KANNUR UNIVERSITY

(Abstract)

M Sc Mathematics Programme in the Department of Mathematical Sciences, Mangattuparamba Campus -Revised Scheme (Distribution of credits of Four semesters) & Syllabus (1st Semester Only) - Approved- Implemented w.e f 2023 admission- Orders Issued

ACADEMIC C SECTION

ACAD C/ACAD C3/26618/2023 Dated: 26.12.2023

Read:-1. UO No ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
2. Circular No dated ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
3. Email dated 18/12/2023 from the Head, Dept of Mathematical Sciences, Mangattuparamba Campus
4. Minutes of the meeting of the Department Council dated 14/09/2023

ORDER

1. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System in the University Teaching Departments/ Schools were implemented w.e.f 2023 admissions vide paper read 1 above

2. As per paper read 2 above, Heads of all Teaching Departments were requested to submit the revised Syllabus in accordance with the approved Regulations along with a copy of the Department Council Minutes.

3. As per paper read 3 above, the Head, Department of Mathematical Sciences, Mangattuparamba Campus submitted the scheme (Distribution of credits of Four Semesters) and the Syllabus (1st Semester Only) of M.Sc Mathematics Programme to be implemented in the University Teaching Department w.e.f 2023 admissions, verified by the external expert.

4. Department Council vide the paper read 4 above approved the aforementioned scheme and syllabus of M.Sc Mathematics Programme to be implemented in the Dept. of Mathematical Sciences, Mangattuparamba Campus of the University w.e.f.2023 admission.

5. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter III of Kannur University Act 1996, ***approved the Scheme (Distribution of credits of Four Semesters) & Syllabus (1st Semester Only) of M.Sc*** Mathematics ***Programme and accorded sanction to implement the same in the Department of Mathematical Sciences, Mangattuparamba Campus w.e.f 2023 admissions, subject to reporting to the Academic Council***

6.The Scheme (Credit distribution of Four Semesters) and Syllabus (1st Semester Only) of M.Sc Mathematics Programme under CBCSS implemented in the Department of Mathematical Sciences, Mangattuparamba Campus with effect from 2023 admission, is appended and uploaded in the University website (www.kannuruniversity.ac.in)

7. Orders are issued accordingly.

Sd/-
Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1. Head, Department of Mathematical Sciences, Mangattuparamba Campus
2. Convenor, Curriculum Committee

Copy To: 1. PS to VC/ PA to PVC/ PA to R
2. To Examination Branch (through PA to CE)
3. EP IV/ EXC I
4. Computer Programmer
5. Web Manager (to publish on the website)
6. SF/DF/FC

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002 THAVAKKARA

Forwarded / By Order
SECTION OFFICER

KANNUR UNIVERSITY

M.Sc. MATHEMATICS

SCHEME & SYLLABUS

(*Under Choice Based Credit & Semester System)*

2023 admission onwards

DEPARTMENT OF MATHEMATICAL SCIENCES
Kannur University
Mangattuparamba Campus,

KANNUR UNIVERSITY

Learning Outcome Based Curriculum Frame Work and Programme Structure.

Post Graduate Programme in Mathematics

The M.Sc. Mathematics course is a comprehensive two-year program designed to provide students with an advanced understanding of various branches of mathematics divided into four semesters, each focusing on different areas of pure mathematical theories.

DURATION: 2 Years (4 semesters)

ELIGIBILITIES:

- B.Sc. Degree in Mathematics with 50% marks

ADMISSION:

- The selection of the candidate is based on the marks secured in the Degree Course/Admission test.
- The admission test will cover basic mathematics at the undergraduate level.

Objective of the Course

1 **:** Advanced knowledge and understanding: Students will develop a thorough understanding of the foundational concepts, principles, and theories within each subject area. They will gain a deep knowledge of algebraic structures, linear transformations, differential equations, real analysis , topology, measure theory, complex analysis, functional analysis, and differential geometry.

2 **:** Mathematical reasoning and problem-solving skills: Students will enhance their ability to apply rigorous mathematical reasoning and critical thinking skills to solve complex problems. They will learn to analyze mathematical structures, formulate hypotheses, and construct logical arguments to prove theorems and solve mathematical problems across various areas of pure mathematics.

3 **:** Advanced mathematical proof writing: Students will develop strong skills in constructing rigorous mathematical proofs. They will also improve their ability to present complex mathematical arguments in a clear and concise manner.

4 **:** Research skills and independent study: Each course may provide opportunities for students to engage in independent research projects and develop research skills. Students will learn to conduct literature reviews, identify research gaps, formulate research questions, and apply appropriate mathematical methods to investigate and contribute to the field of pure mathematics.

5 : Effective mathematical communication: Students will enhance their ability to communicate complex mathematical concepts and results effectively. They will learn to present mathematical ideas, findings, and proofs in both written and oral forms, using appropriate mathematical language and notation.

6 : Preparation for further study or career: An MSc Mathematics degree in pure mathematics can serve as a stepping stone for further academic pursuits, such as pursuing a Ph.D. in mathematics or related fields. It can also provide a solid foundation for careers in academia, research institutions, government agencies, or industries that require advanced mathematical skills and problem-solving abilities.

COURSE DETAILS:

A student must register for the required number of courses at the beginning of each semester. No students shall register for more than 24 credits and less than 16 credits per semester.

A total of 80 credits shall be the minimum for successful completion of the course in which a minimum of 60 credits for core course and 12 credits for electives are mandatory. Those who secure only minimum credit for core/ elective subjects has to supplement the deficiency for obtaining the minimum total credits required for successful completion of the program from the other divisions.

EVALUATION:

The proportion of the distribution of marks among the continuous evaluation and end semester examination shall be **40:60**.

Continuous Evaluation includes assignments, seminars, and written examination for each course. Weightage to the components of continuous evaluation shall be given for all theory papers of the course as follows:

Components of CE	Minimum Number	Weightage	Marks
Test paper	2	40	16
Assignments	1	20	08
Seminar & Viva	1	40	16

Test Paper: For each course there shall be at least two class tests during a semester.

Assignments: Each student shall be required to do one assignment for each course.

Seminar: Students are required to present a seminar on a selected topic in each paper. The evaluation of the seminar shall be done by the concerned teacher handling the course.

Attendance: Minimum attendance required for each paper shall be 75% of the total number of classes conducted for that semester. Those who secured the minimum requirement of attendance only be allowed to register/appear for End Semester Examination.Condonation of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of the PG program may be granted by the university as per university rules.

Conduct of Examination:

The vice chancellor will approve the panel of examiners submitted by the Head of the Department. All the teachers of the Department will be the members of the Board of examiners with Head of the Department as the Chairperson. There shall be a minimum of two external examiners. The panel approved by the Vice-Chancellor will be entrusted with the setting of question papers, conduct and evaluation of examination.

Research Project:

The students have to complete a project during IV Semester under the guidance of a faculty in the department

KANNUR UNIVERSITY

DEPARTMENT OF MATHEMATICAL SCIENCES

VISION

Promote quality education and innovative research in mathematical sciences.

MISSION

Promote quality education and innovative research in mathematical sciences in Kerala, In Particular in North Kerala.

Programme Outcome (PO)

PO 1 : **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2 : **Problem Solving:** Identify, formulate, conduct investigations, and find solutions to problems based on in-depth knowledge of relevant domains.

PO 3 : **Communication:** Speak, read, write and listen clearly in person and through electronic media in English/language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 4 : **Responsible Citizenship:** Demonstrate empathetic social concern, and the ability to act with an informed awareness of issues.

PO 5 : **Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO 6 : **Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PO 7 : Environmental Sustainability and Global Perspective:
Develop an understanding of global standards to foster legal environment.
Learn and practice to critically analyze the legal issues from local, national and international concerns.

ProagrammeSpecific Outcome (PSO)

PSO1: To provide students with a deep and comprehensive understanding of advanced mathematical concepts and theories.

PSO2: To develop student's research skills and provide them with the tools and techniques necessary to conduct independent mathematical research

PSO3: To enhance student's problem-solving abilities through coursework, assignments, and projects, students are challenged to think critically, analyze complex problems, and develop effective strategies to solve mathematical challenges.

PSO4: To improve students' oral and written communication skills, enabling them to convey complex mathematical ideas clearly and concisely to both technical and non-technical audiences

PSO5: Encourage teamwork and collaboration among students through group projects, seminars, and discussions. This helps students develop their interpersonal and teamwork skills, which are essential in many professional settings.

PSO6: To instill a passion for lifelong learning in students and encourage them to stay updated with the latest advancements in mathematics through participation in conferences, workshops, and continued engagement with the mathematical community.

PSO7: The course can serve as a stepping stone to further study, such as pursuing a Ph.D. in Mathematics or a related field. Additionally, the degree equips students with analytical and problem-solving skills that are highly valued in various fields.

Distributions of Grades for the MSc. Mathematics Programme from 2023 onwards									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10** Total credits
	Discipline specific		**Electives**						
Sem	**Core courses (DSC)** (**4 credits** for each coursein semester 1,2,3)	**Electives (DSE-Discipline Specific Elective)**	Interdisciplinary/ Multidisciplinary Elective	AEC 2credits	SEC 2 credits	VAC/Mooc 2 credits	Internship/Field visit/Minor/Project/ Institutional /industrial visit 2 credits	Dissertation / Major project	
1	**MSMAT01DSC01** **MSMAT01DSC02** **MSMAT01DSC03** **MSMAT01DSC04** **MSMAT01DSC05** **(Total 20 credits)**								**20**
2	**MSMAT02DSC06** **MSMAT02DSC07** **MSMAT03DSC08** **MSMAT04DSC09** **MSMAT05DSC10** **(Total 20 credits)**			Offered by other departments	Offered by other departments				
	20 credits			**2 credits**	**2 credits**				**24**
3	**MSMAT03DSC11** **MSMAT03DSC12** **(Total 8 credits)**	Choose one from **MSMAT03DSE 01 To MSMAT03DSE 03**	**Offered by other departments**						
	2x4 = 8 credits	**1x4 credits**	**1x4 credits**						**16**

4		**Choose four from MSMAT04DSE 04 to MSMAT04DSE 21**						**MSMAT04D SC01 (8 credits)**	
		4x4=16 credits						**8 credits**	**24**
	Total credits for MSc Mathematics Programme								**84**

Credits for MOOC is over and above the credit requirements

SCHEME

FIRST SEMESTER								
Course Code	**Title of Paper**	**Contact Hours/Week**			**Marks**			
		L	**T/S**	**P**	**ESE**	**CE**	**Total**	**Credits**
DISCIPLINE SPECIFIC CORE COURSES								
MSMAT01DSC01	Algebra I	4	1		60	40	100	4
MSMAT01DSC02	Linear Algebra	4	1		60	40	100	4
MSMAT01DSC03	Ordinary Differential Equations	4	1		60	40	100	4
MSMAT01DSC04	Real Analysis	4	1		60	40	100	4
MSMAT01DSC05	Topology	4	1		60	40	100	4
	Total	**20**	**5**		**300**	**200**	**500**	**20**

Note: -L:Lecture ,T/S :Tutorial/Seminar, P :Practical ,ESE : End Semester Evaluation, CE Continuous Evaluation

FIRST SEMESTER M.Sc. MATHEMATICS PROGRAMME

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSMAT01DSC01-Algebra I**
Course Objectives	The Course aims ● To gain knowledge in basic group theory and ring theory which are essential for further study.

Module	**Content**	**Module Outcome**

I (15 Hours)	• **Direct products and finitely generated abelian groups.** • **Homomorphisms, Factor groups.** • **Factor group computations and simple groups.** **(Chapter 2 Section11 and Chapter 3 Sections 13-15 of text.)**	Students are able to :learn about homomorphism and factor groups
II (15 Hours)	• **Group Action on a set Application of G-sets to counting,** • **Sylow theorems, Applications of the Sylow theory.** • **Free abelian groups. (** **Chapter 3 Section 16,17 and Chapter 7 Sections 36,37,38 of text.)**	Able to get an understanding about Sylow's theorem and its applications
III (15 Hours)	• **Free groups.** • **Group presentation.** • **The Field of quotients of an integral domain.** • **Ring of polynomials.** **(Chapter 7 Sections 39-40, Chapter 4 Sections 21,22 of text.)**	Able to learn free groups and field of quotients. Also the definitions and properties of rings are introduced.
IV (15 Hours)	• **Factorization of polynomials over a field.** • **Homomorphisms and factor rings.** • **Prime and maximal ideals.** **(Chapter 4 Section 23; Chapter 5 Sections 26,27 of text.)**	Able to learn about factorization of polynomials, and factor rings. Also the basic theory of ideals is introduced.
References	**Text Books:** **J. B. Fraleigh – A First Course in Abstract Algebra- Narosa (7th edn., 2003)** **Reference Books:** **1. I.N. Herstein – Topics in Algebra- Wiley Eastern** **2. J.A.Gallian – Contemporary Abstract Algebra** **3. Hoffman & Kunze – Linear Algebra – Prentice Hall** **4. M. Artin, Algebra, Prentice Hall, 1991** **5. T.W.Hungerford: Algebra;Springer 1980** 6. **N.H.McCoy&Thomas R.Berger: Algebra-Groups,Ring and other topics:Allyn&Bacon**	

Course Outcome	After successful completion of this course, student will be able to:
	CO1:To get a basic understanding of the important algebraic structure including groups, rings and fields. CO2: Knowledge of direct products and fundamental theorem of algebra facilitates students to understand the structure of finitely generated abelian groups. CO3: Understanding of homomorphisms, factor groups, group actions and subsequently the Sylow theorem enables the students to classify a large class of finite groups which are not necessarily abelian and understand their further structures. CO4: Knowledge of ring of polynomials, irreducibility criterion of polynomials and field of quotients help in understanding the field extensions and Galois theory which is part of the second semester syllabus. CO5:Overall at the end of the semester, students can solve a wide range of mathematical problems involving the structures of groups, normal subgroups, factor groups, rings, ideals and factor rings.
Teaching Learning Strategies	Direct Instruction: Brainstorming lecture, Problem solving sessions, Explicit Teaching, E-learning(Video), Interactive Instruction: Active co-operative learning, Seminars, Assignments, Library work and Group discussion, Presentation by individual student/ Group representative.
Mode of Transaction	Face to face: Lecture method Learner centered technique: Computer assisted learning & Individual project teaching, Seminar, Viva-voce

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	**60**
Continuous Evaluation	**40**
● **Test papers**	**16**
● **Tutorial with Seminar presentations/Discussions/Debate, etc.**	**16**
● **Assignment**	**8**

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSMAT01DSC02 - LINEAR ALGEBRA**
Course Objectives	The Course aims ● Equip students with a profound comprehension of linear algebra, which will serve as a solid foundation for further studies, particularly in the context of functional analysis course

	Content	**Module Outcome**
Module I: (15 hours)	● Vector spaces (Quick review) ● Linear Transformations ● The Algebra of Linear Transformations ● Isomorphism (Chapter 2, Chapter-3; Sections 3.1, 3.2,3.3 of text 1)	Students are able to:Demonstrate a thorough understanding of vector spaces, including their properties and examples. Apply concepts of linear transformations and matrix representations to solve mathematical problems. Analyze and perform algebraic operations on linear transformations. Identify and establish isomorphisms between vector spaces.

Module II: (15 hours)	● Representation of Transformation by Matrices ● Linear Functionals ● The Double Dual ● The Transpose of a Linear Transformation. (Chapter 3, sections 3.4, 3.5, 3.6, 3.7 of text 1)	Represent linear transformations using matrices and understand their applications. Apply linear functionals to analyze and solve problems related to vector spaces. Grasp the concept of the double dual and its significance in linear algebra. Understand and apply the concept of transpose in the context of linear transformations
Module III: (15 hours)	● Elementary Canonical Forms: Introductions, ● Characteristic Values ● Annihilating Polynomials ● Invariant Subspace (Chapter-6: Sections 6.1, 6.2, 6.3, 6.4 of text 1)	Comprehend and apply elementary canonical forms to analyze linear transformations. Calculate and interpret characteristic values of linear transformations. Utilize annihilating polynomials for solving problems in linear algebra. Identify and analyze invariant subspaces within linear transformations
Module IV: (15 hours)	● Jordan Canonical form and applications (Chapter 5, 5.1 to 5.3 of Text 2) ● Inner Product Spaces: Inner Products, ● Inner Product Spaces, (Chapter-8: Sections 8.1, 8.2 of text 1)	Understand the concept of Jordan canonical form and its applications in linear algebra. Apply Jordan canonical form to analyze and solve problems related to linear transformations. Demonstrate a solid understanding of inner product spaces and their properties. Give a base to study functional Analysis

References	**Text Books**: Text 1. Kenneth Hoffman & Ray Kunze; Linear Algebra; Second Edition, Prentice-Hall of India Pvt. Ltd Text 2: D W Lewis, Matrix Theory, World Scientific – (section 1, module 4) **Reference:** 1. Serge A Lang: Linear Algebra; Springer 2. Paul R Halmos Finite-Dimensional Vector Spaces; Springer 1974. 3. Thomas W. Hungerford: Algebra; Springer 1980 4.S H Fried Berg ,A J Insel and L E Spence : Linear algebra , Pearson, fifth edition 5. N H McCoy& T R Berger: Algebra-Groups, Rings & Other Topics: Allyn & Bacon. 6. S. Axler Linear Algebra Done right , Springer
Course Outcomes	**After successful completion of this course, student will be able to:**
	CO1: Exhibit a strong grasp of core linear algebra concepts, including vector spaces, matrices, determinants, eigen values, eigen vectors, linear transformations and inner product spaces. CO2: Develop a rigorous mathematical mindset, understanding and using mathematical proofs and theorems related to linear algebra. CO3: Apply linear algebra techniques to solve a wide range of mathematical problems, such as systems of linear equations and matrix theory. CO4: Analyze and manipulate eigen values and eigen vectors to solve problems related to diagonalization. CO5: Equip students with a profound comprehension of linear algebra, which will serve as a solid foundation for further studies, particularly in the context of functional analysis course.

Teaching Learning Strategies	Direct Instruction: Brainstorming lecture, Problem solving sessions, Explicit Teaching, E-learning (Video), Interactive Instruction: Active co-operative learning, Seminars, Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method Learner centered technique: Computer assisted learning & Individual project teaching, Seminar, Viva-voce

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	**60**
Continuous Evaluation	**40**
● **Test papers**	**16**
● **Tutorial with Seminar presentations/Discussions/Debate, etc.**	**16**
● **Assignment**	**8**

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSMAT01DSC03 ORDINARY DIFFERENTIAL EQUATIONS**
Course Objectives	The Course aims ● The objective of this course is to understand and analyze the solutions of some important types of ODEs. This serves as an important path from mathematics to physics and engineering.

Modules	Content	Module Outcome
Module I: 15 hours	● The existence and uniqueness of solutions (The method of successive approximations, Picard's theorem, Systems - the second order linear equation) ● Qualitative properties of solutions (Oscillations and Sturm separation theorem, The Sturm comparison theorem) ● (Chapter 13: Sections - 69-71, Chapter 4: Sections - 24 and 25)	Students are able To: Get a proper understanding about existence and uniqueness of solutions of first order ODE

Module II: 15 hours	• Power series solutions. (Introduction. A review of power series (an overview), series solutions of first order equations, second order linear equations – ordinary points, regular singular points, Gauss's hyper geometric equation, point at infinity) • (Chapter 5, Section 26-29, 31 and 32)	Able to understand the existence of power series solutions and get used to the problem solving
Module III: 15 hours	• Special Functions and System of First Order Equations (Special functions of mathematical physics: Legendre polynomial, Bessel functions, Gamma functions) • Systems of first order equations. (General remarks on systems, linear systems, homogeneous linear systems with constant coefficients • (Chapter 8, Sections 44-47,Chapter 10 sections 54-56)	Able to learn about some very important special functions of mathematical physics
Module IV: 15 hours)	• Nonlinear equations (Autonomous systems. The phase plane and its phenomena, types of critical points, stability, critical points and stability for linear systems, stability by Liapunov's direct method, simple critical points of nonlinear systems) • (Chapter 11, Sections 58-62)	Able to get an understanding about non linear ODE and its solutions.
References	**Textbook:** Differential equations with applications and historical notes by George F. Simmons (CRC Press, Third Edition, 2017) **References**: 1. Ordinary differential equations: Principles and applications by Ian A. K. Nandakumaran, P. S. Datti and Raju K. George Cambridge University Press, 1983) 2. An introduction to ordinary differential equations by Earl A. Coddington (Dover Books, 1989) 3. Ordinary differential equations by Birkhoff G. and G. C. Rota (Wiley, 1989)	
Course Outcomes	**After successful completion of this course, student will be able to:**	
	This is a basic first course on partial differential equations.. The expected outcomes of this course are:: CO1**:**Learn the existence and uniqueness of solutions of first order ODEs CO2: Learn the qualitative properties of solutions CO3: Learn about power series solutions, system of first order equations and some important special functions CO4: Learn about nonlinear equations	

Teaching Learning Strategies	Direct Instruction: Brainstorming lecture, Problem solving sessions, Explicit Teaching, E-learning (Video), Interactive Instruction: Active co-operative learning, Seminars, Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method Learner centered technique: Computer assisted learning & Individual project teaching, Seminar, Viva-voce

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	**60**
Continuous Evaluation	**40**
● **Test papers**	**16**
● **Tutorial with Seminar presentations/Discussions/Debate, etc.**	**16**
● **Assignment**	**8**

DISCIPLINE SPECIFIC CORE COURSE

Course Code & Title	**MSMAT01DSC04 - REAL ANALYSIS**
Course Objectives	**The Course aims:** **Gaining a comprehensive understanding of advanced real analysis , which is the primary means of comprehending higher mathematics is the primary goal of this course**

Modules	Content	Module Outcome
Module I: **(20Hrs)**	● Basic Topology-Finite, Countable and uncountable Sets ● Metric spaces, Compact Sets, Perfect Sets, Connected Sets. ● Continuity-Limits of function ● Continuous functions, Continuity and compactness, continuity and connectedness, ● Discontinuities, Monotonic functions, Infinite limits and Limits at infinity.	Students are able to: Determine if a particular function on a metric space is continuous or not, as well as distinguish between countable and uncountable sets.

Module II: **(10 Hours)**	● **Differentiation** ● Derivative of a real function. ● Mean value theorems, ● Continuity of derivatives. ● L - Hospital's rule. ● Derivatives of higher order. ● Taylor's theorem. ● Differentiation of vector valued functions	Possess the ability to recognize differentiable functions as well as the continuity of derivatives. Alsoable to understand the various applications of the mean value theorem with clarity as well
Module III: (15 Hours)	● Riemann – Stieltjes integral. ● Definition and existence of the integral. ● Integration and differentiation. ● Integration of vector – valued functions. ● Rectifiable curves.	Will gain understanding of Reiman Stieltjes integrals and be able to calculate a function's integral if it is integrable.Alsowill receive an overview of the relationship between differentiation and integration.
Module IV: (15 hours)	● Sequences and series of functions ● Uniform convergence. ● Uniform convergence and continuity. ● Uniform convergence and differentiation. ● Equicontinuous families of functions. Stone – Weierstrass theorem.	Will gain understanding of the notion of the series of functions' point-wise and uniform convergence..Moreover capable of comprehending the idea of an equicontinuous family of functions
References	**Textbook:** Walter Rudin – Principles of Mathematical Analysis (3rd edition) – McGraw Hill, Chapters2,4, 5,6, and 7(up to and including 7.27 only) **Reference Books:** 1. T.M. Apostol – Mathematical Analysis (2nd edition) –Narosa 2. B.G. Bartle – The Elements of Real Analysis – Wiley International 3. G.F. Simmons – Introduction to Topology and Modern Analysis – McGraw Hill 4. Pugh, Charles Chapman:Real Mathematical Analysis, springer, 2015. 5. Sudhir R. Ghorpade , Balmohan V. Limaye, A Course in Calculus and Real Analysis (Undergraduate Texts in Mathematics) , springer, 2006	

Course Outcomes	**After successful completion of this course, student will be able to**: CO1: Students can distinguish between a countable set and an uncountable set. They can provide examples of compact sets and their opposites as well as provide clarification on the design and characteristics of Cantor sets. CO2: Students will be able to determine whether a function is continuous at a certain location. If there is a continuous map between them, students will also be able to analyze the concepts of compactness and connectedness of metric spaces. Additionally, the students will be able to determine whether a given function at a given position is differentiable. CO3 :Students will comprehend RiemannStieltjes integration of many types of functions better.: CO4: With the help of examples, students will gain understanding of the idea of uniform convergence of functions. They will comprehend how uniform convergence, continuity, and integration are related.

Teaching Learning Strategies	Direct Instruction: Brainstorming lecture, Problem solving sessions, Explicit Teaching, E-learning(Video), Interactive Instruction: Active co-operative learning, Seminars, Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method Learner centered technique: Computer assisted learning & Individual project teaching, Seminar, Viva-voce

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	**60**
Continuous Evaluation	**40**
● **Test papers**	**16**
● **Tutorial with Seminar presentations/Discussions/Debate, etc.**	**16**
● **Assignment**	**8**

CORE COURSE

Course Code & Title	**MSMAT01DSC05 - TOPOLOGY**
Course Objectives	The Course aims ● Introduction to topological spaces. ● Emphasize the role of basis and subbasis in a topological spaces. ● Discuss the properties like connectedness, compactness and separation axioms in topological spaces. ● Identify homeomorphic objects.

Modules	**Content**	**Module Outcome**
Module I: (20 hours)	● Topological spaces ● Basis for a topology ● The order topology ● The product topology(finite) ● The subspace topology ● Closed sets and limit points, (sections 12 to 17)	Students are able to: Recognize closed and open sets within a specific topological space. Comprehend the idea of topological spaces and the basis of a topology;
Module II: (15 hours)	● Continuous functions ● The product topology ● The metric topology ● The metric topology (continued) ● The quotient topology (Sections 18-22)	Able to determine if a particular function is continuous or not between two topological spaces. Also capable of understanding the notions of product and metric topologies
Module III: (10 hours)	● Connected spaces, ● Connected subspace of the real line, ● Compact spaces, compact subset of the real line (sections 23,24, 26, 27)	Capable of recognizing compact and connected topological spaces

Module IV: (15 hours)	• The countability axioms • The separation axioms • Normal spaces • The Urysohn lemma • The Urysohn Metrization Theorem (without proof) • Tietze extension Theorem (without proof) • The Tychonoff theorem (without proof) (sections 30, 31, 32, 33,34, 35, 37)	Able to provide examples of topological spaces meeting various separation axioms. Capable of stating and proving the Urysohn lemma as well as elucidating the significance of the Tychonoff and Tietze extension theorems
References	**Textbook:** J.R. Munkres – Topology, Second edition Pearson India, 2015. **Reference Books:** 1. K Parthasarathy, Topology an invitation, Springer (2022) 2. K.D. Joshi – Introduction to General Topology, New age International (1983) 3. G.F. Simmons–Introduction to Topology & Modern Analysis–McGrawHill 4. M.Singer and J.A. Thorpe – Lecture Notes on Elementary Topology and Geometry, Springer Verlag 1967 5. Kelley J.L. – General Topology, von Nostrand 6. Stephen Willard – General Topology, Dover Books in Mathematics.	
Course Outcomes ----------	After successful completion of this course, student will be able to: ---------- CO1: The student will have a solid understanding of fundamental concepts in point set topology such as open sets , closed sets, neighborhoods and topological spaces. CO2 : The student will be proficient in defining and working with basis and subbases for topological spaces. CO3: The student will be able to construct and analyze product topology and subspace topology. CO4: The Student will understand connectedness and compactness and will be able to identify homeomorphic spaces. CO5: The student will get the ability to solve a variety of problems demonstrating the application of topological spaces.	

Teaching Learning Strategies	Direct Instruction: Brainstorming lecture, Problem solving sessions, Explicit Teaching, E-learning(Video), Interactive Instruction: Active co-operative learning, Seminars, Assignments, Library work and Group discussion, Presentation by individual student/ Group representative
Mode of Transaction	Face to face: Lecture method Learner centered technique: Computer assisted learning & Individual project teaching, Seminar, Viva-voce

ASSESSMENT RUBRICS

Components	Marks
End Semester Evaluation	**60**
Continuous Evaluation	**40**
● **Test papers**	**16**
● **Tutorial with Seminar presentations/Discussions/Debate, etc.**	**16**
● **Assignment**	**8**

Sample Questions to test Outcomes Appended

Appendix

1 Abstract Algebra - MSMAT01C01

PART A

1. State First Sylow theorem.
2. Define prime and maximal ideals and give examples and explain the inclusion between them.

PART B

1. Prove that a group of order 56 has a normal Sylow p-subgroup for some prime p dividing its order.
2. Prove that if H is a normal subgroup of G of prime index p then for all $K \leq G$ either (i) $K \leq H$ or (ii) $G = HK$ and $|K : K \cap H| = p$.

PART C

1. State and prove fundamental theorem of finitely generated abelian groups.
2. Prove that the cyclotomic polynomial $\Phi_p(x)$ is irreducible over $\mathbb{Q}$ for any prime p.

2 Linear Algebra - MSMAT01C02

PART A

1. Define minimal polynomial and what is its connection to characteristic polynomial.
2. State rank-nullity theorem.

PART B

1. Let A and B be $n \times n$ matrices. Which of the following equals $\text{trace}(A^2B^2)$ and justify your answer.
   (a) $(\text{trace}(AB))^2$

(b) trace(AB^2A)

(c) trace($(AB)^2$)

(d) trace($BABA$)

2. Apply the Gram-Schmidt process to the vectors $\beta_1 = (1, 0, 1)$, $\beta_2 = (1, 0, -1)$, $\beta_3 = (0, 3, 4)$ to obtain an orthonormal basis for $\mathbb{R}^3$ with the standard inner product.

PART C

1. If A is an $m \times n$ matrix with entries in the field F, then

$$\text{row rank } (A) = \text{column rank } (A)$$

2. Let T be a linear operator on an n-dimensional vector space V. The characteristic and minimal polynomials for T have the same roots, except for multiplicities.

3 Ordinary differential equations - MSMAT01C03

Part A

1. Define Bessel function and Legendre polynomial.

2. State Picard's theorem.

Part B

1. Show that the zeroes of the functions $a\ sin\ x + b\ cos\ x$ and$c\ sin\ x + d\ cos\ x$ are distinct and occur alternatively whenever $ad - bc \neq 0$.

2. If $a_1b_2 - a_2b_1 \neq 0$, Show that the system

$$\begin{cases} \frac{dx}{dy} = a_1x + b_1y + c_1 \\ \frac{dy}{dt} = a_2x + b_2y + c_2 \end{cases}$$

has a single isolated critical point (x_0, y_0).

Part C

1. State and prove Sturm comparison theorem.

2. Find the power series solution of $x^2y' = y$, solve the equation directly, and explain any discrepancies that arise.

4 Real Analysis - MSMAT01C04

Part A

1. Define a metric space. Give an example and justify your answer.
2. What is a rectifiable curve?

Part B

1. Prove that $d(x,y) = \frac{|x-y|}{(1+|x-y|)}$ is a metric in R
2. show that the function f defined by $f(x) = \begin{cases} xsin(\frac{1}{x}) & \text{when } x \neq 0 \\ 0 & \text{when } x = 0 \end{cases}$ is not differentiable at $x = 0$.

Part C

1. What is a Cantor set? Prove that it is compact, perfect and also an uncountable set of measure zero. Also prove that it does not contain any open intervals.
2. Prove that there exists a real continuous function on the real line, which is nowhere differentiable.

5 Topology - MSMAT01C05

5.1 PART A

1. Define product topology and illustrate with an example.
2. Define homeomorphism between topological spaces and illustrate with an example.

5.2 PART B

1. Let $f : X \to Y$; let Y be a compact Hausdorff. Then f is continuous if and only if the graph of f,
$$G_f = \{(x, f(x)) : x \in X\}$$
is closed in $X \times Y$.
2. Show that if A is a countable subset of $\mathbb{R}^2$, then $\mathbb{R}^2 - A$ is path connected.

5.3 PART C

1. Prove that every compact subspace of a Hausdorff space is closed.
2. Prove that a finite cartesian product of connected spaces is connected.