ALGEBRA – I
MM- 451

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives: The main objective of this course is to maintain the standard computations of group theory and to learn the elementary theorems and proof techniques of group and ring theory. To apply the theorems, proof techniques and standard computations of group theory to solve problems.

Course Outcomes:

C.O.(1) : *To evaluate some interesting results of Group actions like Class Equation etc*

C.O.(2) : *Able to learn Lagrange's Theorem, structure theory of groups, solvability and Nil potency of groups*

C.O.(3) : *To evaluate the Symmetric groups, Alternating Groups and their simplicity..*

C.O.(4) : *To know how to apply Sylow Theory to determine structure of groups of finite order*

C. O.(5): *To evaluate the basic properties of Rings and Ideals*

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Section C will consist of one compulsory question having ten short questions covering the entire syllabus uniformly. Each question in sections A and B will be of 10 marks each and section C will be of 30 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions from each sections A and B and compulsory question of section C.

SECTION-A

Review of groups, Normal and subnormal series, Solvable groups, Nilpotent groups, Composition Series, Jordan-Holder theorem for groups. Group action, Stabilizer, orbit, Class equation and its applications, permutation groups, cyclic decomposition, conjugacy classes in permutation groups. Alternating group An, Simplicity of An.

SECTION-B

Structure theory of groups, Fundamental theorem of finitely generated abelian groups, Invariants of a finite abelian group, Groups of Automorphisms of cyclic groups, Sylow's theorems, Groups of order p^2, pq. Review of rings and homomorphism of rings, Ideals, Algebra of Ideals, Maximal and prime ideals, Ideal in Quotient rings, Field of Quotients of integral Domain, Matrix Rings and their ideals: Rings of Endomorphisms of Abelian Groups.

Books Recommended

1. Bhattacharya, Jain & Nagpal: Basic Abstract Algebra, Second Edition .
2. Surjeet Singh. Qazi Zameeruddin: Modern Algebra
3.M.L. khanna ,bhambri: A course in Abstract Algebra,third Edition

COMPLEX ANALYSIS-I
MM-452

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives: This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations, and harmonic functions are then introduced. Students will be prepared with an understanding of the fundamental concepts of complex variable theory..

Course Learning Outcomes*: Upon completion of this course, students should be able to:*

- *Represent complex numbers algebraically, geometrically and analyze limits and continuity for complex functions as well as consequences of continuity.*
- *Apply the concept of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.*
- *Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula*
- *Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.*

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each carrying 10 marks from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short questions carrying 3 marks each covering the entire syllabus uniformly.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions each from Section A and Section B and compulsory question of section C.

SECTION-A

Complex Differentiation: Functions of a complex variable, Analytic function, Cauchy-Riemann equations (Cartesian and polar form), Harmonic function and Harmonic conjugates, construction of analytic functions. Branches of multivalued functions with reference to arg z,logz and z^c

Complex Integration: Line integral, Cauchy's theorem, Cauchy Goursat theorem, Cauchy's Integral formula, Cauchy's inequality, Poisson's integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of Algebra.

SECTION-B

Power series, Taylor's theorem, Laurent series. Maximum Modulus Principle, Minimum Modulus Principle, Schwarz Lemma. Zeros and Singularities of a function, Meromorphic and entire functions: Residues at a pole and at infinity, Cauchy's theorem on residues. Argument Principle, Rouche's theorem, Fundamental Theorem of Algebra.Principal of analytic continuation,General definition ofan analytic function.Analytic continuation by power series method,Natural boundary,Harmonic function on a disc,Schwarz reflection principal.

RECOMMENDED AND SUGGESTED READINGS(R&S):

1. J. W. Brown & R.V. Churchill: Complex Variables and Applications, McGraw Hill, 2009.
2. S. Ponnusamy: Foundations of Complex Analysis, Narosa Publishing House, 2019.
3. Zill Dennis G .P.D.shanehan & Shanti narayan

ORDINARY DIFFERENTIAL EQUATIONS
MM-453

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course Objectives*: • Students learn how derivatives commonly appear in equations that describe theworld. Develop and improve students' problem solving skills and critical thinking. Students mastermathematical techniques and concepts used to analyze and understand differential equations.*

Course Learning Outcomes:
On completion of this course, the students will be able to:
CO-1 Understand the existence, uniqueness and continuity of solutions of first order ODB's
CO-2 Evaluate the solutions of initial and boundary value problems.
CO-3 Understand the eigen values and eigen functions of Sturm-Liouville systems
CO-4 Analyze the qualitative behavior of solutions of system of differential equations

Instructions for Paper Setter/Examiner

The question paper covering the entire course shall be divided into three parts: A, B & C. Each of sections A and B will have 4 questions from the respective sections of the syllabus of 10 marks each and section C will consist of compulsory question having 10 parts of short-answer type of 3 marks

Instructions for Candidates

Candidates are required to attempt five questions in all, selecting two questions from section Aand B each and the compulsory question from section C.

Section - A

Existence of Solution of ODE of First Order, Initial Value Problem, Ascoli's Lemma, Gronwall's Inequality, Cauchy Peano Existence Theorem, Uniqueness of Solutions, Method of Successive Approximations. Existence and Uniqueness Theorem. System of Differential Equations, nth order Differential Equation, Dependence of Solutions on Initial Conditions and Parameters,

Section-B

Linear System of Equations (Homogeneous & Non-Homogeneous). Superposition Principle, Fundamental Set of Solutions, Fundamental Matrix, Wronskian, Abel Liouville Formula, Reduction of Order, Adjoint Systems and Self Adjoint Systems of Second Order.

Linear 2nd Order Equations, Preliminaries, Sturm's Separation Theorem, Sturm's Fundamental Comparison Theorem, Sturm Liouville Boundary Value Problem, Characteristic Values & Characteristic Functions, Orthogonality of Characteristic Functions, Expansion of a Function in a Series of Orthonormal Functions, Floquet Theory

Reference Books:
S.L. Ross, Differential Equations, 3" edition, John Wiley & sons (Asia), 2007.
E.Coddington& N. Levinson. Theory of Ordinary Differential Equations, Tata Mc-Graw Hill,India
G.F. Simmons, Differential Equations with applications and historical notes, Taylor & Francis,3 ed.

NUMBER THEORY-I
MM-454

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: After studying this course, you should be able to: find quotients and remainders from integer division. Apply Euclid's algorithm and backward substitution. Understand the definitions of congruences, residue classes and least residues.*

Course Learning Outcomes:

On completion of this course, the students will be able to:
CO-1 understand the concepts of prime numbers, divisibility, congruence, g.c.d., prime factorizations.
CO-2 apply the results of Chinese remainder theorem, Fermat's Little theorem and Wilson's theorem. CO-3 analyse residue classes and its applications.
CO-4 understand the concept of different arithmetic functions and their relations

Instructions for Paper Setter/Examiner

The question paper covering the entire course shall be divided into three parts: A, B & C. Each of sections A and B will have 4 questions from the respective sections of the syllabus of 10 marks each and section C will consist of 1 compulsory question having 10 parts of short-answer type of 3 marks each covering the entire syllabus uniformly.

Instructions for Candidates

Candidates are required to attempt five questions in all, selecting two questions from section A and B each and the compulsory question from section C.

Section - A

Basic Properties of Divisibility and special divisibility tests by prime numbers using multipliers, The Euclidean algorithm, The Diophantine equation ax+by=c. The Fundamental Theorem of Arithmetic, Sieve of Eratosthenes, Basic Properties of Congruence, Chinese Remainder Theorem, Fermat's Little Theorem and pseudo primes, Wilson's Theorem,

Section-B

Residue Classes and Reduced Residue Classes, Euler's Theorem. Primitive roots and indices. Arithmetic Functions (p(n), d(n), σ(η), μ(n) and their relations, Mobius Inversion Formula, Quadratic Residues, Legendre Symbol, Quadratic Reciprocity Law, Jacobi Symbol, Perfect Numbers, Mersenne Primes and Fermat Numbers,

Reference Books:

1. D. M. Burton, Elementary Number Theory, 7th Edition, Mc Graw Hill Ed., 2017
2. 1. Niven, H.S. Zuckerman, H.LMontgomery, An Introduction to Theory of Numbers, 5th Edition John Wiley & Sons, 2008
3. H. Davenport, The Higher Arithmetic, 8th Edition, Camb, Univ. Press, 2008
4. G.H.Hardy, E.M.Wright. An Introduction to the theory of numbers, 6th Edition Oxford Univ. Press. 2008.
5. J.B. Dence, T.P. Dence, Elements of the Theory of Numbers, academic Press, 1999,

M.Sc(Mathematics)-I
(Paper Code MM455)
Subject: Information Technology(Semester-I)

Total Marks: 50 Maximum Time: 4 Hrs.
External Marks: 40 Minimum Pass Marks: 35%
Internal Assessment: 10

Course Objectives

- *To teach the students the fundamentals of computer related to its hardware & software.*
- *Provide knowledge of different units of computer like processing unit, IO unit, and Storage unit.*
- *Applications of IT.*
- *Advanced trends in IT.*
- *Have a clear understanding of fundamentals of computers so as to apply it in real life problems.*
- *Develop an in depth knowledge of various motivational theories.*
- *To give fundamental knowledge Office tools.*

Learning Outcome

- On the successful completion of the course, students will be able to;
- Have a clear understanding of documents, sheets and presentation.
- Develop an in depth knowledge of various office theories.
- Develop skills to get employment in I.T Field.

UNIT - I

Computer Appreciation: Introduction to computers, characteristics of computer; History of computers; Classification of computers on size: (Micro, Mini, Mainframe and super computers), Generations; Applications of computers; commonly used terms–Hardware, Software.

Basic Computer Organization: Block diagram of computer system, Input Devices and Output Devices.

Memories: Memory Hierarchy, Primary Memory - RAM, ROM, Cache memory. Secondary **Storage Devices** - Hard Disk, Compact Disk, DVD, Flash memory.

Types of software: System and Application software.

Computer Networks: LAN, MAN, WAN Services offered by Internet.

UNIT – II

MS -Word : Basics of Word Processing; Opening, Creating, Saving and Printing Documents, Editing Text, Finding and Replacing Text, Spell Check, Autocorrect; Auto Text, Character formatting, Page formatting;

Document Enhancement; Adding Borders and shading, Adding Headers and Footers, Setting up Multiple columns, Merging Documents, Using Mail merge feature for labels and envelops; Inserting Pictures, Tables

MS-Excel : Worksheet overview, Row, Column, Cells, Menus, Creating Worksheet, Opening, Saving, Printing Worksheets; Calculations, Auto fill, Working with Formulae, Data Formatting (number formatting, date formatting), Working with Ranges, Establishing Worksheet links; Creating, Sorting and Filtering Data Base; Creating chart, Adding Titles, Legends etc. to charts, Printing Charts

MS-Power Point: Creating, Saving, Printing Presentation; Selecting Design Templates, Animations and Transitions.

Reference Books:

Peter Nortorn, Introduction to Computers, Seventh Edition
V. Rajaraman, Fundamentals of Computers, PHI.
N. Subramanian, Introduction to Computers, Tata McGraw-Hill.
D.H. Sanders, Computers Today, McGraw-Hill,
Rob Tindrow, Jim Boyce, Jeffrey R. Shapiro, Windows 10 Bible, Wiley.
Anshuman Sharma: " Fundamental of Information Technology", Lakhanpal Publisher
Pradeep K. Sinha: "Computer Fundamental", BPB Publications

Paper Code MM455P) M.Sc (Mathematics)-I
(Semester-I)

External Marks : 50 Time : 3 Hrs.
Minimum Pass Marks: 35% Practical Units to be conducted:45-55Hrs
The laboratory course will comprise of Activities related to OFFICE and exercise to what is learn under Paper:

Word Processing

Activity 1:
i. Create, open, save, save as and close a document
ii. Typing, copying, moving and deleting data in word document.
iii. Cut and Copy, Paste and Paste Special.
Activity 2:
Formatting of data in word Document:-
i. Text formatting (font size, font style, font color, subscript, superscript, upper/lower case etc.)
ii. Text Alignment and character spacing
iii. Border, shading, Bullets and Numbering
Activity 3:
1. Find and replace and data sorting in a document.
ii. Protect your document.
iii. Create different types of Charts in word.
iv. Set a size, margin, orientation of page, Columns and Line Number Word.
Activity 4:
i. Set Page Color, Page Border, Themes, and Watermarks in Word
ii. Adding Tables, header/footers, pictures, page numbers
iii. Showing Ruler, Gridlines, Document Map, Thumbnails, Inserting Word Art
Activity 5:
i. Perform Mail-merge in word
iii. Set the print properties of a word document

PowerPoint

Activity 1:
i. Create, open, save and close a Presentation
ii. Typing, copying, moving and deleting data in presentation.
iii. New Slide, understanding Slide Layout, adding and deleting slides.
Activity 2:
Formatting of data in slides:-
i. Text formatting (font size, font style, font color, subscript, superscript, upper/lower case etc.)
ii. Text Alignment and character spacing
iii. Indention and line spacing
iv. Border, shading
v. Bullets and Numbering
Activity 3:
i. Set a size, margin, orientation of slides in PowerPoint.
ii. Adding Tables, header/footers, pictures, page numbers and special symbols, Text Box etc. in your presentation
Activity 4:
i. Adding Animation and Transition Effects in Slides, Understanding Slide Show
ii. Presentation Views, Understanding Formatting commands in PowerPoint

Excel

Activity 1:
i. Create, open, save and close workbook
ii. Create a new worksheet, renaming and moving sheet.
iii. Entering, copying, moving and deleting data in cells and worksheets.

iv. Insert and delete cells, columns and rows in Excel.

Activity 2:

i. Formatting of data in cells: -

ii. Text formatting (font size, font style, font color, Cell border etc.)

iii. Text Alignment

Activity 3:

i. Find and replace data in a sheet

ii. Perform data sorting and data filtering in Excel

Protect your Worksheet and Workbook

Activity 4:

i Create a chart in Excel.

ii. Create different types of Charts in Excel.

iii. Set a size, margin, orientation of page in Excel.

iv. The print properties of worksheet in Excel.

LINEAR PROGRAMMING
MM-456

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: To train the student in the domain of linear programming. To give sufficient tools for solving linear programming problems which can be used by students for further applications in different areas of interest*.

Course Learning Outcomes*: Upon the completion of this course, students will be able to:*

- *Formulate, Understand and apply the concept of optimality criteria for various type of optimization problems.*
- *Solve the transportation and assignment problems.*
- *Identify strategic situations and also find sequencing Problems.*
- *Apply the methods of optimization in real life situation.*

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%. Use of scientific calculator is allowed.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C. Use of non-programmable scientific calculator is allowed.

Section-A

Linear programming problems (LPPs); Examples, Mathematical formulation, Graphical solution, Solution by Simplex method, artificial variables, Big-M method and two phase simplex method. Duality in linear programming; Concept, Mathematical formulation, fundamental properties of duality, duality and simplex method and dual simplex method. Sensitivity Analysis: Discrete changes in the cost vector, requirement vector and Co-efficient matrix.

Section –B

Transportation problem; initial basic feasible solution and Optimal solutions using MODI method (for balanced cases only), Assignment problem; solution of balanced and unbalanced assignment problems, maximization case in assignment problem] Sequencing Problems; General Assumptions, Processing n jobs through m machines. Replacement decisions; O.R methodology of solving replacement problems, Replacement of items that deteriorates with time without and with change in the money value.

RECOMMENDED BOOKS:

1. Kanti Swarup, P.K. Gupta and Manmohan: 'Operations Research', Sultan Chand and Sons, New Delhi, Ed. 1996.
2. V.K. Kapoor: 'Operations Research', Sultan Chand and Sons

ALGEBRA-II (RINGS AND MODULES)
MM-551

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: The main objective of this course is to maintain the standard computations of ring theory and to learn the elementary theorems and proof techniques of group and ring theory. To apply the theorems, proof techniques and standard computations of ring theory to solve problems*.

Course Learning Outcomes: Upon completion of this course, students should be able to:

- Understand the concept of unique factorization domains, principal ideal domains, Euclidean domains, polynomial rings over UFD, rings of fractions.
- Understand the concept of modules, submodules, direct sum of submodules, free modules, difference between modules and vector spaces, quotient modules, Homomorphism, simple modules, modules over PID.
- Learn the concept of modules with chain conditions, artinian modules, noetherian modules, artinian Implies noetherían in rings, composition series of a module, length of a module, Hilbert Basis Theorem.
- Learn the concept of Cohen Theorem, Radical Ideal, Nil Radical, Jacobson Radical, radical of an artinian ring. Nil Radical and Jacobson Radical of Polynomial Rings R[x], R commutative.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of five sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answer covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

SECTION-A

Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains, Polynomial Rings over UFD, Rings of Fractions. (RR1: Ch. 11 and Section 1 of Chapter 12).Modules: Definition and Examples, Submodules, Direct sum of submodules, Free modules, Difference between modules and vector spaces, Quotient modules, Homomorphism, Simple modules, Modules over PID. (RR2: Chapter 5)

SECTION-B

Modules with chain conditions: Artinian Modules, Noetherian Modules, Artinian Implies Noetherian in Rings, Composition series of a module, Length of a module, Hilbert Basis Theorem (RR2: Chapter 6).Cohen Theorem, Radical Ideal, Nil Radical, Jacobson Radical, Radical of an Artinian ring. Nil Radical and Jacobson Radical of Polynomial Rings R[x], R commutative. (RR2: Chapter 6)

Books Recommended:

1. Bhattacharya, Jain and Nagpaul: Basic Abstract Algebra, Second Edition,

2. Musili C., Introduction to Rings and Modules, Second Revised Edition

MATHEMATICAL ANALYSIS
MM-552

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course Objectives*: The objective of this subject is to introduce students to understand the importance of measure theory and Integration.*
Course Learning Outcomes*: Upon completion of this course, students should be able to:*
Understand the fundamental concepts of outer measures, Lebesgue measure and non-measurable sets.
Be familiar with outer measure, Lebesgue measurable functions
To understand integrate a measurable function and classical theorems of Lebesgue theory.

INSTRUCTIONS FOR THE PAPER-SETTER
The question paper will consist of five sections: A, B and C. Sections A and B will have four Centions C will consist of one sompolisory question has in pective section of covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

SECTION-A

Functional of several variables: Linear transformations, Derivatives in an open subset of R", Chain Rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem. Algebras, G-algebra, their properties, General measurable spaces, measure spaces, properties of measure, Complete measure, Lebesgue outer measure and its properties, measurable sets and Lebesque measure, A non measurable set.

SECTION-B

Measurable function w.r.t. general measure. Borel and Lebesgue measurability. Integration of nonnegative measurable functions, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem, The general integral, Integration of series, Riemann and lebesgue integrals. Differentiation; Vitalis Lemma, The Dini derivatives, Functions of bounded variation, Differentiation ofan Integral, Absolute Continuity, Convex Fucntions and Jensen's inequality.

Book Recommended

1. H.L. Royden: Real analysis, Macmillan Pub. co. Inc. 4th Edition, New York, 1993.
2. 2. Walter Rudin: Principles of Mathematical Analysis, 3^{\prime8} edition, McGrawHill, Kogakusha, 1976, International student edition. Chapter 9 (Excluding Sections 9.30 to 9.43)
3. T. Apostol: Mathematical Analysis 2nd Edition, Addison Wesley, 1974

MATHEMATICAL STATISTICS
MM-553

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: Statistical methods used in practice are based on the foundations of the statistical theory. One branch of this theory uses the tools of probability to establish important distributional results that are used throughout statistics. Another major branch of statistical theory is statistical inference. This basic course toward the first branch is concerned with the fundamental theory of probability, random variables, Expectation, Distributions. Students will be familiar with many common distributions, continuous or discrete, univariate or multivariate, which provides rich families for modeling real data.*

Course Learning Outcomes: Upon completion of this course, students should be able to:

- Understand the concept of Probability distributions.
- Find mathematical expectation, moments, moment generating functions, product moments, moments of linear combinations of random variables, conditional expectations.
- Be familiar with study of various discrete distributions and continuous distributions.
- Be able apply test of significance and find point estimation.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each carrying 10 marks from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short questions carrying 3 marks each covering the entire syllabus uniformly.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions each from Section A and Section B and compulsory question of section C.

SECTION-A

Real random variables, distribution functions, discrete and continuous random variables, decomposition of a distribution function, Independence of events. Expectation of a real random variable. Linear properties of expectations, Characteristic functions, their simple properties

Discrete probability distributions: Binomial distribution, Poisson distribution,Poisson distribution as a limiting case ofbinomial distribution, negative binomial distribution, geometric distribution, Hypergeometric distribution, power series distribution.

Continuous probability distribution: Normal distribution, rectangular distribution, gamma distribution, beta distribution of first and second kind, exponential distribution. distribution of order statistics and range.

SECTION-B

Theory of Estimation: Population, sample, parameter and statistic, sampling distribution of statistic, standard error. Interval estimation, Methods of estimation, properties of estimators.

Exact Sampling Distributions: Chi-square distribution, Student's t distribution, Snedecor's F. distribution, Fisher's-Z distribution.

Hypothesis Testing: Tests of significance for small samples, Null and Alternative hypothesis, Critical region and level of significance. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Tests of significance based on t, Z and F distributions, Chi square test of goodness of fit. Large Sample fests, Sampling of attributes.

Books Recommended:

1. Goon, A. M., Gupta, M. K., & Dasgupta, B. (2003). An outline of statistical theory(Vol I & 2), World Press Pvt Limited.

2. Lehmann, E. L., & Casella, G. (1998), Theory of point estimation (Vol. 31). Springer Science & Business Media.

3.S.C. Gupta and V.K. Kapoor : Fundamental of Mathematical Statistics, Sultan Chand & Sons 11^{th} edition

4. Rohutgi, V. K., & Saleh, A. M. E. (2011). An introduction to probability and statistics. John Wiley & Sons.

OPTIMIZATION TECHNIQUE- I
MM- 554

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: To train the student in the domain of linear programming. To give sufficient tools for solving linear programming problems which can be used by students for further applications in different areas of interest.*

Course Learning Outcomes: Upon the completion of this course, students will be able to:

- Formulate, Understand and apply the concept of optimality criteria for various type of optimization problems.
- Solve the transportation and assignment problems.
- Identify strategic situations and represent them as games.
- Apply the methods of optimization in real life situation.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each carrying 10 marks from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short questions carrying 3 marks each covering the entire syllabus uniformly.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions each from section A and section B and compulsory question of section C.

SECTION-A

Introduction: Definition of Operation research, Models in operation research, General Methods for solving O.R. models, Elementary theory of convex sets.Linear Programming Problems: Definition of LPP, Examples of LPPs, Mathematical formulation of the mathematical programming problems, Graphical solution of the problem. Simplex method, Big M method, Two Phase method, Exceptional Cases of L.P.P.Duality in linear programming: Concept of duality, duality theorems, complementary slackness theorem,dual simplex method.

Sensitivity Analysis: Discrete changes in the cost vector, requirement vector, addition of a new variable, deletion of a variable, addition of new constraint, deletion of a constraint.

SECTION-B

Transportation Problem: Introduction, Mathematical formulation of the problem, initial basic feasible solution using North West Corner Method, Least Cost Method and Vogel's Approximation Method, Optimal solution using MODI method, degeneracy in transportation problems, some exceptional cases in transportation problems.

Assignment Problems: Introduction, Mathematical formulation of an assignment problem, assignment algorithm, unbalanced assignment problems.

Games & Strategies: Definition & characteristics of Games, Maximin-minimax principle, Two person zero sum games, Games without saddle points, Mixed Strategies, Concept of Dominance, Graphical method for solving games 2 x n & m x 2, Rectangular game.

RECOMMENDED BOOKS:

1. Kanti Swarup, P. K. Gupta and Man Mohan, "Operations Research", Sultan Chand and Sons, New Delhi, 14th Edition 2008.
2. H. A. Taha, "Operations Research: An Introduction", Pearson, 10th Edition, 2017.

3. Chander Mohan and Kusum Deep, "Optimization Techniques", New Age International Publishers, 2009
4. S.D. Sharma, "Operations Research", Kedar Nath and Co., Meerut, 2009.

Differential Geometry
MM-555

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course objectives*: The course gives an introduction to the techniques of differential geometry. We will study connections and curvatures of smooth manifold etc.*

Course Learning Outcomes:

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

CO-1 evaluate the curvature and torsion of space curves and understand the fundamental theorem for space curves

CO-2 Understand the concept of involutes and evolutes with the help of examples.

CO-3 remember about Gaussian map and Gaussian curvature of a curve.

CO-4 Analyse the concept related to minimal surface, holomorphic functions and geodesics .

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short answers covering the entire syllabus uniformly. The weightage of section A and B will be 30% and that of section C will be 40%.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two question from each sections A and B and compulsory question of section C.

Section A

Theory of Space Curves: Curves in the planes and in space, arc length, reparametrization, curvature, Serret-Frenet formulae. osculating circles, evolutes and involutes of curves, space curves, torsion, Serret-Frenet formulae. Theory of Surfaces, smooth surfaces, tangents, normals and orientability, quadric surfaces, the first and the second fundamental forms, Euler's theorem. Rodrigue's formula. Gaussian Curvature, Gauss map and Geodesics: The Gaussian and mean curvatures, the pseudosphere, flat surfaces, surfaces of constant mean curvature.

Section B

Gaussian curvature of compact surfaces, the Gauss map, Geodesics, geodesic equations, geodesics of surfaces of revolution, geodesics as shortest paths, geodesic coordinates. Minimal Surfaces and Gauss'sRemarkable Theorem: Plateau's problem, examples of minimal surfaces, Gauss map of a minimal surface, minimal surfaces and holomorphic functions, Gauss's Remarkable Theorem, isometries of surfaces, The Codazzi-Mainardi Equations, compact surface of constant Gaussian curvature

Book Recommended

- Andrew pressley : elementary differential geometry ,second edition springer.
- A. Goetz: Introduction to Differential Geometry, Addison-Wesley Publishing Company, 1968.
- T.J. Willmore: An Introduction to Differential Geometry, Dover Publications, Inc., Mineola, New York, 1997.

ANALYTIC NUMBER THEORY
MM-556

Pass percentage: 35% External Evaluation: 70
External Examination Time: 3 hours. Internal Evaluation: 30

Course Objectives*: The main objective to study the number theory is to understand the concepts of Divisibility, Arithmetical functions, Averages of arithmetical functions, some elementary theorems on the distribution of prime numbers and Dirichlet characters.*

Course Learning Outcomes: The course will enable the students to:

- Learn about the arithmetical functions.
- Know about the elementary properties of groups.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B and C. Sections A and B will have four questions each carrying 10 marks from the respective sections of the syllabus. Sections C will consist of one compulsory question having ten short questions carrying 3 marks each covering the entire syllabus uniformly.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions in all selecting two questions each from section A and section B and compulsory question of section C.

SECTION-A

Arithmetical functions: Mobius function, Euler's totient function, Mangoldt function, Liouville'sfunction, the divisor functions, Relation connecting and u, product formula for o(n), Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula, Multiplicative functions, Dirichlet multiplication, the inverse of a completely multiplicative function, Generalized convolutions.

Averages of arithmetical functions: The big oh notation, Asymptotic equality of functions, Euler's summation formula, Elementary asymptotic formulas, Average order of d(n), φ(n),σα(η), μ(π), An), The Partial sums of a Dirichlet product, applications to μ(n) and A(n), Legendre's identity.

SECTION -B

Some elementary theorems on the distribution of prime numbers: Chebyshev's functions \Ψ(x) & θ(x) Relation connecting θ(x) and π(x) Abel's identity, equivalent forms of Prime number theoren,inequalities for π (n) and P{n} Shapiro's Tauberian theorem, applications of Shapiro's theorem,Asymptotic formula for the partial sums $\sum p \leq x$(1/p). Elementary properties of groups, Characters of finite abelian groups, The character group, Orthogonality relations for characters, Dirichlet characters, Dirichlet's theorem for primes of the form 4n-1 and 4n+1 , Dirichlet's theorem in primes on Arithmetical progression, Distribution of primes in Arithmetical progression.

RECOMMENDED BOOKS:

1. T.M. Apostol," Introduction to Analytic Number Theory", Springer International student edition, Narosa Publishing House Pvt. Ltd. 1998
2. P.T. Bateman, Harold G. Diamond, "Number Theory", An Introductory Course, World Scientific, 2
3. M. Ram Morty, "Problems in Analytic Number Theory", Springer, 2008

ਮੁੱਢਲਾ ਗਣਿਤ

(ਡਿਗਰੀ ਲਈ ਜ਼ਰੂਰੀ ਪਾਸ ਕਰਨ ਵਾਲਾ Qualifying ਵਿਸ਼ਾ)

MATMCQP , AMCMCQP

L	T	P
3	1	0

Time Allowed: 3 hours
Passing Marks: 40

University Exam: 70
Internal Assessment: 30
Total: 100

ਸੈਕਸ਼ਨ :1

ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਤੱਕ ਬੁਨਿਆਦੀ ਗਣਿਤਿਕ ਨਾਮਕਰਨ। ਸੈੱਟ ਥਿਊਰੀ ਦੀਆਂ ਬੁਨਿਆਦੀ ਧਾਰਨਾਵਾਂ, ਬੇਸਿਕ ਸੈੱਟ, ਫੰਕਸ਼ਨਜ਼ ਅਤੇ ਰਿਲੇਸ਼ਨਜ਼, ਟੋਅਲਰ ਥੀਉਰਮ, ਬਾਈਨੋਮੀਅਲ ਥੀਊਰਮ।

ਸੈਕਸ਼ਨ :II

ਅਸਲ ਜੀਵਨ ਵਿੱਚ ਗਣਿਤ ਅਤੇ ਇਸਦੇ ਉਪਯੋਗ, ਗਣਿਤਿਕ ਮਾਡਲ ਦੀ ਪਰਿਭਾਸ਼ਾ। ਸਾਧਾਰਨ ਡਿਫਰੈਂਸ਼ੀਅਲ ਸਮੀਕਰਨਾਂ ਰਾਹੀਂ ਗਣਿਤਿਕ ਮਾਡਲਿੰਗ।

ਹਵਾਲਾ : 1. ਵੀ. ਸਿੰਘ, ਆਰ.ਐਮ. ਗੋਇਲ, ਬੀ.ਐਸ. ਮਾਂਗਟ ਅਤੇ ਰਾਮ ਸਿੰਘ ;

ਐਲੀਮੈਂਟਰੀ ਗਣਿਤ, ਪਬਲੀਕੇਸ਼ਨ ਬਿਊਰੋ, ਪੰਜਾਬੀ ਯੂਨੀਵਰਸਿਟੀ, ਪਟਿਆਲਾ, ਪੰਜਾਬ, ਭਾਰਤ।

2. ਜੇ.ਐਨ.ਕਪੂਰ ; ਮੈਥੇਮੈਟਕੀਲ ਮਾਡਲਿੰਗ, ਨਿਊ ਏਜ ਪਬਲੀਸ਼ਰਜ਼, ਭਾਰਤ।

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