FACULTY OF SCIENCES

SYLLABUS
of
Master of Science (Mathematics)
(Semester: III -IV)

(Under Continuous Evaluation System)

Session: 2022-23

The Heritage Institution

KANYA MAHA VIDYALAYA JALANDHAR (Autonomous)

Scheme and Curriculum of Examinations of Two Year Degree Programme

Master of Science (Mathematics) Semester-III

Session 2022-23

Master of Science (Mathematics) Semester-III

Course Code	Course Title	Course Type	Marks				Examination time (in Hours)
			Total	Ext.		CA	
				L	P		
MMSL-3331	Functional Analysis-I	C	100	80	-	20	3
MMSL-3332	Topology-I	C	100	80	-	20	3
Optional Subjects							
MMSL-3333 (OPT-II)	Integral Transforms	E	100	80	-	20	3
MMSL-3334 (OPT-III)	Statistics-I	E	100	80	-	20	3
MMSL-3335 (OPT-IV)	Operations Research-I	E	100	80	-	20	3
Total			500				

Note:

In addition to two compulsory papers in third and fourth semester, student has to choose three optional papers in each third and fourth semesters keeping in view the prerequisites and suitability of the combinations.

OPT-I Discrete Mathematics-I
OPT-II Integral Transforms
OPT-III Statistics-I
OPT-IV Operations Research-I
OPT-V Advanced Numerical Analysis
OPT-VI Discrete Mathematics-II
OPT-VII Number Theory
OPT-VIII Statistics-II
OPT-IX Operations Research-II
OPT-X Computer Programming with C

C-Compulsory

E-Elective

Master of Science (Mathematics)

Semester-III

Session 2022-23
Course Title: Functional Analysis-I

Course Code : MMSL-3331

Course outcomes

After passing this course, the students will be able to:

CO 1: Understand the concept of normed linear spaces like, $L^{P(n)}l$(infinite), quotient and LP-spaces.

CO 3: Recognize the examples related to Finite dimensional normed linear spaces and compactness, conjugate space N* and understand The Hahn-Banach theorem and its consequences.

CO 3: Demonstrate the open mapping theorem, closed graph theorem and uniform bounded principal.

CO 4: Describe the concept of Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

Master of Science (Mathematics)

Semester-III

Session : 2022-23

Course Title: Functional Analysis-I

Course Code: MMSL-3331

Examination Time: 3Hrs

Max. Marks: 100

Theory:80

CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Normed linear spaces, Banach spaces, subspaces, quotient spaces, L^P-spaces: Holder's and Minkowski's Inequalities, Convergence and Completeness, Riesz-Fischer Theorem, Continuous linear transformations, equivalent norms.

UNIT-II

Finite dimensional normed linear spaces and compactness, Riesz Theorem, The conjugate space N*, The Hahn-Banach theorem and its consequences, natural imbedding of N into N**, reflexivity of normed spaces.

UNIT-III

Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle, conjugate operators.

UNIT-IV

Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

Text Book:

P. K. Jain, O.P Ahuja, Functional Analysis, New Age International (P) Ltd. Publishers, New Delhi, Second Edition, 2017

Reference Book:

D. Somasundram, A First Course in Functional Analysis, Narosa Publishing House Pvt. Ltd ,New Delhi, Seventh Edition, 2018.

Master of Science (Mathematics)

Semester-III

Session: 2022-23

Course Title : Topology-I

Course Code: MMSL-3332

Course Outcomes

. Upon successful completion of this course the student will be able to:

CO 1: Demonstrate knowledge and understanding of concepts such as open and closed sets, closure and boundary, Neighbourhood's and Neighbourhood system, bases and sub – bases for a topological space etc.

CO 2: Will understand the behaviour of Connectedness on real line, Sequential continuity at point, Homeomorphism and embedding in different topological spaces.

CO 3: Know and understand the concepts related to separation axioms such as T_0, T_1

and T_2 spaces.

CO 4: Create new topological spaces by using product topologies and quotient topologies.

Master of Science (Mathematics)
Semester-III
Session-2022-23
Course Title: Topology-I
Course Code: MMSL-3332

Examination Time: 3Hrs
Max. Marks: 100

Theory:80
CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Topological Spaces, Basic concepts :- closure, interior, exterior and boundary of a set, Dense sets, Closure operator [Kuratowski function] and Interior operator, Neighbourhood's and Neighbourhood system .Coarser and finer topologies. Local bases, bases and sub – bases for a topological space. Convergence of a sequence. First and second countable spaces. Lindeloff spaces, Separable spaces. Sub-spaces, Hereditary properties.

UNIT-II

Separated sets, connected sets, Connected and disconnected spaces, Connectedness on real line. Components, locally connected space. Totally disconnected space. Continuous functions, Restriction and extension of a mapping. Sequential continuity at point. Invariants under a continuous mapping. Open and closed mappings. Homeomorphism and embedding. Topological properties.

UNIT-III

Separation Axioms: T0, T1, T2 – spaces. Regular spaces, T3 – spaces, Normal spaces, T4 – space. Tychonoff lemma, Urysohn lemma, Tietze extension theorem.

UNIT-IV

Product of two spaces, The product of n spaces. Base for a finite product topology. General product spaces. Sub-base and base for product topology. Productive properties. Quotient spaces.

Text Book:

J. R. Munkers, Topology, Pearson Education Publisher, England, Second Edition, 2021.

Reference Books:

1. T.O. Moore, Elementary General Topology, Prentice Hall Publisher, New Jersey, 1965.
2. J. L. Kelley, General Topology, Springer, New York.
3.G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.

Master of Science (Mathematics)

Semester-III

Session-2021-22

Course Title: Integral Transforms

Course Code: MMSL-3333(OPT-II)

Course Outcomes

Having successfully completed this course the students will be able to:

CO 1: Understand how Integral Transforms can be used to solve a variety of Differential Equations. Understand purpose of Fourier series and Transformation.

CO 2: Know the use of Laplace Transform in Solving Boundary Value Problems.

CO 3: Demonstrate applications of Hankel Transform.

CO 4: Use Z-Transform in the characterization of Linear Time Invariant System in development of Scientific Simulation algorithms.

Master of Science (Mathematics)

Semester-III

Session-2022-23

Course Title: Integral Transforms

Course Code: MMSL-3333(OPT-II)

Examination Time: 3Hrs

Max. Marks: 100

Theory:80

CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A- D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Finite Fourier Transforms : Finite Fourier sine, cosine transforms, inversion formula for sine & cosine transforms, multiple finite Fourier transforms, problems related to finite Fourier transforms, Applications of Fourier transforms in initial and boundary valueproblems.

UNIT-II

Application of Laplace Transforms in Initial and Boundary Value Problems: Heat conduction equation, wave equation, Laplace equation and problems based on above equations.

UNIT-III

Hankel Transforms: Hankel transforms, inversion formula for the Hankel transform, infinite Hankel transform, Hankel transform of the derivative of a function, Parseval's theorem. The finite Hankel transforms, Applications of Hankel transform in boundary value problems.

UNIT-IV

Z- Transform, Convergence, properties of Z-Transform, convolution theorem, Inverse Z-transforms, Applications to Difference equations.

Text Book:

Integral Transform : J.K.GOYAL ,K.P.GUPTA

Publisher :PragatiPrakashan

Reference Books:

1.IanN.Sneddon: The Uses of Integral Transforms

2.Churchill,R.V.: Operational Mathematics

[Chapters I, II, III (28-36), IV (40-49), VI (65-68, 70), VII, XI (119-124,129), XII, XIII (138-144), XIV (148-150,152)]

3.Integral Transforms and Fourier Series :A.N.Srivastava, Mohammad Ahmad

Publisher :Narosa publishing house

4.Integral Transforms and Fourier Series: Cambridge International Press.

Master of Science (Mathematics)

Semester-III

Session-2022-23

Course Title: Statistics-I

Course Code: MMSL-3334(OPT-III)

Course Outcomes

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

CO 1: Distinguish between different types of data and interpret examples of methods for summarizing data sets, including common graphical tools such as histogram and summary statistics such as mean, median, mode, variance skewness and kurtosis. Further student will understand the basic concepts and applications of probability in real life scenarios

CO 2: Contrast between discrete and continuous random variable and apply general properties of expectations and variance.

CO 3: Compute probabilities for discrete and continuous distributions.

CO 4: Understand and interpret the knowledge regarding correlation of variables in real time data.

Master of Science (Mathematics)

Semester-III

Session-2022-23

Course Title: Statistics-I

Course Code: MMSL-3334(OPT-III)

Examination Time: 3Hrs

Max. Marks: 100

Theory:80

CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.The students can use only Non Programmable& Non Storage Type Calculator and statistical tables.

UNIT-I

Measures of Central tendency and dispersion, Moments, Measures of skewness and kurtosis. Classical and axiomatic approach to the theory of probability, Additive and multiplicative law of probability, Conditional probability and Bayes' theorem. Random variable, Probability mass function, Probability density function, Cumulative distribution function.

UNIT-II

Two and higher dimensional random variables, Joint distribution, Marginal and conditional distributions, Stochastic independence, Function of random variables and their probability density functions. Mathematical expectations and moments, Moment generating function and its properties.

UNIT-III

Chebyshev's inequality and its application, Stochastic convergence, Central limit (Laplace theorem Linder berg, Levy's Theorem). Discrete Probability Distributions: Bernoulii, Binomial, Poisson, Negative Binomial, Geometric Distribution (For distributions only Mean, Variance, Moment Generating Function).

UNIT-IV

Continuous probability distributions: Uniform, Normal, Gamma, Beta, Exponential distributions (For distributions only Mean, Variance, Moment Generating Function). Least square principle, Correlation and linear regression analysis for bi-variate data. Theory of attributes: Independence of attributes, association of attributes.

Text Book:

S.C. Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 11th edition, 2019 (Scope as in chapters 2-11, 13).

Reference Books:

1. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill, 3rd edition, 1974.

2. A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics Vol-I, World Press, Calcutta, 8th edition, 2002.

Master of Science (Mathematics)

Semester-III

Session-2022-23

Course Title: Operations Research-I

Course Code: MMSL-3335 (OPT-IV)

Course outcomes

After studying this course students will be able to:

CO 1: Identify and develop operational research models from the verbal description of the real system and mathematical tools that are needed to solve optimization problems. They will be able to differentiate feasible, basic feasible and optimum solution of a linear programming problem and Plan optimum allocation of various limited resources such as men, machines, material, time, money etc. for achieving the optimum goal.

CO 2: Plan, forecast and make rational decisions and construct linear programming and integer linear programming models. They will be able to identify the situations where integer linear programming models are desirable and discuss the solution techniques and applications of linear programming. Understand and apply the Duality concepts to find the solutions of the primal problem and the relationship between the primal and dual linear programming problems.

CO 3: Analyze the transportation and assignment problems and solve those using mathematical models. They will become able to handle cases of unequal supply and demand, unacceptable routes etc. for a transport problem and become familiar with the types of problems such as travelling salesman problem that can be solved by applying an assignment model.

CO 4: Solve Zero Sum games, games without saddle points, graphical solution of 2*n and m*2 games. Able to understand approach of Dynamic Programming and find the solution of LPP Using Dynamic Programming.

Master of Science (Mathematics)
Semester-III
Session-2022-23
Course Title: Operations Research-I
Course Code: MMSL-3335 (OPT-IV)

Examination Time: 3Hrs | Max. Marks: 100
Theory:80
CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. The students can use only Non Programmable& Non Storage Type Calculator.

The question paper must contain 30% of the article/theory from the syllabus.

UNIT-I

The linear programming problem, properties of a solution to the linear programming problem, generating extreme point solution, simplex computational procedure, development of minimum feasible solution, the artificial basis techniques, a first feasible solution using slack variables, two phase and Big-M method with artificial variables.

UNIT-II

General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of duality, dual simplex method, Integer Programming: Gomory's all I.P.P. method, constructions of Gomory's constraints, Fractional cut method-all integer and mixed integer, Branch-and-Bound method, applications of integer programming.

UNIT-III

General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, LP formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm (MODI method), Time- minimization transportation problem. Mathematical formulation of assignment problem, assignment method, typical assignment problem, the travelling salesman problem.

UNIT-IV

Game Theory: Two-person zero-sum games, maximin-minimax principle, games without saddle points (Mixed strategies), graphical solution of 2 * n and m * 2 games, dominance property, arithmetic method of n * n games, general solution of m * n rectangular games.
Dynamic Programming: The recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of-Discrete D.P.P., some applications, solution of L.P.P. by Dynamic Programming.

Text Book:
K. Swarup, P.K. Gupta and M.Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 19th edition, 2017. (Scope as in chapters 1, 2, 4, 5, 7, 10, 11, 13, 17)
Reference Books:

1. N.S.Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, 2005.
2. S.D. Sharma, Operations Research, Kedar Nath Ram Nath, Merrut,15th edition, 2010
3. H.A. Taha, Operations Research, Pearson Education Limited, England, 10th edition, 2017.

Scheme and Curriculum of Examinations of Two Year Degree Programme

Master of Science (Mathematics) Semester-IV

Session 2022-23

Master of Science (Mathematics) Semester-IV							
Course Code	Course Title	Course Type	Marks				Examination time (in Hours)
			Total	Ext.		CA	
				L	P		
MMSL-4331	Functional Analysis-II	C	100	80	-	20	3
MMSL-4332	Topology-II	C	100	80	-	20	3
MMSL-4333 (OPT-VII)	Number Theory	E	100	80	-	20	3
MMSL-4334 (OPT-IX)	Operations Research-II	E	100	80	-	20	3
MMSM-4335 (OPT-VIII)	Statistics-II	E	100	60	20	20	3+3
Total			500				

Note:

In addition to two compulsory papers in third and fourth semester, student has to choose three optional papers in each third and fourth semesters keeping in view the prerequisites and suitability of the combinations.

OPT-I Discrete Mathematics-I
OPT-II Integral Transforms
OPT-III Statistics-I
OPT-IV Operations Research-I
OPT-V Advanced Numerical Analysis
OPT-VI Discrete Mathematics-II
OPT-VII Number Theory
OPT-VIII Statistics-II
OPT-IX Operations Research-II
OPT-X Computer Programming with C

C-Compulsory

E-Elective

Master of Science (Mathematics) Semester-IV
Session 2022-23
Course Title: Functional Analysis-II
Course Code: MMSL-4331
Course Outcomes

After passing this course, the students will be able to:

CO 1: Understand the concept of strong and weak convergence in finite and infinite dimensional normed linear spaces and to describe the different operator like, adjoint of an operator, self adjoint operator, and unitary operator.

CO 2: Demonstrate how to find the Eigen values and Eigen vectors for finite dimensional spaces and State and Prove Spectral Theorem for normal operators.

CO 3: Understand the concept of Compact Linear Operators on Normed space.

CO 4: To know the topological division of zeros and formulate for spectral radius and to classify the regular and singular elements.

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Functional Analysis-II
Course Code: MMSL-4331

Examination Time: 3Hrs Max. Marks: 100
Theory:80
CA:20

Instructions for the paper setters/examiners:
Eight questions of equal marks (16 marks each)are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, Weakly compact sets in Hilbert spaces, The adjoint of an operator, Self adjoint operators, Normal operators, Unitary operators.

UNIT-II

Finite dimensional spectral Theory.: Eigen- values and Eigen vectors, Spectrum of a bounded linear operator, Spectrum of Self-adjoint, Positive and Unitary operators. Spectral Theorem for normal operators.

UNIT-III

Compact Linear Operator on Normed spaces, Properties of compact linear operators, Spectral properties of compact linear operators.

UNIT-IV

Banach algebras: Definitions and simple examples. Regular and singular elements. Topological divisors of zero, Spectrum of an element of Banach Algebra, Formula for spectral radius.

Text Book:

D. Somasundram , A First Course in Functional Analysis, Narosa Publishing House Pvt. Ltd, Seventh Reprint 2018.

Reference Books :

1.E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, Singapore, 2019
2.P. K Jain, O. P Ahuja, Functional Analysis, New Age International (P) Limited Publishers, Daryaganj, New Delhi, Third Edition, 2020

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Topology-II
Course Code : MMSL-4332
Course Outcomes

After passing this course, the students will be able to:

CO 1: Know and understand the concepts related to higher separation axioms such as Completely regular spaces, T5 – spaces and Tychonoff spaces etc.

CO 2: Understand and interpret the knowledge regarding Compact spaces, Relation of compact spaces with Hausdorff spaces, Countably compact spaces and One point compactification.

CO 3: Demonstrate knowledge and understanding of Metric spaces & Metrizability of topological spaces.

CO 4: Understand terms, definitions & theorems related to Net, Filter, Ultra filter and convergence of net and filters.

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Master of Science (Mathematics)
Semester-IV
Session :2021-22
Course Title: Topology-II
Course Code : MMSL-4332

Examination Time: 3Hrs | Max. Marks: 100
Theory:80
CA:20

Instructions for the paper setters/examiners

Eight questions of equal marks (16 marks each)are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Higher Separation Axioms: Completely regular spaces. Tychonoff spaces, Completely normal space, T5 – spaces. Metric spaces as Hausdorff regular, normal and completely normal space. Product of metric spaces.

UNIT-II

Compact spaces, Compact sets, Subsets of compact space. Finite intersection property. Compactness of subsets of real line. Relation of compact spaces with Hausdorff spaces, Regular spaces and normal spaces. Sequentially compact spaces, Bolzano Weierstrass property. Countably compact spaces. Locally compact spaces. Compactness in terms of base elements and sub – base elements. Tychonoff theorem. One point compactification.

UNIT-III

The Stone-Čechcompactification, Evaluation mappings, Separate point family, Separate point and closed set family. Embedding lemma, Tychonoff cube, Embedding theorem, Metrization. Urysohnmetrization theorem.

UNIT-IV

Directed sets and nets. Convergence of a net in a space, Clustering of a net, nets and continuity, Nets in product spaces, Ultra nets. Compactness in term of nets, Topologies determined by nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-filters and compactness.

Text Book:

J.R.Munkers, Topology, Pearson Education Publisher, England, Second Edition, 2021.

Reference Books:

1. T.O. Moore, Elementary General Topology, Prentice Hall Publisher, New Jersey, 1965.
2. J.L. Kelley, General Topology, Springer, New York.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.

Master of Science Mathematics Semester-IV

Session 2022-23

Course Title: Number Theory

Course Code: MMSL-4333(OPT-VII)

Course Outcomes

Successful completion of this course will enable the students to:

CO 1: Prove results involving divisibility and greatest common divisors and solve system of given linear and non linear congruences. Further the student will be able to apply the Wilson's and Euler- Fermat's theorem to solve numerical problems.

CO 2: Understand the properties and application of Quadratic residue and corresponding symbols.

CO 3: Find integral solutions of specified Diophantine equation and understand the criterion for an integer to be expressed as sum of two squares and sum of four squares.

CO 4: Understand the basic concept of periodic and purely periodic continued fractions and apply the Pell's equation to real life problems.

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Number Theory
Course Code: MMSL-4333(OPT-VII)

Examination Time: 3Hrs | Max. Marks: 100
Theory:80
CA:20

Instructions for the paper setters/examiners

Eight questions of equal marks (16 marks each)are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Simultaneous Linear Congruences, Chinese Remainder theorem with applications, Wolsten-Holme's theorem, Lagrange's proof of Wilson theorem, Fermat numbers, Order of an integer modulo n. Primitive roots, Existence and number of primitive roots.

UNIT-II

Indices and their applications, Quadratic residues, Euler's criterion, Product of quadratic residues and quadratic non-residues, Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties..

UNIT-III

Arithmetic functions τ (n), σ (n), σ_k (n), μ (n), Perfect numbers, Mobius inversion formula, Diophantine equation $x^2 + y^2 = z^2$ and its applications to $x^n + y^n = z^n$ when n=4. Criterion for an integer to be expressible as sum of two squares and sum of four squares.

UNIT-IV

Farey series, Farey dissection of a circle and its applications to approximations of irrationals by rationals. Finite and Infinite simple continued fractions, periodic and purely periodic continued fractions, Lagrange's Theorem on periodic continued fractions. Applications to Pell's equation, Fundamental solution of Pell's equation.

Text Books

1. D. M. Burton, Elementary Number Theory, McGraw Hill, 7th edition, 2010 (Scope as in Chapters: 4, 6-8, 11-13, 15).
2. G.H. Hardy and E.M. Wright, Theory of Numbers, Oxford University Press, 6th edition, 2008 (Scope as in Chapter: 7).

Reference Book:

Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, Wiley Publication, 5th edition, 2008.

Master of Science (Mathematics)

Semester-IV

Session- 2022-23

Course Title: Operations Research-II

Course Code: MMSL-4334 (OPT-IX)

Course Outcomes

After the completion of the course, the student will be able to:

CO 1: Identify where waiting line problems occur and realize why it is important to study such problems. Understand how Poisson distribution is used to describe arrivals and exponential distribution to describe service times. Study operating characteristics of a queuing model: Single Service Channel with Poisson arrivals, exponential service times and finite or infinite calling population.

CO 2: Study operating characteristics of a queuing model: Multi Service Channel with Poisson arrivals, exponential service times and finite or infinite calling population. Learn where inventory costs occur and why it is important to hold Inventory. Learn Economic order quantity model and extend its basic approach to inventory systems involving production lot size, planned shortages and quantity discounts.

CO 3: Decide optimal replacement policy of an item that deteriorates gradually and of an item that fails suddenly. Apply various techniques to find optimum replacement age of an item so that cost is minimized.

CO 4: Understand what simulation is and how it is helpful in the analysis of a problem. Discuss simulation of inventory models, queuing system, maintenance problems and job sequencing.

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Operations Research-II
Course Code: MMSL-4334 (OPT-IX)

Examination Time: 3Hrs Max. Marks: 100
Theory:80
CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 marks each)are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.The students can use only Non Programmable& Non Storage Type Calculator.

Unit-I

Queuing Theory: Introduction, Queuing System, elements of queuing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queuing models, Single
Service queuing model with infinite capacity (M/M/1): (∞/FIFO), Queuing Model: (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process

Unit-II

(M/M/C):(∞/FIFO), (M/M/C):(N/FIFO), (M/M/R):(K/GD), Power supply model, Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, Economic Order Quantity (EOQ), Deterministic inventory problems with no shortages and with shortages, EOQ problems with price breaks, Multi item deterministic problems.

Unit-III

Replacement Problems: Replacement of equipment/Asset that deteriorates gradually, Replacement of equipment that fails suddenly, Recruitment and Promotion problem, Equipment Renewal problem.

Unit-IV

Need of simulation, methodology of Simulation, Simulation models, event-type Simulation, generation of random numbers, Monte-Carlo Simulation, Simulation of inventory problems, Queuing systems, Maintenance problem, Job sequencing.

Text Book:

K. Swarup, P.K. Gupta and M.Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 19th edition, 2017. (Scope as in chapters 18, 19, 21`, 22)

Reference Books:

1. N.S.Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, 2005.
2. G. Hadley, Linear Programming, Addison-Wesley Publishing Company, 1962.
3. H.A. Taha, Operations Research, Pearson Education Limited, England, 10th edition, 2017.
4. R. Panneerselvam, Operations Research, PHI Learning Private Limited, New Delhi, 2nd edition, 2009

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Statistics-II
Course Code: MMSM-4335(OPT-VIII)

Course Outcomes

After the completion of the course, the student will be able to:

CO 1: Understand the concept of sampling distribution of statistics and in particular describe the behaviour of sample mean, sample variance and order statistics and to distinguish between population and sample and between parameter and statistic.

CO 2: Describe the property of unbiasedness, consistency, sufficiency, efficiency, uniqueness and completeness and to recognize M.P. test, UMP test and BLUE.

CO 3: Identify the Applications of Chi-square, t and F Distributions in terms of different tests and Compute or approximate the probable value of test statistic and explain two types of errors.

CO 4: Demonstrate the techniques of one way and two ways ANOVA.

Master of Science (Mathematics)
Semester-IV
Session 2022-23
Course Title: Statistics-II
Course Code: MMSM-4335(OPT-VIII)

Examination Time: (3+3) Hours
Max. Marks: 100

Theory:60
Practical:20
CA:20

Instructions for the paper setters/examiners:

Eight questions of equal marks (12 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.The students can use only Non Programmable& Non Storage Type Calculator and statistical tables.

UNIT-I

Sampling Distributions: Chi-square, t and F-distributions with their properties, distribution of sample mean and variance, distribution of order statistics and sample range from continuous populations.

UNIT-II

Point Estimation: Estimators, Properties of unbiasedness, consistency, sufficiency, efficiency, uniqueness and completeness, methods of estimation, Testing of Hypothesis: Null hypothesis and its test of significance, simple and composite hypothesis, M.P. test, UMP test, BLUE

UNIT-III

Likelihood ratio test (without properties), Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t-test, F-test.

UNIT-IV

Analysis of variance, analysis ofvariance for one way and two-way classified data with one observation per cell.

Text Book:

S.C. Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand and Sons, 2019

Reference Book

A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol-I, 8th edition, World Press, Calcutta, 2002.