UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Mathematics
Faculty of Science

M.Sc. (Mathematics)

First Semester Examination,
December 2023

Second Semester
Examination, June 2024

UNIVERSITY OF KOTA
MBS Marg, Near Kabir Circle, KOTA
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INDIA

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M.A./ M.Sc. MATHEMATICS EXAMINATION - 2023-24

CONTENTS

Program Objectives

The Program Objectives are the knowledge skills and attributes which the students will have at the time of post-graduation. At the end of the program the student will be able to:

1. To provide comprehensive curriculum to groom the students into qualitative scientific manpower
2. Enable students to enhance mathematical skills and understand the fundamental concepts of pure and applied mathematics.
3. To provide qualitative education through effective teaching learning processes by introducing projects, participative learning, and latest software tools.
4. To inculcate innovative skills, teamwork, ethical practices among students to meet societal expectations.
5. To encourage collaborative learning and application of mathematics to real life situations.
6. To inculcate the curiosity for mathematics in students and to prepare them for future research.

Program Outcome

1. Various courses of Mathematics are selected for the M.Sc. in Mathematics with the aim to achieve higher standard in mathematical reasoning, sophistication in thinking.
2. To acquire acquaintance with enough number of subjects including application-oriented ones to suit the present needs of various allied branches in Engineering and Science as well as provision of opportunities to pursue research in higher mathematics.
3. To prepare for pursuing careers in industry with the understanding of mathematical sciences and allied fields.
4. To inculcate the skills to analyze problems, formulate hypothesis, valuate and validateresults, and draw reasonable conclusions thereof.
5. To inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
6. Imbibe effective scientific and technical communication in both oral and writing.

Program Specific Outcome

1. Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
2. Prepare and motivate students for research studies in mathematics and related fields.
3. Provide knowledge of a wide range of mathematical techniques and application of

mathematical methods/tools in other scientific and engineering domains.

4. Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions.
5. Inculcate mathematical reasoning.
6. Strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory.
7. Good understanding of number theory which can be used in modern online cryptographic technologies.
8. Nurture problem solving skills, thinking, creativity through assignments, project work.
9. Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc
10. To nurture the understanding the scope and willingness to use the latest computing technology with the self-learning of various computing software.
11. Encourage the use of open-source programs and to contribute for further enhancement of those programs.

Duration of the Course

There shall be four semesters in two consecutive academic years and two semesters in each academic year (or as per the Rajasthan Government Directions wherever applicable)

Admission Criteria

Fresh Admissions – Semester – I

A candidate who has passed any one of the following examinations with Mathematics as a major subject from any University recognized by the UGC shall be permitted to take admission:

a. B.Sc. or B.A. with Mathematics as a main subject of study.
b. Three / Four-year B.Sc. (Hons.) with Mathematics
c. Bachelor of Science and Education (B.Sc.-B.Ed.) with Mathematics as a main subject.

Minimum qualifying marks to apply for the admission in M.Sc. Mathematics

A. Qualifying examination passed from any recognised University which is situated in Rajasthan State:

General Category = 55%.

SC / ST / OBC / SBC or MBC = Min. Pass Marks

B. Qualifying examination passed from any recognized University which is situated at outsidethe Rajasthan State:

All Categories = 60%.

Promotion – Semester – III

1. A candidate may be promoted in the next academic session (odd semester i.e. III semester) if he/she has cleared separately at least 50% of the papers of each semester (semester I & II) of previous academic session with 36% of the aggregate marks.
2. The candidate who does not fulfil the above condition will remain as an ex-student and will reappear in the previous semesters (semester I & II) examinations.
3. A candidate who has passed B.Ed. examination as a regular course of study after completing first and second semester examinations from this University shall also be eligible to take admission in third semester succeeding to B.ed. examination session.

Program Structure

The M.Sc. (Mathematics) programme with a credit weightage of 100 credit points, consists of:

1. Core and applied courses of theory papers which are compulsory for all students, which consist of 24 credit points for each semester I and II.
2. In semester III and IV one paper in each semester is compulsory while the candidate may opt for 3 papers from a group of available optional papers.
3. In IV semester the Prior requirement to opt 4O1, 4O2, 4O3, 4O4 and 4O5 are 3O1, 3O2, 3O3, 3O4 and 3O5respectively.
4. In IV semester an optional Dissertation/Project Work will be taken under the guidance of the teaching faculty available in the department/ affiliated college. This consist of 6 credit point of the required 24 credit points for IV semester.
5. Any of the optional courses/activities from following list# will be opted and accordingly completed by the candidate to get remaining 4 credit point to complete the full 100 credit points required to get the degree M.Sc. in Mathematics.

List of Interdisciplinary Courses/ Activities (4 Credits)

To get 4 credit points the candidate needs to engage with the following activities for at least 50 hours. The Course completion certificate, report with geo-tagged photographs, certificate from the organisations the candidate worked with will be submitted to the department/college and will be dully evaluated, only after successful evaluation the credit points would be awarded to the candidate.

1. Courses from UGC-SWAYM (Course Completion Certificate)
2. Courses from MOOC (Course Completion Certificate)
3. Courses from in.coursera.org (Course Completion Certificate)
4. Any other course from the sites like Linkedin* etc. which provide a certificate with clear mention of the course hours.
5. Any relevant theory course from interdisciplinary department available with the institution.
6. Extension Activities# – Community Services** (50 Hours) (Report with geo-tag photographs along with the Certificate by the organisation)
7. Significant contribution toward any research project (Data Collection, Data Analysis, Programming for computation) (Certificate from Principal Investigator/ Mentor/ Student Project with a clear mention of working hours)

#The extension activities do not include activities as NSS, Scout or NCC volunteer.

*The candidate is free to choose the course and site whether paid or free, however a completion certificate with a clear mention of hours attendance will be mandatory.

**Community Services would include – working for cleanliness drives, education specially to deprived children or adolescents, working for skill enhancement of deprived groups specially women, adolescents and children, conservation of natural flora and fauna, conservation of any endangered art or craft or any other activity allotted to the candidate by the organisation he/ she would be working with. This list is suggestive only and not to be considered as complete and final.

Note: All of the above activities must commence and complete within the period of the study of degree i.e. time period between the admission in Semester I to commencement of the examination for Semester IV, which should not ; in any condition be more then 2 years.

Course Code and Nomenclature

Paper Code will stand as MATH for mathematics, 1/2/3/4 for semester number, C or O for

compulsory/ optional and (1/2/3…) for paper number.

Semester I			
S.No.	**Code**	**Name of the Paper**	**Credits**
1	MATH 1C1	ALGEBRA I	6
2	MATH 1C2	ANALYSIS I	6
3	MATH 1C3	MECHANICS	6
4	MATH 1C4	METHODS OF APPLIED MATHS I	6
Semester II			
1	MATH 2C1	NUMERICAL ANALYSIS	6
2	MATH 2C2	ANALYSIS II	6
3	MATH 2C3	PARTIAL DIFFERENTIAL EQUATIONS	6
4	MATH 2C4	METHODS OF APPLIED MATHEMATICS - II	6

University of Kota, Kota
M.Sc. Mathematics: Semester-wise Scheme of Examinations

Year /Semester	Nomenclature of Paper		Duration of Exam	Teaching Hours/ Week	Credit Points	Distribution of Marks				Total Marks	
						Internal Assessment		Final Assessment		Total Marks	
	Paper Code/ ID	Nomenclature of Paper				Max Marks	Passing Marks	Max Marks	Passing Marks	Max Marks	Passing Marks
Semester I	MATH 1C1	ALGEBRA I	3	6	6	50	20	100	40	150	60
	MATH 1C2	COMPLEX ANALYSIS OR ANALYSIS I	3	6	6	50	20	100	40	150	60
	MATH 1C3	MECHANICS	3	6	6	50	20	100	40	150	60
	MATH 1C4	METHODS OF APPLIED MATHS I	3	6	6	50	20	100	40	150	60
TOTAL OF I SEMESTER				**24**	**24**	**200**	**-**	**400**		**600**	
Semester II	MATH 2C1	NUMERICAL ANALYSIS	3	6	6	50	20	100	40	150	60
	MATH 2C2	ANALYSIS II	3	6	6	50	20	100	40	150	60
	MATH 2C3	PARTIAL DIFFERENTIAL EQUATIONS	3	6	6	50	20	100	40	150	60
	MATH 2C4	METHODS OF APPLIED MATHEMATICS - II	3	6	6	50	20	100	40	150	60

Teaching Methodology

The classroom teaching would be through conventional lectures or power point presentations (PPT).The lecture would be such that the student should participate actively in the discussion.

Student seminars would be conducted, and group discussions would be arranged to improve their communicative skills.

The teaching methods would encourage use of technology as computing with some basic programming languages and software like C, C++, R Statistics, Python, MS Excel etc. the list is notconcluding.

Assessment Scheme

There shall be 4 Papers in each of the four semesters. Each paper has Max. 150 marks, 50 marks forInternal assessment and 100 marks for Main semester Examination of 3 hours duration. The Internalassessment consist of CIE (Term Test, Seminar, Assignments etc.) Minimum Pass Marks for InternalAssessment shall be 20 and for Semester Examination 40 for each paper.

A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concerned Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be charged from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to HOD who may permit the candidate to appear in the internal assessment after depositing the defaulter/ improvement fee. A record of such candidates shall be kept in the Department.

Question Paper Pattern

The syllabus for each theory paper is divided into five independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A : One compulsory question with 20 parts, having 2 questions from each unit. Each question will carry equal marks. **Total marks: 20**

Section-B: This section has 10 questions, 2 questions from each unit, 5 questions to be attempted, taking one from each unit. Each question will carry equal marks. **Total marks: 80**

M.A./M.Sc. MATHEMATICS SEMESTER – I (2022-23)

MATH 1C1 – ALGEBRA I

Unit - I

Linear transformations, Range, Kernel, Rank-nullity theorem, Singular and nonsingular transformations, Vector space of linear transformations. Adjoint of a linear transformations. Matrix representation of a linear transformation, Change of Basis. Transition matrix, Similarity, Eigen values and Eigen vectors for a linear transformation, Cayley-Hamilton Theorem.

Unit-II

Bilinear form, its matrix representation and rank, Canonical forms, Diagonalization, Quadratic form associated with a bilinear form, Symmetric matrix associated with a quadratic form.
Diagonalization of a quadratic form, Hermitian form and its matrix representation.

Unit - III

Inner product spaces, Cauchy-Schwartz inequality, orthogonal vectors. Orthogonal complements, orthonormal sets and bases. Gram Schmidt orthogonalisation process.
Homomorphism theorems on groups, Classes and class equation of a finite group, Sylow's Theorem.

Unit-IV

Cauchy's theorem for finite Abelian group. Normal and Subnormal series, Jordan-Holder Theorem, Solvable groups. Ideals, Principal Ideal rings, Euclidean rings and domains.

Unit V

Unique factorization theorem, unique factorization domain**.** Finite field extension, Galois Theory

References :

1. I.N.Herstien Topics in Linear Algebra (Wiley Eastern)
2. Sharma &Vashistha Linear Algebra (Krishna Publication)
3. KHoffemn&R.Kunje Linear Algebra (Prentice- Hall India Ltd)
4. Serge Lang Linear Algebra (Springer, New York)
5. D.S.Chauhan&K.N.Singh Studies in Algebra (JPH, Jaipur)
6. A.R.Vashistha Algebra (Krishna Publications- Meerut)
7. Shanti Naravan A Text book of Modern Abstract algebra (Wiley Eastern)
8. S. Maclane and G. Birkhoff Algebra 2nd ed. (Macniillen Co.)

MATH 1C2 – ANALYSIS I

Unit-I

Analytic functions, Stereographic projection of complex numbers, Holomorphic complex valued functions and their inverses, Power series. conformal mapping. Bilinear transformations their properties and classification. Special Transforms.

Unit-II

Complex integration, Cauchy Theorem and integral formula, Poisson's integral formula, Tayler's and Laurent's series.

Unit -III

Morera's Theorem. Lioville's Theorem, Maximum modulus principle, Minimal modulus principle, Schwarz's Lemma.

Unit-IV

Classification of Singularities. Branch Points, Reimann Theorem on removable Singularity, open mapping theorem.

Unit - V

Meromorphic functions, The Argument Principle. Roche's Theorem, Residues, Cauchy's residue theorem; evaluation of integrals, Branches of many valued functions with reference to $\arg Z, \log z, z^n$ Analytic Continuation.

References :

1. Malik- Arora — Mathematical Analysis (New Age International Limited)
2. Schaum Series — Complex Variable (TataMcgraw Hill)
3. Churchill & Brown — Complex Analysis (TataMcgraw Hill)
4. Walter Rudin — Real and Complex Analysis (TataMcgraw Hill)

MATH 1C3 - MECHANICS

Unit-I

Moment and product of Inertia- principal axes and Momental Ellipsoid, D'Alembert's principle.

Unit II

Motion about a fixed axis (General equation of motion).

Unit-III

Generalized Coordinates, Holonomic and Non-holonomic systems, Scleronomic and Rheonomic systems, Generalized potential. Lagrange's equations.

Unit-IV

Hamilton's variables, Hamilton canonical equations, Euler's dynamical equations for the motion of a rigid body about an axis.

Unit-V

Hamilton's Principle, Principle of least action. Poisson's Bracket, Poisson's identity, Jacobi-Poisson Theorem, Hamilton Jacobi equations.

References :

1. Goldstein — Classical Mechanics (Narosa Publication)
2. P.P. Gupta — Rigid Dynamics (Krishna Prakashan, Meerut.)
3. M. Ray — Dynamics of Rigid Body (Student's and Friend's, Agra)

MATH 1C4 - METHODS OF APPLIED MATHEMATICS - I

Unit-I

Fredholm and Volterra types Linear Integral Equations, Integral Equations of the first and second kinds, Solution of Fredholm Integral Equations with separable Kernels.

Unit II

Solution by successive substitutions and successive approximations of Fredholm types LinearIntegral Equations. Solution by successive substitutions and successive approximations of Volterra types Linear Integral Equations.

Unit-III

Laplace Transform: - Definition, properties, Laplace transform of derivatives. Laplace Transforms for Integrals, Inverse Laplace Transforms, Convolution theorem, Fourier transform – definition and properties of Fourier Sine and Cosine transform.

Unit IV

Applications of Laplace Transforms to solve Ordinary Differential Equations and Integral Equations.

Unit-V

Hypergeometric Function, Bessel Functions, Legendre Function of first kind.

References :

1. Erwin Kreyszig — Engineering Mathematics(New Age Intern. Limited)
2. M.D.Raisinghania — Integral Transform (S. Chand Pub.)
3. Shanti Swaroop — Integral Equations (Krishna Publication Meerut)
4. Pundir & Pundir — Integral Equations and Boundary value Problems (PragatiPrakashan Meerut)
5. Gupta and Goyal — Integral Transform (KrishnaPrakashan Meerut)
6. I N Snedan — Uses of Integral Transform (McGraw Hill)

M.A./M.Sc. MATHEMATICS SEMESTER – II (2022-23)

MATH 2C1 - NUMERICAL ANALYSIS

Unit I

Rate of Convergence of Bisection, Secant method, Regula-falsi, N-R Methods.
N-R Method for non linear equation.
Roots of polynomial equations -Bairstaw and Birge-Veta method, Graeffe's root square method.

Unit II

Solution of System of linear equations: Direct methods, Gauss, Gauss-Jordan, Cholesky, Partition, Triangularisation method.
Iterative methods: Jacobi, Gauss-Seidal and Relaxation Methods

Unit III

Curve Fitting and Approximation: Least square principle, Chebshev Approximation Method.
Matrix inversion and Eigen value problem, Power methods, Jacobi method, Complex Eigen values.

Unit-IV

Numerical Solution of Ordinary Differential Equations: Iterative methods –improved Euler methods. Runge-Kutta methods. Predictor Corrector methods.

Unit V

Stability analysis, Difference methods for Boundary Value Problems (BVP).
Numerical Solution of PDE- Finite step method.

References :

1. Jain-Iyenger-Jain — Numerical Analysis (New Age International Limited)
2. Chauhan, Vyas & Soni — Studies in Numerical Analysis (Jaipur Publishing House)
3. Goyel& Mittal — Numerical Analysis (Pragati Prakashan)
4. Gupta& Malik — Calculus of Finite Difference & Numerical Analysis

MATH 2C2 - ANALYSIS II

Unit-I

Riemann- Stieltjes integral, Properties of Improper Integral.

Unit II

Point-wise and uniform convergence of sequence & series of functions, Cauchy criterion, Weirstrass M-test, Abel and Dirchlet test for Uniform Convergence, Uniform Convergence and continuity.

Unit-III

Monotonic functions, Types of discontinuities, Functions of bounded variations, Functions of several variables, Directional Derivatives, Partial Derivatives, Derivative as a linear transformation, Inverse and implicit function theorem.

Unit IV

Measurable sets, Measurable functions. Lebesgue measure. Borel and Lebesgue measurability. Non measurable sets.

Unit-V

Convergence of sequence of measurable functions. Lebesgue integral of a bounded function.

References:

1. Malik- Arora — Mathematical Analysis (New Age International Limited)
2. H.L.Royden — Real Analysis (Macmillen Pub. Co.)
3. Walter Rudin — Real and Complex Analysis (TataMcgraw Hill)
4. G N.Purohit — Lebesgue measure & Integration (JPH. Jaipur)

MATH 2C3 - PARTIAL DIFFERENTIAL EQUATIONS

Unit-I

Existence and uniqueness of solution of (dy/dx) = f(x,y). Examples of PDE,Cachy problem for Ist order PDE. Classification. Canonical forms, Nonlinear First Order PDE-Complete Integrals, Envelopes.

Unit -II

Method of solving Second order PDE - separation of variable and Cauchy's problem.Laplace's Equation and its solution in Cartesian and Polar co ordinates.

Unit-III

Heat and Wave Equations in two and three dimension Cartesian coordinates. Heat and Wave Equation in two dimensional polar coordinates, their fundamental solutions by separation of variable.

Unit - IV

Variational of a functional, Euler Lagrange's Equations, Necessary and Sufficient Condition for Extrema, Variational Methods for Boundary Value Problems in Ordinary and Partial Differential equations.

Unit V

Calculus of variations, shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic.

References:

1. 1.Erwin Kreyszig — Engineering Mathematics (New Age India Ltd.)
2. 2. M.D. Raisinghania — Advanced Differential Equation (S.Chand)

MATH 2C4 - METHODS OF APPLIED MATHEMATICS - II

Unit-I

Principle of inclusion and exclusion, Pigeon-hole principle. Logic, Validity of Statements, Proof of Implications/Identities

Boolean Algebra : Boolean functions and expression, propositional calculus.

Unit II

Design and Implementation of digital networks, Application to switching and Logic circuits.

Graph Theory : Graphs. planer graph. Eulerian and Hamiltonian Graph. Directed Graphs

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Unit III

Trees: Binary Tree, Binary Search Tree. Lattices: Lattice and algebraic structure, duality, distributed and complemented lattice, partially ordered sets.

Unit IV

Fractional derivatives: Grunwald-Letnikov, Riemann-Liouville and Caputo's fractional derivative, Leibniz rule for fractional derivatives, Geometric and physical interpretation of fractional integration and fractional differentiation.

Unit-V

Sequential fractional derivatives. Left and right fractional derivatives. Properties of fractional derivatives. Laplace transforms of fractional derivatives. Fourier transforms of fractional derivatives.

References :

1. Schuam Series — Discrete Mathematics (TataMcgraw Hill)
2. C.L.Liu — Elements of Discrete Mathematics (Tata McGraw Hill)
3. Kenneth H Rosen — Discrete Mathematics (TataMcgraw Hill)
4. M.k. Gupta — Discrete Mathematics (Krishna Prakashan Meerut)