



Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science & Commerce,
Baramati
(Empowered Autonomous)

Three/Four Year Honours/Honours with Research B.Sc. Degree
Program in Mathematics
(Faculty of Science)

CBCS Syllabus
S.Y.B.Sc. (Mathematics)
For Department of Mathematics

NEP-2.0
Choice Based Credit System Syllabus
(2024 Pattern)

(As Per NEP-2020)

To be implemented from Academic Year 2025-26

Title of the Programme: B.Sc. (Mathematics)**Preamble**

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Mathematics and related subjects, the Board of Studies in Mathematics at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the fourth semester of S.Y.B.Sc. (Mathematics), which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCeF, NHEQF, Prof. R. D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and 13th March, 2024 and Circular of SPPU, Pune dated 31st May 2023.

A Mathematics degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Graduates in Mathematics find opportunities in various fields, including Financial Planner, Market Research Analyst, Data Scientist, teaching, Insurance underwriter, operations research analyst, software developer, and many other domains. After graduating with a degree in mathematics, students can embark on a multitude

of rewarding and diverse career paths. The analytical and problem-solving skills honed during their studies equip them with a strong foundation for success in various fields. Many graduates choose to pursue careers in academia and research, where they can contribute to the advancement of mathematical knowledge through teaching, publishing papers, and conducting ground breaking research. Others may opt for careers in the financial sector, such as investment banking or actuarial science, utilizing their expertise in mathematical modelling and statistical analysis to make informed decisions and manage risks. Additionally, the field of data science offers abundant opportunities for mathematics graduates, as they possess the ability to extract meaningful insights from complex data sets and develop algorithms that drive innovation in industries like technology, healthcare, and marketing. Moreover, mathematics graduates can find fulfilling careers in engineering, cryptography, software development, and operations research, to name just a few areas where their mathematical skills are highly sought after. Overall, a degree in mathematics opens doors to a wide range of intellectually stimulating and financially rewarding professions, allowing graduates to make significant contributions to society and thrive in a rapidly evolving world.

Overall, revising the Mathematics syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Credit Distribution Structure as per NEP 2020 (for NEP 2.0 2024 Pattern)

Level/ Difficulty	Sem	Subject DSC-1				Subject DSC-2	Subject DSC-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2(P)				2(T)+2(P)	2(T)+ 2(P)	2(T)	2 (T/P)	2(T) (Generic)	2(T)	2(T)	--	22
	II	2(T)+2(P)				2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T)	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor Continue option: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped.														
Level/ Difficulty	Sem	Credits Related to Major				Minor	--	GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CE P/RP									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	2 (T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3Years		44	8	8	10	18	8	8	6	4	8	4	6	132
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4(P)	2(T)+2 (T/P)	--	4(RP)	4(RM)(T)	--	--	--	--	--	--	--	22
	VIII	6(T)+4(P)	2(T)+2 (T/P)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		64	16	8	22	22	8	8	6	4	8	4	6	176
Four Year UG Honours with Research Degree in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		72	16	8	14	22	8	8	6	4	8	4	6	176
Four Year UG Honours Degree in Major and Minor with 176 credits														
T = Theory P = Practical DSC = Discipline Specific Course OE = Open Elective SEC = Skill Enhancement Course IKS = Indian Knowledge System AEC = Ability Enhancement Course VEC = Value Education Course CC = Co-curricular Course VSC= Vocational Skill Course OJT= On Job Training CEP= Community Engagement Project FP= Field Project RP= Research Project														

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 NEP-2.0

Course Structure for F.Y.B.Sc. (2024 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
I	DSC-I (General)	-101-GEN		Theory	02
		-102-GEN		Practical	02
	DSC-II (General)	-101-GEN		Theory	02
		-102-GEN		Practical	02
	DSC-III (General)	MAT-101-GEN	Algebra and Calculus	Theory	02
		MAT-102-GEN	Algebra and Calculus Practical with Python	Practical	02
	Open Elective (OE)	MAT-103-OE	Basic Mathematics	Theory	02
	Skill Enhancement Course (SEC)	MAT-104-SEC	Scilab Software	Practical	02
	Ability Enhancement Course (AEC)	ENG-104-AEC		Theory	02
	Value Education Course (VEC)	ENV-105-VEC		Theory	02
II	Generic Indian Knowledge System (GIKS)	GEN-106-IKS		Theory	02
	Total Credits Semester-I				22
	DSC-I (General)	-151-GEN		Theory	02
		-152-GEN		Practical	02
	DSC-II (General)	-151-GEN		Theory	02
		-152-GEN		Practical	02
	DSC-III (General)	MAT-151-GEN	Geometry and Differential Calculus	Theory	02
		MAT-152-GEN	Geometry and Differential Calculus Practical with Geogebra	Practical	02
	Open Elective (OE)	MAT -153-OE	Applied Mathematics	Practical	02
	Skill Enhancement Course (SEC)	MAT -154-SEC	Maxima Software	Practical	02
	Ability Enhancement Course (AEC)	ENG-154-AEC		Theory	02
	Value Education Course (VEC)	COS-155-VEC		Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC-156-CC	To be selected from the CC Basket	Theory	02
	Total Credits Semester-II				22
	Cumulative Credits Semester I + Semester II				44

Course Structure for S.Y.B.Sc. Mathematics (2024 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
III	Major Mandatory	MAT-201-MRM	Multivariable Calculus	Theory	2
	Major Mandatory	MAT-202-MRM	Laplace Transform	Theory	2
	Major Mandatory	MAT-203-MRM	Practical based on Multivariable Calculus and Laplace Transform	Practical	2
	Vocational Skill Course (VSC)	MAT-204-VSC	Practical based on Numerical Methods	Practical	2
	Field Project (FP)	MAT-205-FP	Field Project	Practical	2
	Minor	MAT-206-MN	Fundamentals of Linear Algebra	Theory	2
	Minor	MAT-207-MN	Practical based on Differential Equations	Practical	2
	Open Elective (OE)	MAT-208-OE	Fundamentals of Higher Mathematics	Theory	2
	Subject Specific Indian Knowledge System (IKS)	MAT-209-IKS	Vedic Mathematics	Theory	2
	Ability Enhancement Course (AEC)	MAR-210-AEC		Theory (Any One)	2
		HIN-210-AEC			
		SAN-210-AEC			
	Co-curricular Course (CC)	YOG/PES/CUL /NSS/NCC-211-CC	To be continued from Semester – II	Theory	2
Total Credits Semester-III					22
IV	Major Mandatory	MAT-251-MRM	Vector Analysis	Theory	2
	Major Mandatory	MAT-252-MRM	Introduction to Linear Algebra	Theory	2
	Major Mandatory	MAT-253-MRM	Practical based on Vector Analysis and Linear Algebra	Practical	2
	Vocational Skill Course (VSC)	MAT-254-VSC	Set Theory and Logic	Theory	2
	Community Engagement Project (CEP)	MAT-255-CEP	Community Engagement Project	Practical	2
	Minor	MAT-256-MN	Multivariable Calculus	Theory	2
	Minor	MAT-257-MN	Practical based on Numerical Analysis	Practical	2
	Open Elective (OE)	MAT-258-OE	Basic Applications of Mathematics	Practical	2
	Skill Enhancement Course (SEC)	MAT-259-SEC	LaTeX Software	Practical	2
	Ability Enhancement Course (AEC)	MAR-260-AEC		Theory (Any One)	2
		HIN-260-AEC			
		SAN-260-AEC			
	Co-curricular Course (CC)	YOG/PES/CUL /NSS/NCC-261-CC	To be continued from Semester – III	Theory	2
Total Credits Semester-IV					22
Cumulative Credits Semester III + Semester IV					44

Programme Specific Outcomes (PSOs)

PSO 1-Proficiency in Mathematical Concepts: Graduates will have a deep understanding of fundamental mathematical concepts and theories across various branches of mathematics, including calculus, algebra, geometry, probability, and statistics.

PSO 2-Problem-Solving Skills: Graduates will possess strong problem-solving skills and the ability to apply mathematical principles to real-world situations. They can analyze complex problems, develop logical reasoning, and devise creative strategies to find solutions.

PSO 3-Mathematical Modeling: Graduates will be proficient in mathematical modeling, which involves using mathematical techniques to describe and analyze real-world phenomena. They can formulate and solve mathematical models to address problems in diverse fields, including physics, economics, engineering, and social sciences.

PSO4-Computational and Analytical Skills: Graduates will be skilled in using computational tools and software, such as programming languages, statistical software, and mathematical modeling software. They can leverage these tools to perform numerical analysis, data visualization, and simulations.

PSO 5-Communication and Presentation: Graduates will possess effective communication skills, both written and oral, to convey complex mathematical ideas and results to both technical and non-technical audiences. They can present mathematical arguments, proofs, and findings in a clear and concise manner.

PSO 6-Research and Inquiry: Graduates will have the ability to engage in mathematical research and inquiry. They can critically evaluate existing mathematical theories, develop new mathematical models, and contribute to the advancement of mathematical knowledge through independent research or collaborative projects.

PSO 7-Interdisciplinary Collaboration: Graduates will be adept at collaborating with professionals from other disciplines, such as scientists, engineers, economists, and computer scientists. They can effectively communicate and work in multidisciplinary teams to solve complex problems that require mathematical expertise.

PSO 8-Lifelong Learning: Graduates will have developed a strong foundation for lifelong learning in mathematics. They will have the skills to stay abreast of new developments in the field, adapt to emerging technologies and methodologies, and continue their professional growth through self-directed study or advanced academic pursuits.

PSO 9-Advanced Mathematical Techniques: Graduates will have a command of advanced

mathematical techniques, such as differential equations, mathematical analysis, linear algebra, number theory, and optimization. They can apply these advanced mathematical tools to solve complex problems and contribute to specialized areas of research.

PSO 10-Mathematical Software Development: Graduates will possess programming skills and the ability to develop mathematical software or algorithms. They can design, implement, and optimize software applications that facilitate mathematical calculations, simulations, data analysis, and modeling.

PSO 11-Mathematical Education and Teaching: Graduates interested in pursuing a career in education will have the necessary skills to teach mathematics at various levels. They can design and deliver effective lessons, develop curriculum materials, and assess student progress in mathematics. They can also inspire and motivate students to develop an appreciation for the subject.

PSO 12-Mathematical Finance and Risk Analysis: Graduates with an interest in finance and economics will have specialized knowledge in mathematical finance and risk analysis. They can apply mathematical models, stochastic calculus, and statistical methods to analyze financial markets, manage investment portfolios, assess risk, and make informed financial decisions.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory
Course Name	: Vector Analysis
Course Code	: MAT-251-MRM
No. of Teaching Hours	: 30
No. of Credits	: 2

Course Objectives:

1. To develop a solid foundation in double integrals, focusing on their evaluation over rectangular and general regions, including the use of polar coordinates.
2. To gain proficiency in evaluating triple integrals and understanding their applications, particularly in different coordinate systems such as cylindrical and spherical coordinates.
3. To learn and apply the technique of changing variables in multiple integrals to simplify complex integrals in various coordinate systems.
4. To introduce vector fields and the concept of line integrals, and to explore their fundamental properties and applications.
5. To understand and apply the fundamental theorem for line integrals, as well as Green's theorem, to solve problems involving vector fields.
6. To study surface integrals and the associated concepts of curl and divergence, and to apply the theorems of Stokes and Gauss (Divergence) in practical situations.
7. To explore the real-world applications of double, triple, line, and surface integrals in various fields, including physics, engineering, and geometry.

Course Outcomes:

CO1: Students will be able to evaluate double integrals over rectangular and general regions and apply these integrals to solve problems in polar coordinates.

CO2: Students will demonstrate the ability to compute triple integrals in Cartesian, cylindrical, and spherical coordinates and apply them to relevant problems.

CO3: Students will be able to apply the change of variables technique in multiple integrals to simplify complex integrals.

CO4: Students will be able to understand and analyze vector fields, calculate line integrals, and apply the fundamental theorem for line integrals in practical situations.

CO5: Students will demonstrate the ability to apply Green's theorem to convert line integrals into double integrals and solve related problems.

CO6: Students will be able to evaluate surface integrals, understand parametric surfaces, and apply concepts like curl, divergence, Stokes' theorem, and the divergence theorem in practical contexts.

CO7: Students will be able to apply their understanding of double, triple, line, and surface integrals to solve real-world problems in physics, engineering, and other fields.

Topics and Learning Points	
Unit 1: Double Integrals	Teaching Hours 08
1.1 Double integrals over rectangles	
1.2 Iterated integrals	
1.3 Double integrals over general regions	
1.4 Double integrals in polar coordinates	
1.5 Applications of double integrals	
Unit 2: Triple Integrals	07
2.1 Triple integrals	
2.2 Triple integrals in cylindrical coordinates	
2.3 Triple integrals in spherical coordinates	
2.4 Change of variables in multiple integrals	
2.5 Applications of triple integrals	
Unit 3: Line Integrals	07
3.1 Vector fields	
3.2 Line integrals	
3.3 The fundamental theorem for line integrals	
3.4 Green's theorem	
Unit 4: Surface Integrals	08
4.1 Curl and divergence	
4.2 Parametric surfaces and their areas	
4.3 Surface integrals	
4.4 Stoke's theorem	
4.5 The divergence theorem	

Text Book:

James Stewart, *Calculus with Early Transcendental Functions*, Cengage Learning, Indian Edition

Unit 1: Sections 15.1 to 15.5, **Unit 2:** Sections 15.6 to 15.9,

Unit 3: Sections 16.1 to 16.4, **Unit 4:** Sections 16.5 to 16.9.

Reference Books:

1. G. B. Thomas, *Thomas' Calculus*, Pearson, Edition 2012.
2. Tom M. Apostol, *Calculus Vol. II*, John Wiley.
3. Shanti Narayan and R. K. Mittal, *A text-book of Vector Calculus*, S. Chand and Company.
4. J. E. Marsden, A. J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer.
5. D. V. Widder, *Advanced Calculus*, Printice Hall of India.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	3	3	3	3	3	3	3
PO03	2	2	2	2	2	2	3
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	1	1	1	1	1	2
PO07	2	2	2	2	3	3	3
PO08	2	2	2	2	2	2	3
PO09	1	1	1	1	1	1	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	3
PO13	1	1	1	1	1	1	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding of multivariable integration, coordinate systems, and vector calculus theorems.

PO2: Practical, professional, and procedural knowledge – Strong emphasis on practical computational techniques for multiple integrals, coordinate transformations, and vector field analysis.

PO3: Entrepreneurial mindset and knowledge –

- Direct application to engineering and physics problems with entrepreneurial potential (CO7)
- Moderate application in mathematical modeling and analysis (all remaining COs)

PO4: Specialized skills and competencies – Develops specialized mathematical skills in multivariable calculus, vector analysis, and integral theorems.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Core focus on analytical problem-solving using integration techniques, coordinate transformations, and vector calculus applications.

PO6: Communication skills and collaboration –

- Moderate development through real-world problem applications (CO7)
- Limited emphasis in technical computational content (all remaining COs)

PO7: Research-related skills –

- Strong research foundation in advanced calculus theorems and their applications (CO5, CO6 and CO7)
- Basic research skills in integration techniques (all remaining COs)

PO8: Learning how to learn skills –

- Strong emphasis on adapting calculus concepts to diverse application domains (CO7)
- Moderate development through complex mathematical techniques (all remaining COs)

PO9: Digital and technological skills –

- Some application of computational tools in practical problems (CO7)
- Limited technological integration in theoretical computations (all remaining COs)

PO10: *Multicultural competence, inclusive spirit, and empathy* – Not directly addressed in technical mathematical content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of calculus content

PO12: *Autonomy, responsibility, and accountability* –

- Strong development through real-world engineering and physics applications (CO7)
- Moderate autonomy in mathematical problem-solving (all remaining COs)

PO13: *Community engagement and service*

- Potential application in community technical projects (CO7)
- Limited direct community engagement focus (all remaining COs)

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory
Course Name	: Introduction to Linear Algebra
Course Code	: MAT-252-MRM
No. of Teaching Hours	: 30
No. of Credits	: 2

Course Objectives:

1. To introduce students to the fundamental concepts of vector spaces, including definitions, examples, subspaces, and the concept of basis and dimension.
2. To provide a thorough understanding of quotient spaces and their significance within vector spaces.
3. To develop a strong foundation in linear transformations, including their representation by matrices and the concepts of kernel and image.
4. To explore linear isomorphisms and special types of linear transformations, emphasizing their applications in various mathematical contexts.
5. To familiarize students with inner product spaces and the concept of orthogonality, along with orthogonal projections and transformations.
6. To introduce students to the concepts of eigenvalues and eigenvectors, including their importance in the rotation of axes and other applications.
7. To understand the Cayley-Hamilton theorem and its implications for linear transformations and matrix theory.

Course Outcomes:

CO1: Students will be able to define and identify vector spaces, subspaces, and determine the basis and dimension of a given vector space.

CO2: Students will be able to construct and analyze quotient spaces, demonstrating their understanding of the structure of vector spaces.

CO3: Students will be able to represent linear transformations using matrices and compute the kernel and image of a given transformation.

CO4: Students will gain the ability to identify and apply linear isomorphisms and special linear transformations in various mathematical problems.

CO5: Students will demonstrate a strong understanding of inner product spaces, including the ability to work with orthogonality, orthogonal projections, and orthogonal transformations.

CO6: Students will be able to compute and interpret eigenvalues and eigenvectors, and apply them to problems involving rotations of axes and other transformations.

CO7: Students will understand and apply the Cayley-Hamilton theorem to solve problems related to linear transformations and matrix theory.

Topics and Learning Points	
Unit 1: Vector Spaces	Teaching Hours
1.1 Definitions and Examples	08
1.2 Vector Subspaces	
1.3 Basis and Dimensions of a Vector Space	
1.4 Quotient Space	
Unit 2: Linear Transformations	08
2.1 Linear Transformation	
2.2 Representation of Linear Map by Matrix	
2.3 Kernel and Image of a Linear Transformation	
2.4 Linear Isomorphism	
2.5 Some special Linear Transformations	
Unit 3: Inner Product spaces	08
3.1 Inner Product Spaces	
3.2 Orthogonality	
3.3 Orthogonal Projection onto a Line	
3.4 Orthogonal Basis	
3.5 Orthogonal Completeness and Projections	
3.6 Orthogonal Transformation	
Unit 4: Eigen values and Eigen vectors	06
4.1 Rotation of Axes of Conics	
4.2 Eigenvalues and Eigenvectors	
4.3 Cayley-Hamilton theorem	

Text Book:

S. Kumaresan, *Linear Algebra: A Geometric Approach*, Prentice Hall of India, New Delhi

Unit 1: Sections 2.1 to 2.3 and 3.3,

Unit 2: Sections 4.1 to 4.4 and 4.6,

Unit 3: Sections 5.1 to 5.6 and 5.8,

Unit 4: Sections 7.1 and 7.2.

Reference Books:

1. K. Hoffmann and R. Kunze, *Linear Algebra*, Prentice Hall of India.
2. S. Lang, *Introduction to Linear Algebra*, Springer-Verlag, New York.
3. G. Schay, *Introduction to Linear Algebra*, Narosa, New Delhi, (1998).
4. T. Banchoff and J. Werner, *Linear Algebra through Geometry*, Springer-Verlag.
5. H. Anton and C. Rorres, *Elementary Linear Algebra with Applications*, Wiley, (1994).

CO-PO Mapping

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Programme Outcomes	Course Outcomes						
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PO01	3	3	3	3	3	3	3
PO02	2	2	3	3	3	3	3
PO03	1	1	1	1	1	1	1
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	1	1	1	1	1	1
PO07	2	2	2	2	3	3	3
PO08	2	2	2	2	2	2	2
PO09	1	1	1	1	1	1	1
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	2
PO13	1	1	1	1	1	1	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding of abstract vector spaces, linear transformations, and matrix theory.

PO2: Practical, professional, and procedural knowledge –

- Strong practical application in matrix computations, transformations, and eigenvalue problems (CO3, CO4, CO5, CO6 and CO7)
- Moderate procedural knowledge in abstract space constructions (CO1 and CO2)

PO3: Entrepreneurial mindset and knowledge – Limited direct entrepreneurial application in abstract linear algebra

PO4: Specialized skills and competencies – Develops highly specialized mathematical skills in linear algebra, vector spaces, and transformation theory.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Strong emphasis on analytical reasoning in space structures, transformation properties, and spectral theory.

PO6: Communication skills and collaboration – Theoretical mathematics course with limited emphasis on communication and collaboration

PO7: Research-related skills –

- Strong research foundation in inner product spaces, spectral theory, and advanced matrix theory (CO5, CO6 and CO7)
- Basic research skills in linear algebraic structures (all remaining COs)

PO8: Learning how to learn skills – Moderate development through abstract mathematical concept mastery and proof techniques

PO9: Digital and technological skills – Theoretical course with limited technological integration

PO10: Multicultural competence, inclusive spirit, and empathy – Not directly addressed in abstract algebraic content

PO11: Value inculcation and environmental awareness – Not a focus of pure mathematical theory

PO12: *Autonomy, responsibility, and accountability* – Moderate development through independent work on abstract proofs and theoretical problems

PO13: *Community engagement and service* – Limited direct community engagement in advanced linear algebra

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Major Mandatory
Course Name	: Practical based on Vector Analysis and Linear Algebra
Course Code	: MAT-253-MRM
No. of Teaching Hours	: 60
No. of Credits	: 2

Course Objectives:

1. To develop students' ability to evaluate and compute double and triple integrals in various coordinate systems.
2. To introduce the applications of multiple integrals in calculating areas, volumes, and centers of mass.
3. To familiarize students with vector calculus concepts such as line integrals and their connection to Green's theorem.
4. To provide an understanding of surface integrals and fundamental theorems like Stokes' theorem and the Divergence theorem.
5. To strengthen students' understanding of vector spaces, subspaces, basis, and dimension.
6. To enable students to analyze linear transformations using matrices and compute kernel and image.
7. To equip students with techniques to compute eigenvalues, eigenvectors, and apply orthogonality concepts in inner product spaces.

Course Outcomes:

CO1: Students will be able to evaluate double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinates.

CO2: Students will demonstrate the ability to apply multiple integrals to real-world applications such as finding areas, volumes, and centers of mass.

CO3: Students will compute and analyze line integrals, surface integrals, and apply Green's, Stokes', and Divergence theorems.

CO4: Students will verify vector space properties and determine the basis and dimension of a given vector space.

CO5: Students will compute the kernel and image of a linear transformation and represent it using matrices.

CO6: Students will apply the concepts of inner product spaces, orthogonality, and orthogonal projections in solving problems.

CO7: Students will determine eigenvalues and eigenvectors of matrices and analyze transformations such as rotation of axes.

Topics and Learning Points**Teaching Hours****Practical based on Vector Analysis:****30**

- 1) Evaluation of Double Integrals Over Rectangles and General Regions
- 2) Computation of Double Integrals in Polar Coordinates
- 3) Triple Integrals in Cartesian, Cylindrical, and Spherical Coordinates
- 4) Applications of Multiple Integrals in Finding Area, Volume, and Center of Mass
- 5) Line Integrals and Green's Theorem
- 6) Surface Integrals and Applications of Stokes' and Divergence Theorems

Practical based on Linear Algebra:**30**

1. Verification of Vector Space Properties and Finding Basis and Dimension
2. Computation of Kernel and Image of a Linear Transformation
3. Representation of a Linear Transformation using Matrices
4. Orthogonality and Orthogonal Projection in Inner Product Spaces
5. Computation of Eigenvalues and Eigenvectors of a Given Matrix
6. Rotation of Axes and Orthogonal Transformations

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	3	3	3	2	3	3	3
PO03	2	3	2	1	1	2	2
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	2	1	1	1	1	1
PO07	2	3	3	2	2	2	3
PO08	2	2	2	2	2	2	2
PO09	1	2	1	1	1	1	1
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	2
PO13	1	2	1	1	1	1	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding across multivariable calculus and linear algebra domains.

PO2: Practical, professional, and procedural knowledge –

- Strong practical application in integration techniques, vector calculus, and matrix computations (CO1, CO2, CO3, CO5, CO6 and CO7)
- Moderate procedural knowledge in abstract vector space concepts (CO4)

PO3: Entrepreneurial mindset and knowledge –

- Direct application to real-world problems in physics and engineering (CO2)
- Moderate application in modeling and analysis (CO1, CO3, CO6 and CO7)
- Limited entrepreneurial application in abstract algebra (CO4 and CO5)

PO4: Specialized skills and competencies – Develops specialized mathematical skills in both calculus and linear algebra.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Strong emphasis on analytical reasoning in integration, vector analysis, and linear transformations.

PO6: Communication skills and collaboration –

- Moderate development through real-world application discussions (CO2)
- Limited emphasis in technical mathematical content (all remaining COs)

PO7: Research-related skills –

- Strong research foundation in applied calculus and spectral theory (CO2, CO3 and CO7)
- Basic research skills in mathematical structures (all remaining COs)

PO8: Learning how to learn skills – Moderate development through diverse mathematical techniques and problem-solving approaches

PO9: Digital and technological skills –

- Some application of computational tools in real-world problems (CO2)
- Limited technological integration in theoretical content (all remaining COs)

PO10: *Multicultural competence, inclusive spirit, and empathy* – Not directly addressed in technical mathematical content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of mathematical content

PO12: *Autonomy, responsibility, and accountability* – Moderate development through independent mathematical problem-solving

PO13: *Community engagement and service*

- Potential application in community technical projects (CO2)
- Limited direct community engagement focus (all remaining COs)

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Vocational Skill Course
Course Name	: Set Theory and Logic
Course Code	: MAT-254-VSC
No. of Teaching Hours	: 30
No. of Credits	: 2

Course Objectives:

1. To introduce students to Cantor's concept of sets and fundamental operations in set theory.
2. To develop an understanding of relations, functions, and their properties in mathematical structures.
3. To explore the natural number sequence, induction principles, and concepts of cardinality.
4. To introduce well-ordered sets, ordinal numbers, and Zorn's Lemma as foundational topics in set theory.
5. To familiarize students with sentential logic, truth tables, and principles of validity and consequence.
6. To introduce predicate calculus and its applications in mathematical logic.
7. To provide an understanding of Boolean algebra, its properties, and applications in logic and computing.

Course Outcomes:

- CO1:** Students will be able to understand Cantor's set theory and apply operations on sets.
- CO2:** Students will be able to analyze relations and functions and utilize them in mathematical proofs.
- CO3:** Students will demonstrate knowledge of cardinality, countability, and well-ordering principles.
- CO4:** Students will be able to apply mathematical induction and Zorn's Lemma in problem-solving.
- CO5:** Students will construct and analyze truth tables to determine the validity of logical statements.
- CO6:** Students will be able to apply predicate calculus to verify logical consistency and reasoning.
- CO7:** Students will understand the fundamental properties of Boolean algebra and its significance in logic and computing.

Topics and Learning Points	
Unit 1: Naïve Set Theory	Teaching Hours 07
1.1 Basic definition	
1.2 Cartesian product, relations and functions	
1.3 Equivalence and order	
1.4 Bijections	
1.5 Finite sets	
1.6 Countable sets	
1.7 The number system	
1.8 Shoes and socks	
Unit 2: Ordinal Numbers	09
2.1 Well-order and Induction	
2.2 The ordinals	
2.3 The hierarchy of sets	
2.4 Ordinal arithmetic	
Unit 3: Logic	09
3.1 Formal logic	
3.2 Propositional logic	
3.3 Soundness and Completeness	
Unit 4: Boolean Algebras	05
4.1 Definition of a Boolean algebra	
4.2 Some basic properties of a Boolean algebra	
4.3 Another formulation of the theory	

Text Book:

Peter J. Cameron, *Sets, Logic and Categories*, Springer, 1999.

Unit 1: Sections 1.2 to 1.9, **Unit 2:** Sections 2.1 to 2.4,

Unit 3: Sections 3.1 to 3.3, **Unit 4:** Section 3.4.

Reference Books:

1. Robert R. Stoll, *Set Theory and Logic*, Dover Publications, New York, 1979.
2. Michael L. O'Leary, *A first course in Mathematical Logic and Set Theory*, Wiley.
3. David Makinson, *Sets, Logic and Maths for Computing*, Springer.
4. Patrick Suppes and Shirley A. Hill, *First Course in Mathematical Logic*, Dover Books.
5. William A. R. Weiss, *An Introduction to Set Theory*, CreateSpace Independent Publishing Platform, 2014.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	2	2	2	2	3	3	3
PO03	1	1	1	1	1	1	2
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	1	1	1	1	1	1
PO07	2	2	3	3	2	2	3
PO08	2	2	2	2	2	2	2
PO09	1	1	1	1	1	1	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	2
PO13	1	1	1	1	1	1	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides fundamental understanding of set theory, mathematical logic, and foundational mathematical concepts.

PO2: Practical, professional, and procedural knowledge –

- Strong practical application in logical reasoning, truth tables, and Boolean algebra (CO5, CO6 and CO7)
- Moderate procedural knowledge in set operations and proof techniques (all remaining COs)

PO3: Entrepreneurial mindset and knowledge –

- Some application in computing and logical systems (CO7)
- Limited direct entrepreneurial application in foundational mathematics (all remaining COs)

PO4: Specialized skills and competencies – Develops specialized skills in mathematical reasoning, proof techniques, and logical analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Core focus on analytical reasoning, proof construction, and logical problem-solving.

PO6: Communication skills and collaboration – Theoretical course with limited emphasis on communication and collaboration

PO7: Research-related skills –

- Strong research foundation in advanced set theory, axiomatic methods, and Boolean algebra (CO3, CO4 and CO7)
- Basic research skills in mathematical logic and reasoning (all remaining COs)

PO8: Learning how to learn skills – Moderate development through abstract reasoning and proof-based learning

PO9: Digital and technological skills –

- Some connection to computing applications through Boolean algebra (CO7)
- Limited technological integration in theoretical content (all remaining COs)

PO10: *Multicultural competence, inclusive spirit, and empathy* – Not directly addressed in foundational mathematical content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of mathematical logic content

PO12: *Autonomy, responsibility, and accountability* – Moderate development through independent logical reasoning and proof construction

PO13: *Community engagement and service* – Limited direct community engagement in foundational mathematics

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Community Engagement Project
Course Name	: Community Engagement Project
Course Code	: MAT-255-CEP
No. of Teaching Hours	: 60
No. of Credits	: 2

Course Objectives:

1. To encourage students to apply mathematical concepts and problem-solving techniques to address real-world community challenges.
2. To develop critical thinking and analytical skills by engaging in community-based projects that require data collection and analysis.
3. To foster teamwork and collaboration by working on group projects that serve local communities.
4. To enhance communication skills through written reports and presentations on mathematical applications in societal issues.
5. To promote ethical responsibility and awareness of social issues where mathematics plays a role in decision-making.
6. To provide students with hands-on experience in research, data interpretation, and statistical analysis related to community problems.
7. To instill a sense of civic engagement and responsibility, encouraging students to use their mathematical knowledge for community development.

Course Outcomes:

CO1: Student will apply mathematical methods such as statistics, optimization, and modeling to analyze and solve community-based problems.

CO2: Student will collect, organize, and interpret real-world data to draw meaningful conclusions for community benefit.

CO3: Student will demonstrate teamwork and leadership skills while working on collaborative community engagement projects.

CO4: Student will effectively communicate their findings through presentations, reports, and discussions.

CO5: Student will integrate mathematical reasoning into social, environmental, and economic problem-solving.

CO6: Student will develop a sense of social responsibility and ethical decision-making while applying mathematical concepts to community projects.

CO7: Student will gain experience in research methodologies and practical problem-solving, preparing them for future academic or professional endeavors.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	2	2	3	2	3
PO02	3	3	2	2	3	2	3
PO03	3	3	2	2	3	2	3
PO04	3	3	2	2	3	2	3
PO05	3	3	2	2	3	2	3
PO06	2	2	3	3	2	2	2
PO07	3	3	2	2	3	2	3
PO08	2	2	3	3	2	3	3
PO09	2	2	1	1	2	1	2
PO10	2	2	3	3	3	3	2
PO11	2	2	2	2	3	3	2
PO12	2	2	3	3	2	3	3
PO13	3	3	3	3	3	3	3

Justification for the mapping

PO1: Comprehensive knowledge and understanding –

- Deep understanding of mathematical applications in real-world contexts (CO1, CO2, CO5 and CO7)
- Moderate knowledge component in social and communication aspects (CO3, CO4 and CO6)

PO2: Practical, professional, and procedural knowledge –

- Strong practical application of mathematical methods to community problems (CO1, CO2, CO5 and CO7)
- Moderate procedural knowledge in teamwork and communication (CO3, CO4 and CO6)

PO3: Entrepreneurial mindset and knowledge –

- Direct entrepreneurial application in problem-solving and community development (CO1, CO2, CO5 and CO7)
- Moderate entrepreneurial mindset in leadership and communication (CO3, CO4 and CO6)

PO4: Specialized skills and competencies –

- Specialized skills in applied mathematics and community problem-solving (CO1, CO2, CO5 and CO7)
- Moderate specialized skills in communication and teamwork (CO3, CO4 and CO6)

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning –

- Strong analytical reasoning in mathematical applications (CO1, CO2, CO5 and CO7)
- Moderate problem-solving in social contexts (CO3, CO4 and CO6)

PO6: Communication skills and collaboration –

- Strong emphasis on teamwork, leadership, and communication (CO3 and CO4)
- Moderate collaboration in project-based work (all remaining COs)

PO7: Research-related skills –

- Strong research methodology in data collection and analysis (CO1, CO2, CO5 and CO7)
- Moderate research skills in social contexts (CO3, CO4 and CO6)

PO8: *Learning how to learn skills* –

- Strong development through collaborative learning and reflection (CO3, CO4, CO6 and CO7)
- Moderate learning skills through applied projects (CO1, CO2 and CO5)

PO9: *Digital and technological skills* –

- Moderate use of technology in data analysis and modelling (CO1, CO2, CO5 and CO7)
- Limited technological focus in social components (CO3, CO4 and CO6)

PO10: *Multicultural competence, inclusive spirit, and empathy* –

- Strong emphasis on social responsibility and community engagement (CO3, CO4, CO5 and CO6)
- Moderate multicultural competence in problem-solving (CO1, CO2 and CO7)

PO11: *Value inculcation and environmental awareness* –

- Strong focus on ethical decision-making and social/environmental awareness (CO5 and CO6)
- Moderate value development through community projects (all remaining COs)

PO12: *Autonomy, responsibility, and accountability* –

- Strong development of responsibility in team projects and ethical decisions (CO3, CO4, CO6 and CO7)
- Moderate autonomy in mathematical applications (CO1, CO2 and CO5)

PO13: *Community engagement and service* – This is the core focus of the entire course, with direct community engagement and service learning embedded in all course outcomes.

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Minor
Course Name	: Multivariable Calculus
Course Code	: MAT-256-MN
No. of Teaching Hours	: 30
No. of Credits	: 2

Course Objectives:

1. To introduce students to vectors, their operations, and their applications in various physical and mathematical contexts.
2. To understand the behavior of vector functions, including their derivatives, integrals, and applications in describing motion in space.
3. To teach students about functions of several variables, including the computation of partial derivatives and their applications.
4. To help students learn the chain rule for multivariable functions and the concept of directional derivatives in various directions.
5. To enable students to compute double and triple integrals and apply them to solve problems in different coordinate systems.
6. To introduce students to essential theorems in vector calculus, including Green's, Stoke's, and the divergence theorems.
7. To equip students with the ability to apply vector calculus concepts to solve physical problems, such as fluid flow and electromagnetic fields.

Course Outcomes:

CO1: Students will be able to perform vector operations, including dot and cross products, and apply them in solving geometric and physical problems.

CO2: Students will demonstrate the ability to work with vector functions, analyze space curves, and calculate their derivatives and integrals.

CO3: Students will be able to compute partial derivatives for functions of several variables and apply them in various contexts, including optimization problems.

CO4: Students will use the chain rule for multivariable functions and compute directional derivatives to analyze rates of change in specific directions.

CO5: Students will be able to evaluate double and triple integrals in Cartesian and other coordinate systems, and apply them to problems involving volume and mass.

CO6: Students will gain an understanding of Green's theorem, Stoke's theorem, and the divergence theorem, and apply them to solve integrals in vector fields.

CO7: Students will apply vector calculus techniques to model and solve real-world physical problems, such as fluid dynamics and electromagnetism.

Topics and Learning Points	
Unit 1: Vectors and Vector Functions	Teaching Hours
1.1 Vectors	08
1.2 Dot and cross products	
1.3 Vector functions and space curves	
1.4 Derivatives and integrals of vector functions	
1.5 Arc length and curvature	
1.6 Motion in space: Velocity and acceleration	
Unit 2: Partial Derivatives	07
2.1 Functions of several variables	
2.2 Limits and continuity	
2.3 Partial derivatives and the chain rule	
2.4 Directional derivatives	
Unit 3: Multiple Integrals	07
3.1 Double integrals	
3.2 Iterated integrals	
3.3 Triple integrals	
Unit 4: Vector Calculus	08
4.1 Vector fields	
4.2 Line integrals	
4.3 Green's theorem (without proof)	
4.4 Surface integrals	
4.5 Stoke's theorem (without proof)	
4.6 The divergence theorem (without proof)	

Text Book:

James Stewart, *Calculus with Early Transcendental Functions*, Cengage Learning, Indian Edition

Unit 1: Ch 12 & 13,

Unit 2: Ch 14,

Unit 3: Ch 15,

Unit 4: Ch 16.

Reference Books:

1. G. B. Thomas, *Thomas' Calculus*, Pearson, Edition 2012.
2. Tom M. Apostol, *Calculus Vol. II*, John Wiley.
3. Shanti Narayan and R. K. Mittal, *A text-book of Vector Calculus*, S. Chand and Company.
4. J. E. Marsden, A. J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer.
5. D. V. Widder, *Advanced Calculus*, Printice Hall of India.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	3	3	3	3	3	3	3
PO03	2	2	2	2	2	2	3
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	1	1	1	1	1	2
PO07	2	2	2	2	2	3	3
PO08	2	2	2	2	2	2	3
PO09	1	1	1	1	1	1	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	3
PO13	1	1	1	1	1	1	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding of vector operations, multivariable calculus, and integral theorems.

PO2: Practical, professional, and procedural knowledge – Strong emphasis on practical computational techniques for vector operations, derivatives, and integrals with physical applications.

PO3: Entrepreneurial mindset and knowledge –

- Direct application to engineering and physics problems with entrepreneurial potential (CO7)
- Moderate application in modeling and analysis techniques (all remaining COs)

PO4: Specialized skills and competencies – Develops specialized mathematical skills in vector calculus, multivariable analysis, and physical modeling.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Core focus on analytical problem-solving using vector methods, optimization, and integral theorems.

PO6: Communication skills and collaboration –

- Moderate development through real-world problem applications and presentations (CO7)
- Limited emphasis in technical computational content (all remaining COs)

PO7: Research-related skills –

- Strong research foundation in advanced vector theorems and physical applications (CO6 and CO7)
- Basic research skills in vector analysis techniques (all remaining COs)

PO8: Learning how to learn skills –

- Strong emphasis on adapting vector calculus concepts to diverse physical applications (CO7)
- Moderate development through complex mathematical techniques (all remaining COs)

PO9: Digital and technological skills –

- Some application of computational tools in physical modelling (CO7)

- Limited technological integration in theoretical computations (all remaining COs)

PO10: *Multicultural competence, inclusive spirit, and empathy* – Not directly addressed in technical mathematical content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of vector calculus content

PO12: *Autonomy, responsibility, and accountability* –

- Strong development through real-world engineering and physics applications (CO7)
- Moderate autonomy in mathematical problem-solving (all remaining COs)

PO13: *Community engagement and service* –

- Potential application in community technical projects (CO7)
- Limited direct community engagement focus (all remaining COs)

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Minor
Course Name	: Practical based on Numerical Analysis
Course Code	: MAT-257-MN
No. of Teaching Hours	: 60
No. of Credits	: 2

Course Objectives:

1. To introduce the need and importance of numerical methods in solving mathematical problems.
2. To develop an understanding of different types of numerical errors and their propagation in computations.
3. To familiarize students with numerical techniques for solving algebraic and transcendental equations.
4. To introduce interpolation methods for estimating unknown values from given data.
5. To equip students with numerical differentiation and integration techniques for approximating derivatives and integrals.
6. To apply numerical methods for solving ordinary and partial differential equations.
7. To enhance computational skills using numerical algorithms and improve problem-solving abilities.

Course Outcomes:

CO1: Students will be able to understand the significance of numerical methods and their applications in real-world problems.

CO2: Students will be able to analyze different types of errors and determine their effects on numerical computations.

CO3: Students will be able to apply numerical techniques such as Bisection, Regula-Falsi, and Newton-Raphson methods to solve equations.

CO4: Students will be able to use interpolation techniques like Newton's and Lagrange's formulas to estimate missing data points.

CO5: Students will be able to implement numerical differentiation and integration techniques for approximating derivatives and definite integrals.

CO6: Students will be able to solve ordinary and partial differential equations using methods such as Euler's and Runge-Kutta methods.

CO7: Students will be able to develop computational algorithms for numerical methods and apply them to practical scientific problems.

Topics and Learning Points

Teaching Hours

12

Theory:

1. **Basics of Numerical Methods & Errors:** Absolute, Relative, Percentage errors, Bisection Method, Regula-Falsi Method and Newton-Raphson Method
2. **Interpolation & Curve Fitting:** Newton's Forward and Backward Interpolation Formulae, Lagrange's Interpolation Formula and Least Squares Approximation
3. **Numerical Differentiation and Integration:** Numerical Differentiation, Trapezoidal Rule, Simpson's 1/3 Rule and Simpson's 3/8 Rule
4. **Numerical Solutions of Differential Equations:** Euler's Method, Modified Euler's Method, Runge-Kutta Method and Finite Difference Methods for PDEs

List of practical:

48

1. Error Analysis: Compute absolute, relative, and percentage errors in given numerical computations.
2. Solving Algebraic and Transcendental Equations using the Bisection Method.
3. Implementation of the Regula-Falsi Method for finding roots of equations.
4. Solving nonlinear equations using the Newton-Raphson Method and analyzing convergence.
5. Newton's Forward and Backward Interpolation: Estimating unknown values from given data.
6. Lagrange's Interpolation: Using Lagrange's formula for interpolation of tabulated data.
7. Curve Fitting: Fitting a straight line and quadratic curve using the least squares method.
8. Numerical Differentiation: Using finite differences to approximate derivatives.
9. Numerical Integration using Trapezoidal Rule and comparing with analytical results.
10. Numerical Integration using Simpson's 1/3 and 3/8 Rules.
11. Solving First-Order Differential Equations using Euler's Method.
12. Implementation of Runge-Kutta Method (RK4) to solve first-order ODEs.

Text Book:

S. S. Sastry, *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd., 5th Edition.

Reference Books:

1. R. W. Hamming, *Numerical Methods for Scientists and Engineers*, McGraw-Hill.
2. Ralph G. Stanton, *Numerical Methods in Science and Engineering*, Printice-Hall.
3. Francis Scheid, *Numerical Analysis*, Schaum's Outline.
4. Rajasekaran S., *Numerical Methods in Science and Engineering: A Practical Approach*, S. Chand.
5. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education India.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	3	3	3	3	3	3	3
PO03	2	2	2	2	2	2	3
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	1	1	1	1	1	1	2
PO07	2	2	2	2	2	3	3
PO08	2	2	2	2	2	2	3
PO09	3	3	3	3	3	3	3
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	3
PO13	1	1	1	1	1	1	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding of numerical algorithms, error analysis, and computational mathematics.

PO2: Practical, professional, and procedural knowledge – Strong emphasis on practical implementation of numerical techniques for equation solving, interpolation, and differential equations.

PO3: Entrepreneurial mindset and knowledge –

- Direct application to scientific computing and technology development with entrepreneurial potential (CO7)
- Moderate application in analytical and computational techniques (all remaining COs)

PO4: Specialized skills and competencies – Develops specialized computational skills in numerical analysis, algorithm development, and scientific computing.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Core focus on analytical problem-solving using numerical methods for mathematical and scientific problems.

PO6: Communication skills and collaboration –

- Moderate development through algorithm documentation and practical applications (CO7)
- Limited emphasis in technical computational content (all remaining COs)

PO7: Research-related skills –

- Strong research foundation in differential equation solving and computational algorithm development (CO6 and CO7)
- Basic research skills in numerical techniques (all remaining COs)

PO8: Learning how to learn skills –

- Strong emphasis on adapting numerical methods to new computational challenges (CO7)
- Moderate development through algorithm implementation (all remaining COs)

PO9: Digital and technological skills – Strong digital skills development in computational algorithms, programming implementations, and numerical simulations.

PO10: *Multicultural competence, inclusive spirit, and empathy* – Not directly addressed in technical computational content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of numerical methods content

PO12: *Autonomy, responsibility, and accountability* –

- Strong development through independent algorithm development and implementation (CO7)
- Moderate autonomy in computational problem-solving (all remaining COs)

PO13: *Community engagement and service*

- Potential application in community technical and scientific projects (CO7)
- Limited direct community engagement focus (all remaining COs)

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: Second Year
Semester	: IV
Course Type	: Open Elective
Course Name	: Basic Applications of Mathematics
Course Code	: MAT-258-OE
No. of Teaching Hours	: 60
No. of Credits	: 2

Course Objectives:

1. To develop fundamental mathematical skills for solving real-life financial and business problems.
2. To enable students to apply mathematical concepts in calculating profit, loss, discount, and percentage changes.
3. To introduce students to financial mathematics, including interest calculations and EMI computations.
4. To provide practical knowledge of data analysis using statistical tools like measures of central tendency and correlation.
5. To familiarize students with the applications of linear equations, matrices, and probability in business decision-making.
6. To equip students with the ability to analyze tax computations, break-even points, and cost-revenue relationships.
7. To enhance students' problem-solving skills in business mathematics through hands-on practical applications.

Course Outcomes:

CO1: Students will be able to calculate profit, loss, discount, and percentage changes in business transactions.

CO2: Students will demonstrate proficiency in computing simple and compound interest for various financial scenarios.

CO3: Students will apply mathematical techniques to analyze business transactions and economic problems.

CO4: Students will use statistical tools such as mean, median, mode, correlation, and regression for decision-making.

CO5: Students will solve real-life problems related to transportation, logistics, and financial modeling using matrices and linear equations.

CO6: Students will analyze probability-based situations to assess risks and make informed business decisions.

CO7: Students will compute taxation values, break-even points, and EMIs using mathematical formulas.

Topics and Learning Points

Teaching Hours
60

List of practical:

1. Solving problems on profit, loss, discount, and percentage changes.
2. Calculation of interest for different time periods and rates.
3. Solving real-life problems related to business transactions.
4. Applications in transportation and logistics.
5. Computing central tendency measures for given datasets.
6. Understanding relationships between two variables using correlation and regression.
7. Solving cost-revenue analysis problems using linear equations.
8. Introduction to matrices and their applications in financial modeling.
9. Simple probability problems related to sales, risk, and decision-making.
10. Understanding basic tax calculations and their applications.
11. Finding the break-even point using algebraic methods.
12. Computing Equated Monthly Installments (EMI) using formula-based methods.

Reference Books:

1. Qazi Zameeruddin, V. K. Khanna & S. K. Bhambri, Business Mathematics, Vikas Publishing House, 2nd Edition.
2. R. S. Aggarwal, *Quantitative Aptitude for Competitive Examinations*, S. Chand.
3. Trevor Johnson and Hugh Neill, *Mathematics: A complete introduction*, Teach Yourself Books
4. Haym Kruglak and John T. Moore, *Basic Mathematics with Applications to Science and Technology*, Schaum's Outline.
5. Hugh Neill and Trevor Johnson, *Mathematics: A Complete Introduction*, Mobius.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	3	3	3	3	3	3	3
PO02	3	3	3	3	3	3	3
PO03	3	3	3	3	3	3	3
PO04	3	3	3	3	3	3	3
PO05	3	3	3	3	3	3	3
PO06	2	2	2	2	2	2	2
PO07	2	2	2	3	3	3	2
PO08	2	2	2	2	2	2	2
PO09	2	2	2	2	2	2	2
PO10	2	2	2	2	2	2	2
PO11	2	2	2	2	2	2	2
PO12	2	2	2	2	2	2	2
PO13	2	2	2	2	2	2	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding – Course provides comprehensive understanding of business mathematics concepts, financial calculations, and statistical applications.

PO2: Practical, professional, and procedural knowledge – Strong emphasis on practical business applications including financial calculations, statistical analysis, and economic problem-solving.

PO3: Entrepreneurial mindset and knowledge – Direct application to business planning, financial management, risk assessment, and entrepreneurial decision-making.

PO4: Specialized skills and competencies – Develops specialized business mathematics skills in finance, statistics, and quantitative decision-making.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Core focus on analytical problem-solving in business contexts, financial modeling, and data-driven decision-making.

PO6: Communication skills and collaboration – Moderate development through business case analyses and financial reporting

PO7: Research-related skills –

- Strong research application in statistical analysis, financial modeling, and risk assessment (CO4, CO5 and CO6)
- Moderate research skills in business calculations (all remaining COs)

PO8: Learning how to learn skills – Moderate development through business problem-solving and financial analysis

PO9: Digital and technological skills – Moderate use of technology in financial calculations and statistical analysis

PO10: Multicultural competence, inclusive spirit, and empathy – Moderate consideration in business decision-making and economic analysis

PO11: Value inculcation and environmental awareness – Moderate emphasis on ethical business practices and financial responsibility

PO12: *Autonomy, responsibility, and accountability* – Moderate development through financial decision-making and business analysis

PO13: *Community engagement and service* – Moderate application in community business development and economic planning

CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2024 Pattern)

Name of the Programme	: B.Sc. Mathematics
Program Code	: USMT
Class	: S.Y.B.Sc.
Semester	: IV
Course Type	: Skill Enhancement Course
Course Name	: LaTeX Software
Course Code	: MAT-259-SEC
No. of Teaching Hours	: 60
No. of Credits	: 2

Course Objectives:

1. To introduce students to the fundamentals of LaTeX, including text formatting, fonts, styles, and paragraphs.
2. To develop proficiency in typesetting mathematical expressions and equations with LaTeX.
3. To enable students to create structured documents using lists, tables, arrays, and sections.
4. To familiarize students with inserting figures and diagrams using TikZ and PGF for mathematical illustrations.
5. To teach students how to manage citations, references, and bibliographies effectively using BibTeX.
6. To equip students with the skills to compile and organize large documents such as articles, reports, and books.
7. To introduce students to Beamer for creating professional presentations and troubleshoot common LaTeX errors.

Course Outcomes:

CO1: Students will be able to format text, apply different font styles, and structure paragraphs in LaTeX.

CO2: Students will demonstrate the ability to typeset mathematical equations, symbols, and expressions correctly.

CO3: Students will create well-organized documents using lists, tables, arrays, and sectioning commands.

CO4: Students will insert and manipulate figures, diagrams, and illustrations using TikZ and PGF.

CO5: Students will effectively reference sources and manage bibliographies using LaTeX and BibTeX.

CO6: Students will compile and structure large-scale documents, ensuring clarity and coherence in academic writing.

CO7: Students will design professional mathematical presentations using Beamer and troubleshoot common LaTeX issues.

Topics and Learning Points

Teaching Hours

12

Theory:

1. **Introduction to LaTeX and Basic Document Structure:** Overview of LaTeX, Installing and Setting Up LaTeX, Basic Document Structure, Writing and Formatting Text
2. **Mathematical Typesetting in LaTeX:** Inline and Display Math Modes, Common Mathematical Symbols and Operators, Formatting Equations, Matrices, Aligning Equations, and Multi-line Equations
3. **Structuring Documents and Advanced Features:** Creating Lists, Inserting Tables and Figures, Sections, Subsections, and Automatic Table of Contents, Referencing Equations, Theorems, and Bibliography with BibTeX
4. **Theorem Environments, Beamer Presentations, and Best Practices:** Writing Theorems, Definitions, Lemmas, and Proofs, Creating Beamer Presentations for Mathematical Talks, Compiling Large Documents and Handling Errors, Best Practices and Troubleshooting in LaTeX

List of practical:

48

1. Formatting Text: Fonts, Styles, and Paragraphs
2. Typesetting Mathematical Expressions and Equations
3. Creating Lists, Tables, and Arrays in LaTeX
4. Inserting Figures and Diagrams using TikZ and PGF
5. Using Sections, Subsections, and Table of Contents
6. Referencing and Citing Sources in LaTeX
7. Writing and Formatting Theorems, Definitions, and Proofs
8. Creating and Managing Bibliographies with BibTeX
9. Compiling Large Documents: Articles and Reports (*split from previous practical for more depth*)
10. Creating Books and Thesis Documents in LaTeX (*new practical focusing on book-style documents*)
11. Creating Beamer Presentations for Mathematical Talks
12. Troubleshooting LaTeX Errors and Best Practices (*keeps original troubleshooting but with an explicit focus on debugging errors*)

Text Book:

Leslie Lamport, *LaTeX: A Document Preparation System*, Addison-Wesley Publishing Company, 2nd Edition, 1994.

Reference Books:

1. George Grätzer, *More Math Into LaTeX*, Springer Science & Business Media, 2007.
2. Helmut Kopka and Patrick W. Daly, *Guide to LaTeX*, Pearson Education, 2003.
3. Stefan Kottwitz, *LaTeX for Beginners*, Packt Publishing (Open Source).
4. David J. Buerger, *LATEX: For Scientists and Engineers*, McGraw-Hill.
5. Dilip Datta, *LaTeX in 24 Hours: A Practical Guide for Scientific Writing*, Springer.

CO-PO Mapping

Weightage: 1 – weak or low relation, 2 – moderate or partial relation, 3 – strong or direct relation

Programme Outcomes	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO01	2	3	2	2	2	3	2
PO02	3	3	3	3	3	3	3
PO03	2	2	2	2	2	2	3
PO04	3	3	3	3	3	3	3
PO05	2	2	2	2	2	2	2
PO06	2	2	2	2	2	3	3
PO07	2	2	2	2	3	3	2
PO08	2	2	2	2	2	3	3
PO09	3	3	3	3	3	3	3
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	3	3
PO13	1	1	1	1	1	1	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding –

- Strong understanding of mathematical typesetting and document structuring (CO2 and CO6)
- Moderate knowledge in technical documentation principles (all remaining COs)

PO2: Practical, professional, and procedural knowledge – Strong emphasis on practical LaTeX skills, document preparation, and professional formatting standards.

PO3: Entrepreneurial mindset and knowledge –

- Direct application in professional presentations and technical consulting (CO7)
- Moderate entrepreneurial value in documentation skills (all remaining COs)

PO4: Specialized skills and competencies – Develops specialized technical documentation skills, mathematical typesetting, and presentation design.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Moderate problem-solving in document design and troubleshooting

PO6: Communication skills and collaboration –

- Strong emphasis on clear academic writing and professional presentations (CO6 and CO7)
- Moderate communication skills in document creation (all remaining COs)

PO7: Research-related skills –

- Strong research application in bibliography management and academic document structuring (CO5 and CO6)
- Moderate research skills in technical documentation (all remaining COs)

PO8: Learning how to learn skills –

- Strong development through large-scale document management and presentation design (CO6 and CO7)
- Moderate learning skills in technical software usage (all remaining COs)

PO9: Digital and technological skills – Strong digital skills development in LaTeX programming, TikZ graphics, and technical software applications.

PO10: *Multicultural competence, inclusive spirit, and empathy* – Limited direct emphasis in technical documentation content

PO11: *Value inculcation and environmental awareness* – Not a primary focus of technical documentation course

PO12: *Autonomy, responsibility, and accountability* –

- Strong development through independent document compilation and presentation design (CO6 and CO7)
- Moderate autonomy in technical tasks (all remaining COs)

PO13: *Community engagement and service* – Limited direct community engagement focus