**Anekant Education Society's**

# Tuljaram Chaturchand College, Baramati

***(Autonomous)***

**Four Year B.Sc. Degree Program in Mathematics**

**(Faculty of Science & Technology)**

**CBCS Syllabus**

## S.Y.B.Sc. (Mathematics) Semester -III

**For Department of Mathematics**

**Tuljaram Chaturchand College, Baramati**

**Choice Based Credit System Syllabus (2023 Pattern)**

**(As Per NEP 2020)**

**To be implemented from Academic Year 2023-2024**

# Title of the Programme: S.Y.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 third 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), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 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.

## 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.

**Anekant Education Society's**

# Tuljaram Chaturchand College, Baramati

*(Autonomous)*

## Board of Studies (BOS) in Mathematics

**From 2022-23 to 2024-25**

| Sr. No. | Name | Designation |
|---|---|---|
| 1. | Mr. Sadashiv R. Puranik, | Chairman |
| 2. | Ms. Varsha H. Shinde | Member |
| 3. | Dr. Prakash B. Fulari | Member |
| 4. | Ms. Shaila S. Jadhav | Member |
| 5. | Ms. Nikita R. Shinde | Member |
| 6. | Ms. Sonali V. Kate | Member |
| 7. | Dr. Anil S. Khairnar | Vice-Chancellor Nominee |
| 8. | Dr. Nitin S. Darkunde | Expert from other University |
| 9. | Dr. Kishor D. Kucche | Expert from other University |
| 10. | Mr. Amit Patil | Industry Expert |
| 11 | Dr. Haribhau R. Bhapkar | Meritorious Alumni |
| 12. | Ms. Pranali Jadhav | Student Representative |
| 13. | Ms. Ankita Anpat | Student Representative |

## Credit Distribution Structure for S.Y.B.Sc.-2023-2024 (Mathematics)

| Level | Semester | Major | | Minor | OE | VSC, SEC, (VSEC) | AEC, VEC, IKS | OJT, FP, CEP, CC, RP | Cum. Cr/Sem | Degree/ Cum.Cr. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mandatory | Electives | | | | | | | |
| | | | | | | | | | | |
| 4.5 | III | **MAT-201-MJM**: Calculus of Several Variable **(2 Credits)**<br>**MAT-202-MJM**: Laplace Transform & Fourier Series **(2 Credits)**<br>**MAT-203-MJM**: Ordinary Differential Equations **(2 Credits)**<br>**MAT-204-MJM**: Mathematics Practical III **(2 Credits)** | | **MAT-241-MN**: Foundations of Linear Algebra **(2 Credits)**<br>**MAT-242-MN**: Practical based on Ordinary Differential Equations **(2 Credits)** | **MAT-216-OE:** Intermediate Mathematics **(2 Credits)** | **MAT-221-VSC:** Financial Mathematics **(2 Credits)** | **MAR-231-AEC:** भाषिक उपयोजन व लेखन कौशल्ये **(2 Credits)**<br>**HIN-231-AEC:** हिंदी भाषा: श्रुजन कौशल **(2 Credits)**<br>**SAN-231-AEC:** प्राथमिक संभाषणकौशल्यम् **(2 Credits)**<br>**GEN-245-IKS:** **(2 credits)** | **MAT-235-FP**: Field Project **(2 Credits)**<br>**CC** **(2 Credits)** | 24 | UG Diploma 46 credits |
| | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IV | **MAT-251-MJM**: Vector Calculus **(2 Credits)**<br>**MAT-252-MJM**: Linear Algebra **(2 Credits)**<br>**MAT-253-MJM**: Operations Research **(2 Credits)**<br>**MAT-254-MJM**: Mathematics Practical IV **(2 Credits)** | | **MAT-261-MN**: Multivariable Calculus **(2 Credits)**<br>**MAT-262-MN**: Practical based on Partial Differential Equations **(2 Credits)** | **MAT-216-OE:** Applied Mathematics **(2 Credits)** | **MAT-276-SEC:** Geogebra Software **(2 Credits)** | **MAR-281-AEC:** लेखन निर्मिती व परीक्षण कौशल्ये **(2 Credits)**<br>**HIN-281-AEC:** हिंदी भाषा: संप्रेषण कौशल **(2 Credits)**<br>**SAN-281-AEC:** प्रगत संभाषणकौशल्यम् **(2 Credits)** | **MAT-285-CEP**: Community Engagement Project **(2 Credits)**<br>**CC (2 Credits)** | 22 | |
| | Cum Cr. | **16** | -- | 8 | 4 | 4 | 6 | 8 | 46 | |

**Anekant Education Society's**

# Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati (Autonomous)

## Course Structure for S.Y.B.Sc. Mathematics (2023 Pattern)

| Sem | Course Type | Course Code | Course Title | Theory / Practical | Credits |
|---|---|---|---|---|---|
| III | Major Mandatory | MAT-201-MJM | Calculus of Several Variable | Theory | 02 |
| | Major Mandatory | MAT-202-MJM | Laplace Transform & Fourier Series | Theory | 02 |
| | Major Mandatory | MAT-203-MJM | Ordinary Differential Equations | Theory | 02 |
| | Major Mandatory | MAT-204-MJM | Mathematics Practical III | Practical | 02 |
| | Minor | MAT-241-MN | Foundations of Linear Algebra | Theory | 02 |
| | Minor | MAT-242-MN | Practical based on Ordinary Differential Equations | Practical | 02 |
| | Open Elective (OE) | MAT-216-OE | Intermediate Mathematics | Theory | 02 |
| | Vocational Skill Course (VSC) | MAT-221-VSC | Financial Mathematics | Theory | 02 |
| | Ability Enhancement Course (AEC) | MAR-231-AEC<br>HIN-231-AEC<br>SAN-231-AEC | भाषिक उपयोजन व लेखन कौशल्ये<br>हिंदी भाषा: श्रुजन कौशल<br>प्राथमिक संभाषणकौशल्यम् | Theory | 02 |
| | Field Project (FP) | MAT-235-FP | Field Project | Practical | 02 |
| | Co-curricular Course (CC) | YOG/PES/CUL /NSS/NCC-239-CC | To be selected from the Basket | Theory | 02 |
| | Generic IKS Course (IKS) | GEN-245-IKS | | Theory | 02 |
| | | | | **Total Credits Semester-III** | **24** |
| IV | Major Mandatory | MAT-251-MJM | Vector Calculus | Theory | 02 |
| | Major Mandatory | MAT-252-MJM | Linear Algebra | Theory | 02 |
| | Major Mandatory | MAT-253-MJM | Operations Research | Theory | 02 |
| | Major Mandatory | MAT-254-MJM | Mathematics Practical IV | Practical | 02 |
| | Minor | MAT-261-MN | Multivariable Calculus | Theory | 02 |
| | Minor | MAT-262-MN | Practical based on Partial Differential Equations | Practical | 02 |
| | Open Elective (OE) | MAT-266-OE | Applied Mathematics III | Practical | 02 |
| | Skill Enhancement Course (SEC) | MAT-276-SEC | Geogebra Software | Practical | 02 |
| | Ability Enhancement Course (AEC) | MAR-281-AEC<br>HIN-281-AEC<br>SAN-281-AEC | लेखन निर्मिती व परीक्षण कौशल्ये<br>हिंदी भाषा: संप्रेषण कौशल<br>प्रगत संभाषणकौशल्यम् | Theory | 02 |
| | Community Engagement Project (CEP) | MAT-285-CEP | Community Engagement Project | Practical | 02 |
| | Co-curricular Course (CC) | YOG/PES/CUL /NSS/NCC-289-CC | To be selected from the Basket | Theory | 02 |
| | | | | **Total Credits Semester-IV** | **22** |
| | | | | **Cumulative Credits Semester III + Semester IV** | **46** |

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Major Mandatory
**Course Name** : Calculus of Several Variables
**Course Code** : MAT-201-MJM
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. Understand the fundamental concepts of vectors including representation, magnitude, and direction.
2. Apply dot product operations to compute angles, projections, and work done by forces.
3. Apply cross product operations to compute areas of parallelograms and volumes of parallelepipeds.
4. Analyze vector functions and space curves in three dimensions.
5. Calculate derivatives and integrals of vector functions for velocity, acceleration, and displacement.
6. Determine arc length and curvature of space curves.
7. Analyze motion in space using velocity and acceleration vectors.
8. Understand functions of several variables and their domains.
9. Compute partial derivatives and interpret their geometric meaning.
10. Apply optimization techniques including directional derivatives, gradients, and Lagrange multipliers to solve real-world problems.

## Course Outcomes:

1. Students will be able to represent vectors geometrically and algebraically and perform basic operations on vectors.
2. Students will demonstrate proficiency in computing dot and cross products and interpreting their geometric significance.
3. Students will be able to differentiate and integrate vector functions and interpret the results in terms of motion in space.
4. Students will be able to compute arc length and curvature of space curves and apply them in practical scenarios.
5. Students will understand the concept of partial derivatives and apply them to functions of several variables.
6. Students will be able to calculate directional derivatives and use them to analyze the rate of change of multivariable functions in given directions.
7. Students will apply optimization techniques to find maximum and minimum values of functions of several variables and solve constrained optimization problems using Lagrange multipliers.

## Topics and Learning Points

| | Teaching Hours |
|---|---|
| **Unit 1: Vectors** | **5** |
| 1.1 Vectors<br>1.2 The dot product<br>1.3 The cross product | |
| **Unit 2: Vector Functions** | **9** |
| 2.1 Vector functions and space curves<br>2.2 Derivatives and integrals of vector functions<br>2.3 Arc length and curvature<br>2.4 Motion in space: Velocity and Acceleration | |
| **Unit 3: Partial Derivatives** | **9** |
| 3.1 Functions of several variables<br>3.2 Limits and continuity<br>3.3 Partial derivatives<br>3.4 Tangent planes and linear approximations<br>3.5 The chain rule | |
| **Unit 4: Optimization Techniques** | **7** |
| 4.1 Directional derivatives<br>4.2 The gradient vector<br>4.3 Maximum and minimum values<br>4.4 Lagrange multipliers | |

## Text Books:

James Stewart, *Calculus with Early Transcendental functions*, Cengage Learning, Indian Edition.
**Unit 1** – Sections 12.2 to 12.4, **Unit 2** – Sections 13.1 to 13.4,
**Unit 3** – Sections 14.1 to 14.5, **Unit 4** – Sections 14.6 to 14.8

## Reference Books:

1. Tom M. Apostol, *Calculus Volume II*, Wiley, Second Edition.
2. George B. Thomas, *Thomas' Calculus: Early Transcendentals*, Pearson, 13th Edition.
3. Shanti Narayan and P. K. Mittal, *A Textbook of Vector Calculus*, S. Chand.
4. David V. Widder, *Advanced Calculus*, Dover Publications, 2nd Edition.
5. John H. Hubbard and Barbara B. Hubbard, *Vector Calculus, Linear Algebra, and Differential Forms: A Unified Approach*, Matrix Editions.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Calculus of Several Variables **Course Code:** MAT-201-MJM
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO3 | | | | | | | 1 |
| PO4 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO6 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| PO7 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| PO10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | | | | | | | |
| PO12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO13 | | | | | | | |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All course outcomes directly contribute to this programme outcome as they cover fundamental concepts and operations related to vectors and multivariable functions.

**PO2: Practical, Professional and Procedural Knowledge**
CO7 directly relates to practical problem-solving skills by applying optimization techniques, making it a strong connection. Other course outcomes also contribute by providing foundational knowledge applicable in various professional contexts.

**PO3: Entrepreneurial Mindset and Knowledge**
While vector calculus may not directly relate to entrepreneurial activities, understanding mathematical concepts and problem-solving skills (especially evident in CO7) can foster an entrepreneurial mindset indirectly.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in mathematics, particularly in vector representation, operations, differentiation, integration, optimization, etc.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve problem-solving and analytical reasoning, especially CO7 which deals explicitly with optimization, making them directly linked to this programme outcome.

**PO6: Communication Skills and Collaboration**
While the course focuses more on mathematical concepts and operations, the ability to communicate solutions and collaborate on problem-solving can be developed through assignments and discussions related to these course outcomes.

**PO7: Research-related Skills**
Understanding vector calculus concepts and their applications can contribute to research skills, especially in fields like physics, engineering, computer graphics, etc.

**PO8: Learning How to Learn Skills**

Mastering vector calculus requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO9: Digital and Technological Skills**

Although not directly related to digital or technological skills, the course provides foundational knowledge necessary for understanding and applying mathematical concepts in various technological contexts.

**PO10: Multicultural Competence, Inclusive Spirit and Empathy**

While vector calculus itself may not directly relate to multicultural competence or empathy, the problem-solving skills developed in this course can be applied in diverse cultural and social contexts.

**PO12: Autonomy, Responsibility and Accountability**

Mastering vector calculus requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Major Mandatory
**Course Name** : Laplace Transform & Fourier Series
**Course Code** : MAT-202-MJM
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. To equip the students with the knowledge of Laplace and Fourier Transforms and their Inverses.
2. To train the students to convert Differential Equations into algebraic equations by applying Laplace transform and solve them.
3. To develop proficiency in manipulating Fourier Series to analyze periodic functions and solve differential equations with periodic boundary conditions.
4. To understand the significance of these mathematical tools in various applications such as electrical circuits, control systems, heat transfer, vibrations, and signal analysis.
5. To analyze the advantages and limitations of Laplace Transforms and Fourier Series compared to other mathematical methods.
6. Apply Laplace Transforms and Fourier Series techniques to model and solve real-world problems in engineering, physics, signal processing, and other related fields.
7. To interpret and visualize the results obtained from numerical computations.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Demonstrate a through understanding of the principles and concepts of Laplace Transforms, Inverse Laplace Transform and Fourier Series.
2. Understand the required conditions for transforming variables in functions by the Laplace transform.
3. Find Laplace transforms of derivatives, integrals and periodic functions.
4. Solve differential equations with initial conditions using Laplace transform.
5. Understand some special functions such as Gamma Function, Unit Step function and Dirac Delta Function.
6. Apply Laplace Transforms and Fourier Series techniques to model and analyze engineering and physical systems, including electrical circuits, control systems, heat transfer problems, and vibrations.
7. Develop the skills and motivation to seek out and engage with advanced topics related to Laplace Transforms, Fourier Series, and related mathematical techniques.

## Topics and Learning Points

**Teaching Hours**

**Unit 1: The Laplace Transform** **10**

1.1 Laplace Transform of some elementary functions
1.2 Some important properties of Laplace Transform
1.3 Laplace Transform of derivatives, Laplace Transform of Integrals
1.4 Methods of finding Laplace Transform, Evaluation of Integrals
1.5 The Gamma function, Unit step function and Dirac delta function

**Unit 2: The Inverse Laplace Transform** **10**

2.1 Definition, Some inverse Laplace Transform
2.2 Some important properties of Inverse Laplace Transform
2.3 Inverse Laplace Transform of derivative, Inverse Laplace Transform of integrals
2.4 Convolution Theorem, Evaluation of Integrals

**Unit 3: Applications of Laplace Transform** **4**

3.1 Solution of Ordinary Differential Equations with constant coefficients

**Unit 4: Fourier Series** **6**

4.1 Fourier series
4.2 Odd and even functions
4.3 Half range Fourier sin and cosine series
4.4 The Fourier Integral, Dirichlet Conditions

## Text Books:

Schaum's Outline Series - Theory and Problems of Laplace Transform by Murray R. Spiegel.
**Unit 1** – Chapter 1, **Unit 2** – Chapter 2,
**Unit 3** – Chapter 3, **Unit 4** – Chapter 6.

## Reference Books:

1) Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970). Art. 12.1
2) Joel L. Schiff: The Laplace Transforms - Theory and Applications, Springer- Verlag New York 1999.
3) Dyke: An Introduction to Laplace Transforms and Fourier Series, Springer International Edition, Indian Reprint 2005.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Laplace Transform & Fourier Series **Course Code:** MAT-202-MJM
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| PO3 | | | | 2 | | 2 | 2 |
| PO4 | | | | | | | |
| PO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO6 | | | | | | | |
| PO7 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| PO9 | | | | | | | |
| PO10 | | | | | | | |
| PO11 | | | | | | | |
| PO12 | | | | | | | |
| PO13 | | | | | | | |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All of these course outcomes (COs) contribute to the development of student's disciplinary knowledge in mathematics. For example, CO1, CO2, CO3, CO4, CO5 requires student to develop deep learning of Laplace transform, inverse Laplace transform, Solution of differential equation using Laplace transform and Fourier series. CO6, CO7 requires students to apply the concepts of Laplace Transform and Fourier series in many fields like engineering and computer science.

**PO2: Practical, Professional and Procedural Knowledge**
All of these course outcomes contribute to acquire practical skills and expertise essential for professional tasks within their field. For example, CO4, CO5, CO5, CO6, CO7 course outcomes with the ability to apply this knowledge effectively in real-world problem in various field like Physics and Computer Science.

**PO3: Entrepreneurial Mindset and Knowledge**
The course outcomes CO4, CO6 &CO7 will demonstrate students' proficiency in problem solving relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All of these course outcomes (COs) contribute to the student's capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn. For example, CO1, CO2, CO3, CO4, CO5, CO6 requires students to apply Laplace transform and Fourier series as tools in various fields like Physics, Engineering and Computer science.

**PO7: Research-related Skills**
CO5, CO6, CO7 contribute to the development of students research related skills and scientific temper. CO7 requires students to develop their ability to think critically and apply knowledge to various field. CO6 requires students to apply knowledge of special function and apply to solve real world problem.

**PO8: Learning How to Learn Skills**

All these course outcomes contribute to development of student's ability to engage in self-directed and life-long learning. For example, all COs requires students to develop their ability to learn new concepts, form a simple proof and apply them to new problem.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Major Mandatory
**Course Name** : Ordinary Differential Equations
**Course Code** : MAT-203-MJM
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. Understand the concept of linear differential equations with constant coefficients.
2. Identify and solve differential equations using the method of auxiliary equations.
3. Distinguish between distinct roots, repeated roots, and complex roots in differential equations and solve them accordingly.
4. Apply the method of particular solutions to solve non-homogeneous differential equations.
5. Utilize the operator $1/f(D)$ to evaluate functions like $x^m$, $e^{mx}$, $e^{axv}v$.
6. Apply the operator $1/(D^2 + a^2)$ to solve differential equations involving $\sin ax$ and $\cos ax$.
7. Construct non-homogeneous differential equations from specified solutions.
8. Solve non-homogeneous differential equations using the method of undetermined coefficients.
9. Employ the method of variation of parameters to solve second-order linear differential equations.
10. Solve differential equations using power series solutions, identifying ordinary points and regular singular points.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Demonstrate proficiency in solving linear differential equations with constant coefficients using various methods.
2. Apply mathematical techniques to classify roots of characteristic equations and solve corresponding differential equations.
3. Develop skills in solving non-homogeneous differential equations through the method of undetermined coefficients.
4. Demonstrate understanding and application of reduction of order and variation of parameters methods in solving differential equations.
5. Apply power series solutions to solve differential equations near ordinary points and regular singular points.
6. Analyze convergence of power series solutions and their implications on the solutions of differential equations.
7. Demonstrate problem-solving skills by applying learned methods to real-world problems involving differential equations.

## Topics and Learning Points

**Teaching Hours**

**Unit 1: Linear Differential Equations with constant coefficients** **8**

1.1 The auxiliary equations
1.2 Distinct roots, repeated roots, complex roots
1.3 Particular solution
1.4 The operator $1/f(D)$ and its evaluation for the functions $x^m$, $e^{mx}$, $e^{axv}v$.
1.5 The operator $1/(D^2 + a^2)$ acting in $\sin ax$ and $\cos ax$ without proofs.

**Unit 2: Non-Homogeneous Differential Equations** **7**

2.1 Construction of a non-homogeneous equation from a specified solution
2.2 Solution of a non-homogeneous equation
2.3 The method of undetermined coefficients
2.4 Solution by inspection

**Unit 3: Variation of Parameters** **7**

3.1 Introduction
3.2 Reduction of order
3.3 Variation of parameters
3.4 Solution of $y" + y = f(x)$

**Unit 4: Power Series Solutions** **8**

4.1 Introduction to review of power series
4.2 Linear equations and power series
4.3 Convergence of power series
4.4 Ordinary point and regular singular points

## Text Books:

Eart D. Rainville and Phillip E. Bedient, *Elementary Differential Equations*, Macmillan Publication, 7th Edition.

**Unit 1** – Sections 34 to 38 and 48 to 50, **Unit 2** – Sections 39 to 42,
**Unit 3** – Sections 43 to 46, **Unit 4** – Sections 107 to 109

## Reference Books:

1. George F. Simmons and Steven G. Krantz, *Differential Equations*, Tata McGraw Hill.
2. M. D. Raisinghania, *Ordinary and Partial Differential Equations*, S. Chand and Company Ltd., 2009.
3. Daniel Murry, *Introductory Course in Differential Equations*, Orient Longman.
4. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, Dover Publication.
5. A. K. Nandakumaran, P. S. Datti and Raju K. George, *Ordinary Differential Equations: Principles and Applications*, Cambridge – IISc Series.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Ordinary Differential Equations **Course Code:** MAT-203-MJM
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | | | | | | | 1 |
| PO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| PO7 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO9 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| PO10 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| PO11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO13 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All course outcomes are directly related to understanding and proficiency in solving differential equations, making them strongly connected to this programme outcome.

**PO2: Practical, Professional and Procedural Knowledge**
Solving differential equations involves practical and procedural knowledge, especially evident in CO7 where students apply learned methods to real-world problems.

**PO3: Entrepreneurial Mindset and Knowledge**
While differential equations themselves may not directly relate to entrepreneurial activities, the problem-solving skills developed in this course, especially in CO7, can foster an entrepreneurial mindset indirectly.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in mathematics, particularly in the area of differential equations and their solutions.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve problem-solving and analytical reasoning, especially evident in CO7 where students solve real-world problems using differential equations.

**PO6: Communication Skills and Collaboration**
Communication skills and collaboration are not directly addressed in the course outcomes, but students may develop these skills through collaborative problem-solving sessions or presenting solutions.

**PO7: Research-related Skills**
While the course outcomes themselves may not directly relate to research skills, the problem-solving techniques learned can be applied in research contexts where differential equations arise.

**PO8: Learning How to Learn Skills**

Mastering differential equations requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO9: Digital and Technological Skills**

Differential equations may not directly relate to digital or technological skills, but understanding mathematical concepts is foundational for various technological applications.

**PO10: Multicultural Competence, Inclusive Spirit and Empathy**

While differential equations themselves may not directly relate to multicultural competence or empathy, the problem-solving skills acquired can be applied in diverse cultural and social contexts.

**PO11: Value Inculcation and Environmental Awareness**

The course outcomes do not directly contribute to value inculcation or environmental awareness, but problem-solving skills acquired can be utilized to address environmental challenges indirectly.

**PO12: Autonomy, Responsibility and Accountability**

Mastering differential equations requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

**PO13: Community Engagement and Service**

While the course outcomes themselves do not directly relate to community engagement or service, the problem-solving skills acquired can be utilized in community-oriented projects or initiatives.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Major Mandatory
**Course Name** : Mathematics Practical III
**Course Code** : MAT-204-MJM
**No. of Teaching Hours** : 60
**No. of Credits** : 2

## Course Objectives:

1. Understand the concepts of limits, continuity, partial derivatives, and tangent planes in multivariable calculus.
2. Develop proficiency in optimization techniques for multivariable functions.
3. Master the Laplace and inverse Laplace transforms for solving differential equations.
4. Gain familiarity with Fourier series and their applications in solving differential equations.
5. Learn techniques for solving non-homogeneous differential equations.
6. Acquire skills in using power series solutions for solving differential equations.
7. Develop proficiency in utilizing mathematical software for computation and visualization in calculus and differential equations.
8. Enhance problem-solving abilities through the application of mathematical concepts and software tools.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Demonstrate the ability to apply the concepts of limits, continuity, partial derivatives, and tangent planes to solve problems involving multivariable functions.
2. Apply optimization techniques to real-world problems involving multivariable functions.
3. Solve differential equations using Laplace and inverse Laplace transforms.
4. Compute Fourier series expansions and apply them to analyze periodic functions.
5. Solve non-homogeneous differential equations using appropriate methods.
6. Utilize power series solutions to solve differential equations and analyze their behavior.
7. Demonstrate proficiency in using mathematical software for computation, visualization, and problem-solving in calculus and differential equations.

## List of Practical

**Teaching Hours**

**Practical based on Calculus of Several Variables:** **10**

1. Practical 1: Limit, Continuity, Partial derivatives and Tangent planes
2. Practical 2: Optimization Techniques

**Practical based on Laplace Transform & Fourier Series:** **10**

1. Practical 3: The Laplace and inverse Laplace Transform
2. Practical 4: Fourier Series

**Practical based on Ordinary Differential Equations:** **10**

1. Practical 5: Non-Homogeneous Differential Equations
2. Practical 6: Power Series Solutions

**Practical using Mathematical Software (Scilab/Maxima/Mathematica etc):** **30**

1. Practical 7: Compute the partial derivatives of a given function of two variables and visualize the gradient vector field using quiver plots (Scilab).
2. Practical 8: Use fminsearch function in Scilab to optimize a multivariable function.
3. Practical 9: Compute the Laplace and inverse Laplace transform of a given function.
4. Practical 10: Implement the Fourier series expansion of function and visualize the Fourier series approximation of a function by plotting successive partial sums.
5. Practical 11: Visualize the solution of a first order ODE using plot commands.
6. Practical 12: Solve a second order ODE using Scilab's ode function with given initial conditions.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Mathematics Practical III **Course Code:** MAT-204-MJM
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| PO3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| PO4 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| PO5 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| PO6 | 1 | 2 | 2 | 2 | 1 | 1 | 2 |
| PO7 | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO9 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO10 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 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**
All course outcomes directly contribute to comprehensive knowledge and understanding of calculus and differential equations, making them strongly connected to this programme outcome.

**PO2: Practical, Professional and Procedural Knowledge**
CO7 directly relates to practical knowledge and procedural skills in using mathematical software for computation and visualization. Other course outcomes also contribute to practical knowledge, especially in problem-solving using optimization techniques and differential equations.

**PO3: Entrepreneurial Mindset and Knowledge**
While some course outcomes indirectly foster an entrepreneurial mindset by applying mathematical techniques to real-world problems (CO2, CO7), others may not directly relate to entrepreneurship.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in calculus, differential equations, and mathematical software usage.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve application, problem-solving, and analytical reasoning, especially evident in CO2, CO3, CO4, and CO5 where students solve real-world problems and analyze functions.

**PO6: Communication Skills and Collaboration**
While communication skills and collaboration are not explicitly addressed in the course outcomes, students may develop these skills through group discussions, presentations, and collaborative problem-solving activities.

**PO7: Research-related Skills**
CO7 involves using mathematical software for computation, visualization, and problem-solving, which can contribute to research-related skills, especially in computational mathematics.

**PO8: Learning How to Learn Skills**

Mastering the concepts and techniques in calculus and differential equations requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO9: Digital and Technological Skills**

CO7 directly relates to digital and technological skills in using mathematical software, while other course outcomes indirectly contribute to digital skills through application in various technological contexts.

**PO10: Multicultural Competence, Inclusive Spirit and Empathy**

While the course outcomes themselves may not directly relate to multicultural competence or empathy, problem-solving skills acquired can be applied in diverse cultural and social contexts.

**PO11: Value Inculcation and Environmental Awareness**

The course outcomes do not directly contribute to value inculcation or environmental awareness, but problem-solving skills acquired can be utilized to address environmental challenges indirectly.

**PO12: Autonomy, Responsibility and Accountability**

Mastering calculus and differential equations requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

**PO13: Community Engagement and Service**

While the course outcomes themselves do not directly relate to community engagement or service, the problem-solving skills acquired can be utilized in community-oriented projects or initiatives, especially when solving real-world problems.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Minor
**Course Name** : Foundations of Linear Algebra
**Course Code** : MAT-241-MN
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. Understand the fundamental concepts of vector spaces and their properties, including subspaces, sums, direct sums, linear independence, span, bases, and dimensions.
2. Explore the theory of linear maps and their applications, including null spaces, ranges, and transformations on polynomial spaces with both real and complex coefficients.
3. Investigate eigenvalues and eigenvectors, including the concepts of invariant subspaces, diagonalization, and applications of polynomials to operators.
4. Develop a comprehensive understanding of inner product spaces, including inner products, norms, orthonormal bases, orthogonal projections, and linear functionals.
5. Apply linear algebra techniques to solve problems in various fields, such as physics, engineering, computer science, and economics.
6. Analyze upper-triangular and diagonal matrices, and understand their significance in relation to eigenvalues, eigenvectors, and invariant subspaces.
7. Explore advanced topics in linear algebra, such as adjoints, self-adjoint operators, and spectral theory, and their applications in mathematical modeling and analysis.
8. Enhance problem-solving skills through practical exercises, assignments, and applications of linear algebra concepts in real-world scenarios.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Demonstrate proficiency in analyzing and manipulating vector spaces, subspaces, and linear transformations, as well as determining bases and dimensions of vector spaces.
2. Apply linear maps to solve problems with real and complex coefficient polynomials, including identifying null spaces, ranges, and transformations.
3. Compute eigenvalues and eigenvectors of matrices, and interpret their significance in the context of invariant subspaces and diagonalization.
4. Utilize inner product spaces for norms, orthonormal bases, orthogonal projections, and understanding vector-linear functional duality.
5. Apply linear algebra to solve real-world problems across diverse fields, showcasing the capacity to model phenomena using matrices and transformations.
6. Analyze the structure and properties of upper-triangular and diagonal matrices, and their role in understanding the behavior of linear transformations and eigenvalues.
7. Understand advanced topics such as adjoints, self-adjoint operators, and spectral theory, and apply them in analyzing complex systems and phenomena.

## Topics and Learning Points

**Teaching Hours**

**Unit 1: Vector Spaces** **8**

1.1 Vector space and its properties
1.2 Subspaces, sums and direct sums
1.3 Linear independence and span
1.4 Bases and dimensions

**Unit 2: Linear maps and Polynomials** **7**

2.1 Linear maps
2.2 Null spaces and ranges
2.2 Polynomials with complex coefficients
2.3 Polynomials with real coefficients

**Unit 3: Eigenvalues and eigenvectors** **7**

3.1 Invariant subspaces
3.2 Polynomials applied to operators
3.3 Upper-triangular matrices
3.4 Diagonal matrices
3.5 Invariant subspaces on real vector spaces

**Unit 4: Inner Product Spaces and Applications** **8**

4.1 Inner products
4.2 Norms
4.3 Orthonormal bases
4.4 Orthogonal projections
4.5 Linear functionals and adjoints
4.6 Applications of linear algebra in various fields

## Text Book:

Sheldon Axler, *Linear Algebra Done Right*, Springer, 2nd Edition.
**Unit 1** – Chapter 1 and Chapter 2, **Unit 2** – Chapter 3 and Chapter 4,
**Unit 3** – Chapter 5, **Unit 4** – Chapter 6

## Reference Books:

1. S. Kumaresan, *Linear Algebra: A Geometric Approach*, Prentice Hall of India, New Delhi.
2. G. Strang, *Linear Algebra and its Applications*, Harcourt Brace Jovanovich.
3. H. Anton and C. Rorres, *Elementary Linear Algebra with Applications*, Wiley.
4. K. Hoffmann and R. Kunze, *Linear Algebra*, Prentice Hall of India.
5. S. Lang, *Introduction to Linear Algebra*, Springer-Verlag.
6. G. Schay, *Introduction to Linear Algebra*, Narosa, New Delhi.
7. L. Smith, *Linear Algebra*, Springer-Verlag, New York.
8. M. Artin, *Algebra*, Prentice Hall of India, New Delhi (1994).

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Foundations of Linear Algebra **Course Code:** MAT-241-MN
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | | | | | 1 | | |
| PO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO6 | 1 | 1 | 1 | 2 | 1 | 2 | 2 |
| PO7 | 2 | 2 | 2 | 3 | 2 | 3 | 3 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PO9 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO10 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| PO11 | | | | | | | |
| PO12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO13 | | | | | | | |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All course outcomes directly contribute to comprehensive knowledge and understanding of linear algebra concepts and their applications, making them strongly connected to this programme outcome.

**PO2: Practical, Professional and Procedural Knowledge**
The course outcomes involve practical knowledge and procedural skills in analyzing and manipulating vector spaces, linear transformations, and matrices, especially evident in CO5 where linear algebra techniques are applied to solve real-world problems.

**PO3: Entrepreneurial Mindset and Knowledge**
While linear algebra concepts may not directly relate to entrepreneurship, the ability to model phenomena using matrices and transformations (CO5) can foster an entrepreneurial mindset indirectly.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in linear algebra, particularly in understanding and applying concepts such as eigenvalues, eigenvectors, inner product spaces, and spectral theory.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve application, problem-solving, and analytical reasoning, especially evident in CO2, CO3, CO4, and CO5 where students solve problems involving linear transformations, matrices, and real-world applications.

**PO6: Communication Skills and Collaboration**
Communication skills and collaboration are not explicitly addressed in the course outcomes, but students may develop these skills through group discussions, presentations, and collaborative problem-solving activities related to linear algebra concepts.

**PO7: Research-related Skills**

CO7 involves understanding advanced topics and applying them in analyzing complex systems and phenomena, which can contribute to research-related skills, especially in fields where linear algebra concepts are applied.

**PO8: Learning How to Learn Skills**

Mastering linear algebra concepts requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO9: Digital and Technological Skills**

While not directly related to digital or technological skills, understanding linear algebra concepts is foundational for various technological applications, such as computer graphics, machine learning, and data analysis.

**PO10: Multicultural Competence, Inclusive Spirit and Empathy**

While linear algebra concepts themselves may not directly relate to multicultural competence or empathy, problem-solving skills acquired can be applied in diverse cultural and social contexts.

**PO12: Autonomy, Responsibility and Accountability**

Mastering linear algebra concepts requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Minor
**Course Name** : Practical based on Ordinary Differential Equations
**Course Code** : MAT-242-MN
**No. of Teaching Hours** : 60
**No. of Credits** : 2

## Course Objectives:

1. Understand the fundamental concepts and classification of differential equations.
2. Develop proficiency in solving first-order ordinary differential equations (ODEs) analytically using techniques such as separation of variables, exact equations, and linear equations.
3. Apply Euler's method for numerical approximation of solutions to first-order ODEs.
4. Solve homogeneous second-order linear ODEs with constant coefficients.
5. Analyze second-order linear ODEs using the characteristic equation and determine complementary and particular solutions.
6. Extend the understanding of linear ODEs to higher-order cases with constant coefficients.
7. Apply the method of undetermined coefficients and variation of parameters to solve higher-order linear ODEs.
8. Introduce the concept of systems of first-order ODEs and their applications in various fields such as physics, electronics, and chemistry.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Demonstrate proficiency in classifying differential equations based on their order and linearity, and identify initial value problems (IVP) and boundary value problems (BVP).
2. Solve a variety of first-order ODEs analytically using different methods, including separation of variables, exact equations, and linear equations.
3. Implement Euler's method to approximate solutions to first-order ODEs numerically, ensuring accuracy and understanding of the limitations of numerical methods.
4. Apply the techniques learned to solve homogeneous second-order linear ODEs with constant coefficients and verify solutions using appropriate methods.
5. Analyze second-order linear ODEs using the characteristic equation to find complementary and particular solutions, demonstrating a thorough understanding of the concept.
6. Extend the understanding of linear ODEs to higher-order cases with constant coefficients, solving problems efficiently and accurately.
7. Utilize the method of undetermined coefficients and variation of parameters to solve higher-order linear ODEs, demonstrating mastery of advanced techniques in differential equations analysis.

## List of Practical

1. **Introduction to Differential Equations:** Overview, classification, IVP and BVP.
2. **First order ODEs 1:** Solving first order ODEs analytically – Separable, exact and linear equations.
3. **First order ODEs 2:** Implementing Eules's method for numerical solution of forst order ODEs.
4. **Second order linear ODEs 1:** Solving homogeneous second order linear ODEs with constant coefficients.
5. **Second order linear ODEs 2:** Characteristic equation and finding complementary and particular solution.
6. **Higher order linear ODEs 1:** Extension to higher order linear ODEs with constant coefficients.
7. **Higher order linear ODEs 2:** Method of undetermined coefficients and variation of parameters.
8. **System of ODEs 1:** Introduction to system of first order ODEs
9. **System of ODEs 2:** Solving system of ODEs using matrix method – Eigenvalues and eigenvectors
10. **Applications in Physics:** Modeling physical phenomena using ODEs
11. **Applications in Electronics:** Analysis of electronic circuits using ODEs
12. **Applications in Chemistry:** Modeling chemical reactions using ODEs

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Practical based on Ordinary Differential Equations **Course Code:** MAT-242-MN
**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 |
| PO1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| PO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | 2 | 1 | 3 | 1 | 1 | 2 | 3 |
| PO4 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| PO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO6 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| PO7 | 1 | 1 | 2 | 2 | 2 | 2 | 3 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO9 | 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**
All course outcomes directly contribute to comprehensive knowledge and understanding of differential equations, making them strongly connected to this programme outcome.

**PO2: Practical, Professional and Procedural Knowledge**
The course outcomes involve practical knowledge and procedural skills in solving differential equations, both analytically and numerically, demonstrating proficiency in various methods and techniques.

**PO3: Entrepreneurial Mindset and Knowledge**
While some course outcomes indirectly foster an entrepreneurial mindset by problem-solving and understanding the limitations of numerical methods (CO3), others may not directly relate to entrepreneurship.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in differential equations analysis, particularly in understanding and applying various methods to solve different types of differential equations.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve application, problem-solving, and analytical reasoning, especially evident in CO2, CO4, CO5, and CO7 where students solve problems and analyze solutions.

**PO6: Communication Skills and Collaboration**
While communication skills and collaboration are not explicitly addressed in the course outcomes, students may develop these skills through group discussions, presentations, and collaborative problem-solving activities related to differential equations concepts.

**PO7: Research-related Skills**
CO7 involves understanding advanced topics and applying them in analyzing complex systems and phenomena, which can contribute to research-related skills, especially in fields where differential equations concepts are applied.

**PO8: Learning How to Learn Skills**

Mastering differential equations concepts requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO9: Digital and Technological Skills**

While not directly related to digital or technological skills, understanding differential equations concepts is foundational for various technological applications, such as modeling physical systems and engineering simulations.

**PO10: Multicultural Competence, Inclusive Spirit and Empathy**

While differential equations concepts themselves may not directly relate to multicultural competence or empathy, problem-solving skills acquired can be applied in diverse cultural and social contexts.

**PO11: Value Inculcation and Environmental Awareness**

The course outcomes do not directly contribute to value inculcation or environmental awareness, but problem-solving skills acquired can be utilized to address environmental challenges indirectly.

**PO12: Autonomy, Responsibility and Accountability**

Mastering differential equations concepts requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

**PO13: Community Engagement and Service**

While the course outcomes themselves do not directly relate to community engagement or service, the problem-solving skills acquired can be utilized in community-oriented projects or initiatives, especially when solving real-world problems involving differential equations.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : Second Year
**Semester** : III
**Course Type** : Open Elective
**Course Name** : Intermediate Mathematics
**Course Code** : MAT-216-OE
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. To understand the properties and applications of trigonometric ratios in solving geometric problems.
2. To master the operations involving radicals, including simplification, addition, subtraction, multiplication, and division.
3. To develop proficiency in solving quadratic equations through various methods such as square root method, completing the square, and using the quadratic formula.
4. To explore the geometric interpretation of quadratic equations through graphing techniques.
5. To comprehend the concepts of permutations and combinations and their applications in counting problems.
6. To analyze probability concepts, including basic principles and applications in real-world scenarios.
7. To enhance problem-solving skills through the application of trigonometry, radicals, quadratic equations, permutations, combinations, and probability.
8. To cultivate critical thinking and logical reasoning abilities in mathematical contexts.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Students will be able to apply trigonometric concepts to solve problems involving similar figures and right triangles.
2. Students will demonstrate proficiency in simplifying radicals and performing operations involving radicals.
3. Students will acquire skills to solve quadratic equations using multiple methods and interpret their graphical representations.
4. Students will develop the ability to solve equations containing radicals and apply these skills in practical contexts.
5. Students will be able to graph quadratic equations accurately and interpret their key features.
6. Students will apply permutations and combinations principles to solve counting problems in diverse scenarios.
7. Students will analyze and evaluate probabilities in various situations, enabling them to make informed decisions based on statistical data.

## Topics and Learning Points

| | Teaching Hours |
|---|---|
| **Unit 1: Trigonometry** | **8** |
| 1.1 Similar figures<br>1.2 Similar right triangles<br>1.3 Sine and cosine of an angle<br>1.4 Tangent of an angle<br>1.5 Square roots<br>1.6 The Pythagorean theorem<br>1.7 Finding the distance between two points | |
| **Unit 2: Radicals** | **7** |
| 2.1 Introduction to radicals<br>2.2 Simplifying radicals<br>2.3 Adding and subtracting radicals<br>2.4 Multiplying and dividing radicals<br>2.5 Solving equations containing radicals | |
| **Unit 3: Quadratic Equations** | **7** |
| 3.1 Solving quadratic equations using the square root method<br>3.2 Solving quadratic equations by completing the square<br>3.3 Solving quadratic equations using the quadratic formula<br>3.4 Graphing quadratic equations | |
| **Unit 4: Statistics and Probability** | **8** |
| 4.1 Permutations<br>4.2 Combinations<br>4.3 Probability | |

**Text Book:**

Gary S. Goldman, *Pre-Algebra: A practical step-by-step approach*, Pearblossom Academy, 4th Edition.
**Unit 1** – Chapter 9: 9.1 to 9.7, **Unit 2** – Chapter 10,
**Unit 3** – Chapter 11, **Unit 4** – Chapter 12.

**Reference Books:**

1. Bobson Wong, Larisa Bukalov and Steve Slavin, *A self-teaching guide: Practical Algebra*, Wiley Publication.
2. Lynn Marecek, Mary Anne Anthony-Smith, *Prealgebra*, Openstax.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Intermediate Mathematics **Course Code:** MAT-216-OE
**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 |
| PO1 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| PO2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |
| PO3 | | | 1 | | 1 | | |
| PO4 | 2 | 2 | 2 | 3 | 2 | 1 | 2 |
| PO5 | 2 | 1 | 2 | 2 | 1 | 1 | 2 |
| PO6 | | | | | | | |
| PO7 | | | | | | | 2 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO9 | | | | | | | |
| PO10 | | | | | | | |
| PO11 | | | | | | | |
| PO12 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO13 | | | | | | | |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All course outcomes directly contribute to comprehensive knowledge and understanding of trigonometry, radicals, quadratic equations, permutations, combinations, and probabilities.

**PO2: Practical, Professional and Procedural Knowledge**
The course outcomes involve practical knowledge and procedural skills in solving mathematical problems involving trigonometric concepts, radicals, quadratic equations, permutations, combinations, and probabilities.

**PO3: Entrepreneurial Mindset and Knowledge**
While some course outcomes indirectly foster an entrepreneurial mindset by problem-solving and interpreting graphical representations (CO3, CO5), others may not directly relate to entrepreneurship.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in mathematics, particularly in trigonometry, algebra, and probability.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve application, problem-solving, and analytical reasoning, especially evident in CO1, CO3, CO4, and CO7 where students solve problems and make decisions based on statistical data.

**PO7: Research-related Skills**
CO7 involves analyzing probabilities in various situations, which can contribute to research-related skills, especially in fields where statistical analysis is applied.

**PO8: Learning How to Learn Skills**
Mastering mathematical concepts and techniques requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO12: Autonomy, Responsibility and Accountability**
Mastering mathematical concepts requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for problem-solving accuracy, contributing indirectly to this programme outcome.

# CBCS Syllabus as per NEP 2020 for S.Y.B.Sc. Mathematics (2023 Pattern)

**Name of the Programme** : B.Sc. Mathematics
**Program Code** : USMT
**Class** : S.Y.B.Sc.
**Semester** : III
**Course Type** : Vocational Skill Course (VSC)
**Course Name** : Financial Mathematics
**Course Code** : MAT-221-VSC
**No. of Teaching Hours** : 30
**No. of Credits** : 2

## Course Objectives:

1. Understand and apply mathematical models to analyze economic phenomena, particularly focusing on market dynamics and recurrence.
2. Explore the concept of market equilibrium and its implications in economic decision-making, including the effects of excise taxes.
3. Master the principles of first-order recurrence and their relevance in economic modeling and analysis.
4. Develop proficiency in utilizing limits and special cases to solve economic problems and interpret real-world scenarios.
5. Analyze the impact of continuous compounding of interest on financial decision-making and investment strategies.
6. Gain insights into the fundamentals of finance, including interest, capital growth, and income generation, and their role in economic systems.
7. Explore the Cobweb model and its implications for understanding market stability and dynamics.
8. Introduce the concept of optimization in economics, including the use of marginal cost, profit maximization, and critical points in decision-making processes.

## Course Outcomes:

**By the end of the course, students will be able to:**

1. Students will be able to construct and analyze mathematical models of markets to understand supply, demand, and equilibrium conditions.
2. Students will demonstrate proficiency in assessing the effects of excise taxes on market equilibrium and consumer behavior.
3. Students will be able to solve first-order recurrence problems and apply them to economic scenarios, such as inventory management and production planning.
4. Students will interpret limits and special cases in economic contexts and apply them to analyze real-world economic phenomena.
5. Students will analyze the implications of continuous compounding of interest on investment strategies and financial decision-making.
6. Students will demonstrate an understanding of the principles of finance, including interest, capital growth, and income generation, and their applications in economic systems.
7. Students will apply optimization techniques, such as marginal cost analysis and profit maximization, to make informed economic decisions and analyze market behavior.

## Topics and Learning Points

| | Teaching Hours |
|---|---|
| **Unit 1: Mathematical models in Economics and recurrence** | **6** |
| 1.1 Introduction, a model of the market<br>1.2 Market equilibrium and excise tax<br>1.3 The first order recurrence<br>1.4 Limits and special cases<br>1.5 Continuous compounding of interest | |
| **Unit 2: The elements of Finance** | **5** |
| 2.1 Interest and capital growth<br>2.2 Income generation<br>2.3 The interval of compounding | |
| **Unit 3: The Cobweb model and Introduction to optimization** | **5** |
| 3.1 Stability of market equilibrium<br>3.2 The general linear case<br>3.3 Economic interpretation | |
| **Unit 4: Introduction to optimization** | **6** |
| 4.1 Marginal cost as a derivative<br>4.2 Profit maximization<br>4.3 Critical points<br>4.4 Optimization in an interval | |
| **Unit 5: The derivative in Economics** | **8** |
| 5.1 Elasticity of demand<br>5.2 Competition verses monopoly<br>5.3 The efficient small firm<br>5.4 Startup and break-even points | |

## Text Book:

Martin Anthony and Norman Biggs, *Mathematics for Economics and Finance: Methods and Modeling*, Cambridge University Press, Reprint 2012.

**Unit 1** – Chapter 3: 3.2, 3.3 and 3.4, **Unit 2** – Chapter 4,

**Unit 3** – Chapter 5 and Chapter 6: 6.3, **Unit 4** – Chapter 8

**Unit 5** – Chapter 9 and Chapter 10

## Reference Books:

1. Edward T. Dowling, *Mathematical Economics*, Schaum's Outline Series, Second Edition.
2. Aswath Damodaran, *Corporate Finance – Theory and Practice*, John Wiley and Sons, Inc.
3. Sheldon M. Ross, *An Introduction to Mathematical Finance*, Cambridge University Press.

## Mapping of Program Outcomes with Course Outcomes

**Class:** S.Y.B.Sc. (Sem III) **Subject:** Mathematics
**Course:** Financial Mathematics **Course Code:** MAT-221-VSC
**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 |
| PO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| PO3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| PO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 |
| PO5 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| PO6 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO7 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| PO8 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO9 | | | | | | | |
| PO10 | | | | | | | |
| PO11 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PO12 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| PO13 | | | | | | | |

### Justification for the mapping

**PO1: Comprehensive Knowledge and Understanding**
All course outcomes directly contribute to comprehensive knowledge and understanding of economic principles and models, making them strongly connected to this programme outcome.

**PO2: Practical, Professional and Procedural Knowledge**
The course outcomes involve practical knowledge and procedural skills in constructing mathematical models of markets, assessing the effects of taxes, solving recurrence problems, interpreting limits, analyzing compounding interest, understanding finance principles, and applying optimization techniques.

**PO3: Entrepreneurial Mindset and Knowledge**
Understanding economic principles and models, as addressed in all course outcomes, fosters an entrepreneurial mindset by providing insights into market dynamics and decision-making processes.

**PO4: Specialized Skills and Competencies**
All course outcomes contribute to specialized skills and competencies in economic analysis, mathematical modeling, financial decision-making, and optimization techniques.

**PO5: Capacity for Application, Problem-Solving and Analytical Reasoning**
All course outcomes involve application, problem-solving, and analytical reasoning, especially evident in CO2, CO3, CO4, CO5, and CO7 where students analyze economic scenarios, solve problems, and make informed decisions.

**PO6: Communication Skills and Collaboration**
While communication skills and collaboration are not explicitly addressed in the course outcomes, students may develop these skills through discussions, presentations, and collaborative projects related to economic analysis and decision-making.

**PO7: Research-related Skills**

CO7 involves applying optimization techniques to analyze market behavior, which contributes to research-related skills, especially in fields where economic analysis and modeling are applied.

**PO8: Learning How to Learn Skills**

Mastering economic principles and mathematical modeling techniques requires self-directed learning and problem-solving skills, contributing to the development of learning how to learn skills.

**PO11: Value Inculcation and Environmental Awareness**

While the course outcomes themselves may not directly relate to value inculcation or environmental awareness, economic analysis and decision-making can contribute to addressing societal challenges and promoting sustainability indirectly.

**PO12: Autonomy, Responsibility and Accountability**

Mastering economic principles and mathematical modeling techniques requires autonomy in learning, taking responsibility for understanding concepts, and being accountable for decision-making accuracy, contributing indirectly to this programme outcome.