 2007.
6. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics,Pearson, Fifth Edition, 2005.

MM-20-331:Operations Research

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. To identify and develop Operations Research Models.
2. To understand the mathematical tools that are needed to solve optimization problems.
3. To analyze the queuing and inventory situations.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Objectives of O.R., nature and definitions of O.R., scope of O.R., meaning and necessity of O.R. models, classification of O.R. models, advantages and disadvantages of O.R. models, Steps in model formulation. principles of modelling General Linear Programming problem and its formulation for transport problem trim loss problem, product mix problem, diet problem.

Unit-II

Transportation Problems: Basic feasible solutions, Optimum solution by stepping stone and modified distribution methods, Unbalanced and degenerate problems, Transhipment problem. Assignment problems: Hungarian method, Unbalanced problem, Case of maximization, Travelling salesman and crew assignment problems.

Unit-III

Game Theory : Two person zero sum game, Game with saddle points, The rule of dominance; Algebric, Graphical and linear programming methods for solving mixed strategy games.

Unit-IV

Inventory Management: ABC inventory system, characteristics of inventory system, Economic order quantity(EOQ) model with and without shortages, quantity discount model with price breaks, uniform demand.

Suggested Readings:

1. H.A. Taha, Operation Research-An introduction, Printice Hall of India.
2. K.Swarup,P.K.Gupta and Manmohan, Operations Research,13e,Sultan Chand & Sons,2007.
3. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
4. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Publications.
5. J.K. Sharma, Mathematical Model in Operation Research, Tata McGraw Hill

MM-332:Parametric and Non-Parametric Tests

Maximum marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**

Course Objectives:

1. Able to define the terms moment generating function, skewness chi-square test.
2. To understand concept of contingency table, coefficient of contingency.
3. To learn about constants and mode of F-distribution, confidence intervals.
4. To define the terms non-parametric tests, run test and median test.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Chi-square distribution: Definition, derivation of y2 distribution, moment generating function, Cumulant generating function, mean mode, skewness, additive property, conditions for the validity of chi-square, Pearson's chi-square test for goodness of fit. Contingency table, coefficient of contingency, test of independence of attributes in a contingency table.

Unit- II

t and F statistics: Definition of Student's 't' and Fisher's 't', derivation of Student's 't' distribution, distribution of Fisher's 't' , constant of t-distribution, limiting form & graph of t-distribution. Definition & derivation of Snedcor's F-distribution, constants of Fdistribution, mode of F-distribution.

Unit-III

Testing for the mean and variance of univariate normal distributions, testing of equality of two means and testing of equality of two variances of two univariate normal distributions.Related confidence intervals.Testing for the significance of sample correlation coefficient in sampling from bivariate normal distribution.

Unit-IV

Nonparametric Tests: Definition of order statistics and their distributions, Non-parametric test: Sign test for univariate&bevariate distribution, run test and median test.

Suggested Readings:

1. Goon, A.M., Gupta, M.K., and B. Das Gupta: Fundamentals of Statistics, Vol II, 2016.
2. Mood, A.M. and Graybill, F.A.: Introduction to the theory of Statistics, 1973.
3. Hogg, R.V. & A.T. Craig: Introduction to Mathematical Statistics, 2004.

MM-20-333: Data Ware Housing and Mining

Maximum Marks : 100 **External:30**
Time : 3 Hours **Internal: 20**
Practical :50

Course Objectives :-

1. To understand formation of Data Warehouse.
2. To understand schemas and processes in Data Warehousing.
3. To understand concept of Data Mining.
4. To study Descriptive and Predictive Data Mining.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 4 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 6 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 6 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Introduction to Data Warehouse, Data Warehouse Delivery Methods.
System Process : Typical Process Flow within a Data Warehouse, Extract and Load Process, Clean and Transform Data, Backup and Archive Process, Query Management Process.Process Architecture: Load Manager, Warehouse Manager, Query Manager, Detailed Information, Summary Information, Metadata, Data Marting
Database Schema: Starflake Schema, Snowflake Schema, Fact Constellation Schema, Identifying facts and dimensions, Designing Fact Tables, Designing Dimension Table, Designing various schema, Query Redirection

Unit-II

Partitioning Strategy: Horizontal Partitioning, Vertical Partitioning, Hardware Partitioning, Sizing the partition.
Aggregations: Need of Aggregation, designing summary tables
Data Mart: Introduction, Need of Data Mart, Design of Data Mart, Cost of Data Mart.
Metadata: Data Transformation and Load, Data management, Query Generation, Metadata and tools.
Process Managers: Need of tools to manage data warehouse, system managers, data warehouse process managers, load manager, warehouse manager, query manager.

Unit-III

Knowledge Discovery in Databases : Kamber's Model of KDD, Types of Data Mining, Major Issues in Data Mining.Data Preprocessing : Data Cleaning, Data Integration and Transformation, Data Reduction, Data Transformation, Data Discretization.Predictive Data Mining : Classification by Decision Tree Induction, Classification by Bayesian Method, Classification by Rule Based Method, Classification by Backpropagation, Classification by Support Vector Machine, Classification by Rough Set Theory, Classification by Fuzzy Approach, Classifier Accuracy Measures : Confusion Matrix and ROC curves.
Prediction by Linear Regression, Prediction by Non Linear Regression, Predictor Error Messages, Methods to increase accuracy of prediction.

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Unit-IV

Descriptive Data Mining : Association Rule Mining: Market Basket Analysis, Types of Association Rules, Methods of Mining Association Rules in Transactional Databases, Pattern Evaluation Methods, Pattern Mining in Multidimensional Space, Constraint Based Frequent Pattern Mining, Mining High Dimensional Data, Compressed or Approximate Patterns.
Clustering : Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, Outlier Analysis.

Suggested Readings:

1. Berson Alex, Smith Stephen J., "*Data Warehousing, Data Mining and OLAP*", Tata McGraw Hill, 2008.
2. Anahory Sam, Murray Dennis, "*Data Warehousing in the Real Word*", Pearson Education, 2009.
3. Jiawein Han, Jian Pein, Micheline Kamber, " Data Mining : Concept and Techniques", Morgan and Kauffman Publisher, 2011.
4. Mohammed J Zaki, Wagner Mira Jr, " Data Mining and Machine Learning", Cambridge University Press, 2020

Vedic Mathematics

Maximum marks: 100 **External:80**
Time: 3 Hours **Internal:20**

Course Objectives:

1. To understand the concepts of Number system and their applications in Vedic Mathematics.
2. To be familiar with Multiplication using base and Sub-base Method.
3. To learn about Cube using Nikhilam and Anurupyena Sutra, Division using Dhwajank Method.
4. To understand the concept of Simultaneous simple equations, equation of the line passing through the points using Vedic methods.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Introduction to Vedic Mathematics, History of Vedic Mathematics, Number system and their applications in Vedic Mathematics, Multiplication of any number by numbers containing digit 1 only, Multiplication of any number by numbers containing digit 9 only, Multiplication any numbers Using Sutra- Urdhvatiryagbhyam.

Unit-II

Multiplication using base and Sub-base Method, Multiplication using Ekadhikena Sutra, Sum & Difference of Products, SquareusingNikhilam Sutra, Square using Duplex Method, Sum and Difference of Squared numbers.

Unit-III

Sum and difference of squared and products numbers, Cube using Nikhilam and Anurupyena Sutra, Division using Dhwajank Method, Square root and cube root, Algebraic Multiplication.

Unit-IV

Sum and difference of algebraic products, Square and square root of algebraic expressions, Simultaneous simple equations, equation of the line passing through the points using Vedic methods, Highest common factor using Vedic sutras, Simultaneous Quadratic Equations, Partial Fractions.

Suggested Readings:

1. Sri Bharati KrsnaTirthaji, "Vedic Mathematics", published by Motilal Banarsidass, 1965. ISBN 81-208-0163-6.
2. Williams K.R. "Discover Vedic Mathematics." Vedic Mathematics Research Group, 1984. ISBN 1-869932-01-3
3. Williams K.R. and M. Gaskell "The Cosmic Calculator". MotilalBanarsidass, 2002. ISBN 81-208-1871-7.
4. Nicholas A.P., Williams, J. Pickles. "Vertically and Crosswise". Inspiration Books, 1984. ISBN 1-902517-03-2.

MM-20-401:MATLAB

Maximum marks: 100
Time: 3 Hours
~~**Practical: 80**~~
Practical (External): 80
Internal : 20

Course Objectives:

1. To introduce the software MATLAB.
2. Perform basic mathematical operations on simple variables vector, matrices & complex numbers.
3. To generate 2-D plots.
4. Use and write script files (MATLAB Programs)

Introduction of Starting MATLAB, Creating Arrays, Mathematical operations with Arrays, creating M. files, script-files and functions and files and managing data, Two-dimensional plots, Programming in MATLAB, User-defined functions and function files, Polynomials, Applications in numerical analysis, Symbolic Math.

Suggested Readings:

1. Amos Gilat, MATLAB : An Introduction with Applications, John and Wiley & Sons.
2. Brian R. Hunt, Ronald Lipsman and Jonathan M. Rosenberg, A Guide to Matlab, Cambridge University Press.

MM-20-402:Integral Equations and Calculus of Variations

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**

Course Objectives :-

1. To familiarize the students with the concepts of Integral Equations.
2. To understand the various methods to solve different types of Integral Equations
3. Learn methods to solve various mathematical and physical problems using variational techniques.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Linear integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series in, Laplace transform method for a difference kernel, Solution of a Voletrra integral equation of the first kind.

Unit-II

Boundary value problems reduced to Fredholm integral equations. Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredhlom resolvent kernel as a ratio of two series. Fredhlom equations with separable kernels, Approximation of kernel by a separable kernel. Fredhlom Alternative, Non homogenous Fredhlom equations with degenerate kernels.

Unit-III

Green's function. Use of method of variation of parameters to construct the Green's function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green's function, Orthogonal series representation of Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredhlom integral equation with kernel as Green's function. Hilbert-Schmidt theory for symmetric kernels.

Unit-IV

Motivating problems of calculus of variations, Shortest distance Minimum surface of revolution, Branchistochrone problem, Isoperimetric problem, Geodesic Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.

Suggested Readings:

1. A.J.Jerry, Introduction to Integral Equations with Applications, A Wiley-Interscience Pub.
2. R.P.Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York.
3. J.M.Gelfand and S.V.Fomin , Calculus of Variations, Prentice Hall, New Jersy, 1963.
4. Weinstock, Calculus of Variations, McGraw Hall.
5. Abdul-Majid wazwaz, A first course in Intergral Equations, World Scientific Pub.
6. P.David and S.G.David, Stirling, Integral Equations, Combridge University Press.

MM-20-403:Discrete Mathematics

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**
Course Objectives :-

1. To express a logic sentence in terms of predicates, quantifiers and logical connectives.
2. To apply the rules of inference and contradiction for proofs of various results.
3. To evaluate Boolean functions.
4. To use finite state machines to model computer operations.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Recurrence Relations and Generating Functions, Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

Unit-II

Statements Symbolic Representation and Tautologies, Quantifiers, Predicates and validity.

Prepositional Logic. Lattices as partially ordered sets, their properties, Lattices as Algebraic systems, Sub lattices, Direct products and Homomorphism, Some special lattices e.g. complete, Complemented and Distributive Lattices.

Unit-III

Boolean Algebras as Lattices, Various Boolean identities, The switching Algebra. Example, Sub algebras, Direct products and Homomorphism, Joint-irreducible elements, Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms.

Sum of Products, Cononical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates.) The Karnaugh method.

Unit-IV

Finite state Machines and their Transition table diagrams, Equivalence of Finite State, Machines, Reduced Machines, Homomorphism. Finite automata, Acceptors, Non-deterministic, Finite Automata and equivalence of its power to that of deterministic. Finite automata, Moore and Mealy Machines Grammars and Language: Phrase-Structure Grammars, Requiting rules, Derivation, Sentential forms, Language generated by a Grammar, Regular, Context-Free and context sensitive grammars and Languages, Regular sets, Regular Expressions and the pumping Lemma.

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Suggested Readings:

1. Kenneth. H Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, 8e,2018.
2. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co. New York,3e,2007.
3. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, 5e, 2017.
4. J.P. Tremblay, R. Manohar, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt. Ltd, 1988.
5. J.E. Hopcraft and J. D. Ullman Introduction to Automata Theory, Languages and Computation, Narosa Publishing House,1979.
6. M.K. Das, Discrete Mathematical Structures for Computer Scientist and Engineers, Narosa Publishing House,2007
7. C.L. Liu and D.P. Mohapatra, Elements of Discrete Mathematics – A Computer Oriented Approach, Tata McGraw-Hill, 4e, 2012.

MM-20-404 Wavelet Analysis

Maximum marks: 100
Time: 3 Hours
External:80
Internal:20

Course Objectives:

1. To know basic concepts of signals and systems.
2. To understand the concept of Haar spaces.
3. To learn Fourier transform and wavelet transform of digital signals.
4. To learn applications of wavelets to the real-world problems.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Fourier transform in $L^1(R)$, Properties of Fourier transforms, Fourier transform in $L^2(R)$. Parseval Identities, Change of Root, Inversion formula, Plancherel Theorem, Duality Theorem, Poission summation formula, Sampling theorem, Heisenbergas uncertainty principle, Heisenbergas inequality, Discrete Fourier transform, Fast Fourier transform.

Unit-II

Wavelet Transform: Gabor transform, Parseval formula, Inversion formula, Continuous wavelet transform, Maxican hat wavelet, Properties of wavelet transform, Discrete wavelet transform.

Unit-III

Multiresolution Analysis and Construction of Wavelet: Multiresolution Analyis, Mother wavelet, Haar wavelet, Shannon wavelet, Meyer wavelet, Franklin wavelet, Orthonormal spline wavelets, Compactly supported wavelets.

Unit-IV

Wavelets and Applications: Biorthogonal wavelets, Wavelets in several variables, Wavelet packets, Multiwavelet, Wavelet frames, Applications in Neural Networks, Turbulance and Medicine.

Suggested Readings:

1. Khalil Ahmad and F.A. Shah, Introduction to Wavelets with Applications, World Education Publishers, 2012.
2. D.F. Walnut, An Introduction to Wavelet Analysis, Birkhauser, Boston, 2002.
3. C.K. Chui Wavelets: A Tutorial in Theory and Applications, Academic Press, 1992.

MM-20-411:Advanced Algebraic Coding & Number Theory

Maximum marks: 100 **External: 80**
Time: 3 hours **Internal: 20**
Course Objectives:

1. To understandLinear codes, Generator matrices of linear codes, Hadamard transform.
2. Tolearn about Maximum distance separable codes, (MDS codes), Dual code of a MDS code.
3. Tobe familiar with Different of an algebraic number field K, Equivalent fractional ideals. Ideal class group.
4. To learn about Diophantine equations, Minkowski's bound, Quadratic fields.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Linear codes, Generator matrices of linear codes, Equivalent codes and permutation matrices, Relation between generator and parity-check matrix of a linear codes over a finite field, Dual code of a linear code, Self dual codes, Weight distribution of a linear code, Weight enumerator of a linear code, Hadamard transform, Macwilliams identity for binary linear codes.

Unit-II

Maximum distance separable codes, (MDS codes), Examples of MDS codes, Characterization of MDS codes in terms of generator and parity check matrices, Dual code of a MDS code, Trivial MDS codes, Weight distribution of a MDS code, Number of code words of minimum distance d in a MDS code. Reed-Solomon codes.

Unit-III

Different of an algebraic number field K. Dedekind theorem.Hurwitz Lemma and Hurwitz constant.Equivalent fractional ideals.Ideal class group.Finiteness of the ideal class group. Number of equivalence classes of ideal.

Unit-IV

Class number of the algebraic number field K. Diophantine equations.Minkowski's bound. Quadratic reciprocity Legendre Symbol. Gauss sums. Law of quadratic reciprocity.Quadratic fields.

Suggested Readings:

1. L.R. Vermani, Elements of Algebraic Coding Theory (Chapman and Hall Mathematics) 1996.
2. Jody Esmonde and M.RamMurty Problems in Algebraic Number Theory (Springer Verlag) 1998.
3. Paulo Ribenboim Algebraic Numbers 2013.
4. R. Narasimhan Algebraic Number Theory and S. Raghavan Mathematical Pamphlets-4. Tata Institute of Fundamental Research 1966.

MM-20-412:Commutative Algebra

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To study commutative rings with unity.
2. To study modules which help in developing basic foundation in other area of Mathematics.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Zero divisors, nilpotent elements and units, Prime ideals and maximal ideals. Nil radical and Jacobson radical, Comaximal ideals, Chineese remainder theorem, Ideal quotients and annihilator ideals. Extension and contraction of ideals. Exact sequences. Tensor product of module Restriction and extension of scalars. Exactness property of the tensor product. Tensor products of algebras.

Unit-II

Rings and modules of sections. Localization at the prime ideal P. Properties of the localization. Extended and contracted ideals in rings of fractions.

Primary ideals, Primary decomposition of an ideal, Isolated prime ideals, Multiplicatively closed subsets.

Unit-III

Integral elements, Integral closure and integrally closed domains. Going-up theorem and the Going-down theorem, valuation rings and local rings, Noether's normalization lemma and weak form of nullstellensatz Chain condition, Noetherian and Artinian modules, composition series and chain conditions.

Unit-IV

Noetherian rings and primary decomposition in Noetherian rings, radical of an ideal. Nil radical of an Artinian ring, Structure Theorem for Artinian rings, Discrete valuation rings, Dedekind domains, Fractional ideals.

Suggested Readings:

1. M.F. Atiyah and I.G. MacDonald, *Introduction to Commutative Algebra*, CRC Press,Taylor& Francis, 2018.
2. B. Singh, *Basic Commutative Algebra*, World Scientific, 2011.
3. D. Eisenbud, *Commutative Algebra with a View Towards Algebraic Geometry*, Springer, 2004.
4. O. Zariski and P. Samuel, *Commutative Algebra*, Volume I & II, Springer, 1975.
5. R.Y. Sharp, *Steps in Commutative Algebra*, Cambridge University Press, 2

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MM-413:Advanced Complex Analysis

Maximum marks: 100 **External: 80**
Time: 3 hours **Internal: 20**
Course Objectives:

1.Tounderstand the concepts of Gamma function and its properties.
2. Toget familiar with Riemann Zeta function, Riemann functional equation and MittagLeffler theorem.
3. To demonstrate the idea of Harnack Inequality, Dirichletregion, Green function.
4. To understand the concept of integral functions, their factorization, order of an entire function.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Integral Functions, Factorization of an integral function, Weierstrass primary factors,Weierstrass' factorization theorem, Gamma function and its properties, Stirling formula,Integral version of gamma function, Riemann Zeta function, Riemann functional equation.

Unit-II

Analytic Continuation, Power series method of analyticcontinuation, Schwarz Reflection principle,Harmonic functions on a disk, Poisson kernel,Harnack inequality, Harnack theorem, Dirichlet region, Green function.

Unit-III

Canonical product,Jensen formula, Poisson-Jensen formula, Hadamard three circles theorem, Growth andorder of an entire function, Hadamard factorization theorem.Mittag-Leffler theorem.The Dirichlet problem for a unit disc.

Unit-IV

Germ of an analytic function, Monodromy theorem, Schottky theorem, Little Picard theorem,Montel Caratheodory theorem, Great Picard theorem, Univalent functions, Bieberbachconjecture(Statement only) and the "1/4 theorem".

Suggested Readings:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 2011.
3. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 2002.
4. Liang-shin Hann&Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.

MM-20-421:Elasticity

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**
Course Objectives :

1. To explain Cartesian Tensor.
2. To understand Analysis of Strain and Stress.
3. To Explain Hooke's law.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Cartesian Tensor: Coordinate transformation, Cartesian Tensor of different order, Sum or difference and product of two tensors. Contraction theorem, Quotient law, Symmetric & Skewsymmetric tensors, Kronecker tensor, alternate tensor and relation between them, Scalar invariant of second order tensor, Eigen values & vectors of a symmetric second order tensor, Gradient, divergence & curl of a tensor field.

Unit-II

Analysis of Strain: Affine transformations. Infinitesimal affine deformation. Geometrical interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariants. General infinitesimal deformation. Saint- Venant' s equations of Compatibility.

Analysis of Stress: Stress tensor. Equations of equilibrium. Transformation of coordinates.

Unit-III

Stress quadric of Cauchy. Principal stress and invariants. Maximum normal and shear stresses.Equations of Elasticity: Generalised Hooke's law. Homogeneous isotropic media.

Unit-IV

Elastic moduli for isotropic media, Equilibrium and dynamic equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's law. Beltrami-Michell compatibility equations. Saint-Venant' s principle.

Suggested Readings:

1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. Shanti Narayan, Text Book of Cartesian Tensors, S. Chand & Co., 1950.
3. S. Timoshenko and N. Goodier, Theory of Elasticity, McGraw Hill, New York, 1970.
4. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
5. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi.

MM-20-422:Viscous Fluid Dynamics

Maximum Marks : 100 **External: 80**
Time : 3 Hours **Internal: 20**
Course Objectives :

1. To give fundamental knowledge of fluid, its properties.
2. To develop understanding about hydrostatic law.
3. To imbibe basic laws and equations used for analysis of static dynamics fluids.
4. To determine the losses in a flow system, flow through piper boundary layer flow and flow past immersed bodies.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Vorticity in two dimensions, Circular and rectilinear vortices, Vortex doublet, Images, Motion due to vortices, Single and double infinite rows of vortices. Karman vortex street.
Wave motion in a Gas. Speed of sound in a gas. Equation of motion of a Gas. Subsonic, sonic and supersonic flows. Isentropic gas flow, Flow through a nozzle.

Unit-II

Stress components in a real fluid. Relation between Cartesian components of stress. Translational motion of fluid element. Rates of strain. Transformation of rates of strains. Relation between stresses and rates of strain. The co-efficient of viscosity and laminar flow. Newtonian and non-Newtonian fluids.
Navier-Stoke equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates. Equation of energy. Diffusion of vorticity. Energy dissipation due to viscosity. Equation of state.

Unit-III

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Hagen Poiseuille flow. Steady flow between co-axial circular cylinders and concentric rotating cylinders. Flow through tubes of uniform elliptic and equilateral triangular cross-section. Unsteady flow over a flat plate. Steady flow past a fixed sphere. Flow in convergent and divergent chennals.

Unit-IV

Dynamical similarity. Inspection analysis. Non-dimensional numbers. Dimensional analysis. Buckingham π-theorem and its application. Physical importance of non-dimensional parameters.
Prandtl boundary layer. Boundary layer equation in two-dimensions. The boundary layer on a flat plate (Blasius solution). Characteristic boundary layer parameters. Karman integral conditions. Karman-Pohlhausen method. .

Suggested Readings:

1. W.H. Besant and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers,Delhi,4e, 2006.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
4. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989
5. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.
6. H. Schlichting, Boundary-Layer Theory, McGraw Hill Book Company, New York, 1979.
7. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
8. G.K. Batchelor, An Introduction to Fluid Dynamics, Foundation Books, New Delhi, 1994.

MM-20-423:Mathematical Aspects of Seismology

Maximum Marks : 100 **External: 80**
Time : 3 Hours Internal: 20
Course Objectives :-

1. To understand different types of waves.
2. To understand reflection and refraction laws.
3. To explain the mathematics behind the approaches that are presented.
4. To understand how the earthquake mechanism is derived from wave form data.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

General form of progressive waves, Harmonic waves, Plane waves, the wave equation. Principle of superposition. Special types of solutions: Progressive and Stationary type solutions of wave equation. Equation of telegraphy. Exponential form of harmonic waves. D' Alembert's formula. Inhomogeneous wave equation Dispersion Group velocity.

Unit-II

Reduction of equation of motion to wave equations. P and S waves and their characteristics. Polarisation of plane P and S waves. Snell's law of reflection and refraction. Reflection of Plane P and SV waves at a free surface. Partition of reflected energy. Reflection at critical angles. Reflection and reflection of plane P.S.V. and SH waves at an interface. Special cases of Liquid-Liquid interface, Liquid-Solid interface and Solid-Solid interface. Rayleigh waves, Love waves and Stoneley waves.

Unit-III

Two dimensional Lamb's problems in an isotropic elastic solid: Area sources and Line Sources in an unlimited elastic solid. A normal force acts on the surface of a semi-infinite elastic solid, tangential forces acting on the surface of a semi-infinite elastic solid. Three dimensional Lamb's problems in an isotropic elastic solid: Area sources and Point sources in an unlimited elastic solid, Area source and Point source on the surface of semi-infinite elastic solid.

Haskell matrix method for Love waves in multilayered medium

Unit-IV

Spherical waves. Expansion of a spherical wave into plane waves: Sommerfield's integral Kirchoff's solution of the wave equation. Poisson's formula. Helmhotz's formula.

Introduction on Seismology: Location of earthquakes, Aftershocks and Foreshocks, Earthquake magnitude, Seismic moment, Energy released by earthquakes, observation of earthquakes, interior of the earth.

Suggested Readings:

1. P.M. Shearer, Introduction to Seismology, Cambridge University Press, UK.,3e, 2019
2. C.M.R. Fowler, The Solid Earth, Cambridge University Press, 2e, 2005.
3. C.A. Coulson and A. Jefferey, Waves, Longman, New York, 1977.
4. M. Bath, Mathematical Aspects of Seismology, Elsevier Publishing Company, 1968.
5. W. M. Ewing, W.S. Jardetzky and F. Press, Elastic Waves in Layered Media, McGraw Hill Book Company, 1995.

MM-20-431:Econometrics

Maximum Marks: 100 **External: 80**
Time: 3 Hours **Internal: 20**
Course Objectives:

1. To carryout evaluation of economic theories in numerical terms.
2. To judge the validity of the economic theories.
3. To extract useful information about important economic policy issues from the available data.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 8 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 16 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 16 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit-I

Nature and scope of econometrics: objective behind building econometric models, nature of econometrics, model building, role of econometrics, interpretation of regression, nature and sources of data for econometric analysis, different measurement scales of variables.

Unit-II

Simple linear Regression model: Two variable case, estimation of model by method of ordinary least squares, properties of estimators, goodness of fit, tests of hypotheses, scaling and units of measurements, Gauss-Markov theorem.

Unit-III

Multiple linear Regression: OLS estimation of parameters, properties of OLS estimators, goodness of fit-R^2, partial regression coefficients and testing of hypotheses on parameters (individual and joint)

Unit-IV

Violations of classical Assumptions: multicollinearity concept, consequences, detection and remedies, heteroscedasticity and senior correlation concept & consequences, goodness of fit-R^2, partial regression coefficients and testing of hypotheses on parameters.

Suggested Readings:

1. D.N.Gujarati&S.Gunasekar, Basic Econometrics,4e,McGraw Hill, 2007.
2. G.S.Maddola&K.Lahiri, Introduction to Econometrics ,4e,John Wiley & Sons,2009.
3. A.Koutsoyiannis, Theory of Econometircs,2e,Palgrave Macmillan Ltd. 2004.
4. J.Johnston, Econometrics Methods, 2e, McGraw Hill International, 1997.

MM-20-432:Statistics through SPSS

Maximum Marks: 100 Practical External: 80
Time: 3 Hours Internal: 20

Course Objectives:

1. To understand SPSS and its role in problem solving.
2. To understand data handling and its analysis.
3. To learn the basic statistical software will help students to easily switch over to any other Statistical software in future.

Qualitative and quantitative data, Cross-sectional and time series data, Univariate and multivariate data. Scales of measurement of data.SPSS data file: Opening a data file in SPSS, SPSS Data Editor, Creating a data file, Editing and manipulating data, Missing values, Editing SPSS output, Copying SPSS output, Printing from SPSS, Importing data.Descriptive statistics with SPSS: Measures of central tendency, Dispersion, Skewness, Kurtosis.Charts and graphs with SPSS: Frequencies, Bar charts, Pie charts, Line graphs, Histograms, Box plots. Statistical tests using SPSS: Normality tests, t-tests, F-test, One way and Two way ANOVA, Non-parametric tests- Chi Square, Spearman rank, Maan Whitney U and Wilcoxon signed rank test. Correlation and regression using SPSS: Linear correlation and regression, Multiple regression. Factor analysis using SPSS.

Suggested Readings:

1. S.L. Gupta and H. Gupta, SPSS for Researchers, International Book House Pvt. Ltd.
2. A. Field, Discovering Statistics using SPSS, SAGE Publications.
3. V. Gupta, SPSS for Beginners, VJ Books Inc.
4. A. Rajathi and P. Chandran, SPSS for you, MJP Publishers

MM-20-433: Big Data Analytics With R

Maximum Marks : 100 **External :30**
Time : 3 Hours **Internal:20**
Practical:50

Course Objectives :-

1. To understand the concept of Big Data
2. To know about applications of Big Data in Mathematics
3. To understand R Language for Big Data Analytics.
4. To expertise R for Big Data in Mathematical Applications.

Examiner Note: Examiner will be required to set NINE questions in all. Question Number 1 will consist of total 4 parts (objective type/short-answer type questions) covering the entire syllabus and will carry 6 marks. In addition to the compulsory question there will be four units i.e. Unit-I to Unit-IV. Examiner will set two questions from each Unit of the syllabus and each question will carry 6 marks.

Student will be required to attempt FIVE questions in all. Question Number 1 will be compulsory. In addition to compulsory question, student will have to attempt four more questions selecting One question from each Unit.

Unit – I

Introduction to Big Data, Mining Unstructured Data, Context Building through Multilevel Data Mining, Data and Learning

Data Cleaning, Sorting and Categorization of Data, Data Protection and Security to Data, Data Storage Technologies, Data Mining with Big Data.

Unit – II

Introduction to R, Reading data from CSVs, Excel Sheets, Databases, Statistical Tools, Extract Data from websites.

Writing R functions

Control Statements : if and else, switch, if else, compound tests.

Unit – III

Loop Statements : for, while, controlling loops.

Data Reshaping : cbind and rbind, joins, reshape2, binding rows and columns, converting data formats.

Probability Distribution : Normal, Binomial, Poisson.

Unit – IV

Basic Statistics : Correlation and Covariance, T – test, ANOVA, Simple Linear Regression, Multiple Regression, Logistic Regression, Poisson Regression, Survival Analysis

Non Linear Models : Nonlinear Least Square, Splines, Decision Trees, Autoregressive Moving Average, VAR, GARCH

Suggested Readings:

1. Parag Kulkarni, Sarang Joshi and Meta S Brown, *Big Data Analytics*, PHI Learning Private Limited, 2017
2. Jared P. Lander, *R for Everyone*, Pearson Education, 2018.

Scheme of Examination of M.Sc. Mathematics,

Semester- IV

(w.e.f. Session 2018-19)

Course Code	Title of the Course	Theory Marks	Internal Marks	Practical Marks	Credit (L:T:P)
Hard Core					
MM-4H1	Functional Analysis-II	80	20	--	5:1:0
MM-4H2	Classical Mechanics	80	20	--	5:1:0
MM-4H3	Advanced Complex Analysis	80	20	--	5:1:0
MM-4H4	Matlab	--	20	80	0:0:4
Soft Core					
Group C (Any One)					
MM-4SC1	Discrete Mathematics	80	20	--	5:1:0
MM-4SC2	Boundary Value Problems	80	20	--	5:1:0
MM-4SC3	Dynamical Systems	80	20	--	5:1:0
MM-4SC4	Algebraic Number Theory	80	20	--	5:1:0
MM-4SC5	Mechanics of Solids	80	20	--	5:1:0
Group D (Any One)					
MM-4SD1	Operational Research	80	20	----	5:1:0
MM-4SD2	Viscous Fluid Dynamics	80	20	--	5:1:0
MM-4SD3	Mathematical Aspects of Seismology	80	20	--	5:1:0
MM-4SD4	Fuzzy Sets & Applications-II	80	20	--	5:1:0
MM-4SD5	Non Commutative Rings	80	20	----	5:1:0
	Total Credits		**:**	**34**	

Note 1 : The Criteria for awarding internal assessment of 20 marks shall be as under:

A) Class test : 10 marks.

B) Assignment & Presentation : 5 marks

C) Attendance : 5 marks

Less than 65% : *0 marks*

Upto 70% : *2 marks*

Upto 75% : *3 marks*

Upto 80% : *4 marks*

Above 80% : *5 marks*

Note 2 : The syllabus of each course will be divided into **four** Sections of **two** questions each. The question paper of each course will consist of **five** Sections. Each of the sections I to IV will

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SEMESTER – IV

MM-4SD1 **Operational Research**

Time : 3 hours **Credits : 5:1:0**
Max. Marks : 80

Note : The questions paper will consist of **five** Sections. Each of the first four units will contain two questions from Section **I, II, III, IV** respectively and the students shall be asked to attempt one question from each Section. Section five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Section -I

Operations Research : Origin, definition, methodology and scope, Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big – M and two phase methods, Degeneracy, Duality in linear programming.

Section -II

Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems. Transhipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem case of maximization, travelling salesman and crew assignment problems.

Section -III

Queuing models: Basic components of a queuing system, General birth-death equations steady-state solution of Markovin queuing models with single and multiple servers (M/M/I, M/M/C, M/M/I/k, M/MC/k) Inventory control models: Economics order quantity (EOQ) model with uniform demand and with different rates of demands in different cycles, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.

Section -IV

Game Theory : Two person zero sum game, Game with saddle points, the rule of dominance; Algebraic, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Books recommended :

1. Taha, H.A., Operation Research-An introduction, Printice Hall of India.
2. Gupta, P.K. and Hira, D.S., Operations Research, S. Chand & Co.
3. Sharma, J.K., Mathematical Model in Operation Research, Tata McGraw Hill.
4. Sharma, J.K., Mathematical Model in Operation Research, Tata McGraw Hill.

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Vedic Mathematics

Time: 3Hours **Credits:3:0:0**

Max.Marks:80

Course Objectives:

1. To understand the concepts of Number system and their applications in Vedic Mathematics.
2. To be familiar with Multiplication using base and Sub-base Method.
3. To learn about Cube using Nikhilam and Anurupyena Sutra, Division using Dhwajank Method.
4. To understand the concept of Simultaneous simple equations, equation of the line passing through the points using Vedic methods.

Note : The questions paper will consist of **five** Sections. Each of the first four units will contain two questions from Section **I, II, III, IV** respectively and the students shall be asked to attempt one question from each Section. Section five will contain **eight to ten** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.**

Unit-I

Introduction to Vedic Mathematics, History of Vedic Mathematics, Number system and their applications in Vedic Mathematics, Multiplication of any number by numbers containing digit 1 only, Multiplication of any number by numbers containing digit 9 only, Multiplication any numbers Using Sutra- Urdhvatiryagbhyam.

Unit-II

Multiplication using base and Sub-base Method, Multiplication using Ekadhikena Sutra, Sum & Difference of Products, SquareusingNikhilam Sutra, Square using Duplex Method, Sum and Difference of Squared numbers.

Unit-III

Sum and difference of squared and products numbers, Cube using Nikhilam and Anurupyena Sutra, Division using Dhwajank Method, Square root and cube root, Algebraic Multiplication.

Unit-IV

Sum and difference of algebraic products, Square and square root of algebraic expressions, Simultaneous simple equations, equation of the line passing through the points using Vedic methods, Highest common factor using Vedic sutras, Simultaneous Quadratic Equations, Partial Fractions.

Books Recommended:

1. Sri Bharati KrsnaTirthaji, "Vedic Mathematics", published by Motilal Banarsidass, 1965. ISBN 81-208-0163-6.
2. Williams K.R. "Discover Vedic Mathematics." Vedic Mathematics Research Group, 1984. ISBN 1-869932-01-3
3. Williams K.R. and M. Gaskell "The Cosmic Calculator". MotilalBanarsidass, 2002. ISBN 81-208-1871-7.
4. Nicholas A.P., Williams, J. Pickles. "Vertically and Crosswise". Inspiration Books, 1984. ISBN 1-902517-03-2.

(Prof. Manju Pruthi) (Prof. Khaled Ahmad) (Dr. Anupam Bhatia)