Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure for B.Sc. Mathematics (2022 Pattern)

F. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	USMT111	Algebra	2	36
	USMT112	Calculus	2	36
	USMT113	Practical based on USMT111 and USMT112	2	48
II	USMT121	Geometry	2	36
	USMT122	Calculus and Differential Equations	2	36
	USMT123	Practical based on USMT121 and USMT122	2	48

S. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
III	USMT231	Calculus of Several Variables	3	48
	USMT232	Laplace Transform & Fourier Series	3	48
	USMT233	Practical based on USMT231 and USMT232	2	48
IV	USMT241	Vector Calculus	3	48
	USMT242	Linear Algebra	3	48
	USMT243	Practical based on USMT241 and USMT242	2	48

T.Y.B.Sc Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
V	USMT351	Metric Spaces	3	48
	USMT352	Real Analysis I	3	48
	USMT353	Group Theory	3	48
	USMT354	Ordinary Differential Equation	3	48
	USMT355	Number Theory	3	48
	USMT356(A)	Operation Research	3	48
	USMT356(B)	C Programming	3	48
	USMT357	Practical based on USMT351 and USMT352	2	48
	USMT358	Practical based on USMT353 and USMT354	2	48
	USMT359	Practical based on USMT355 and USMT356	2	48
VI	USMT361	Complex Analysis	3	48
	USMT362	Real Analysis II	3	48
	USMT363	Ring Theory	3	48
	USMT364	Partial Differential Equation	3	48

	USMT365	Lebesgue Integration	3	48
	USMT366(A)	Optimization Techniques	3	48
	USMT366(B)	Python Programming	3	48
	USMT367	Practical based on USMT361, USMT362, and USMT363	2	48
	USMT368	Practical based on USMT364, USMT365, and USMT366	2	48
	USMT369	Mathematics Project	2	48

Equivalence of the old syllabus with the new syllabus

Old Course		New Course	
MAT 1201	Geometry	USMT121	Geometry
MAT 1202	Calculus-II	USMT122	Calculus and Differential Equations
MAT 1203	Practical based on MAT 1101 and MAT 1102	USMT123	Practical based on USMT121 and USMT122

Academic Year 2022-23

Class: F.Y.B.Sc. (Semester – II)

Paper Code: USMT121

Paper: I **Title of the Paper:** Geometry

Credit: 2 **No. of Lectures:** 36

A) TOPICS/CONTENTS:

Unit 1: Analytical Geometry of two dimensions [*10 Lectures*]

1.1 Change of axes: Translation and Rotation
1.2 General equation of second degree in two variables
1.3 Reduction to standard form

Unit 2: Planes in three dimensions [*10 Lectures*]

2.1 Direction cosines and direction ratios
2.2 Equation of the plane: Normal form, Transform to the normal form
2.3 Planes passing through three non-collinear points
2.4 Intercept form
2.5 Angle between two planes
2.6 Distance of a point from a plane
2.7 Distance between parallel planes
2.8 System of planes
2.9 Two sides of planes
2.10 Bisectors of angles between two planes

Unit 3: Lines in three dimensions [*8 Lectures*]

3.1 Equations of lines in symmetric and asymmetric forms
3.2 Line passing through two points
3.3 Angle between a line and a plane
3.4 Coplanar lines
3.5 Skew lines
3.6 Distance of a point from a line

Unit 4: The Sphere [*8 Lectures*]

4.1 Equation of a sphere
4.2 Plane section of a sphere
4.3 Intersection of two spheres
4.4 Sphere through a given circle
4.5 Intersection of a sphere and a line
4.6 Equation of tangent plane

Text Books:

1. **Analytic Geometry in Two and Three Dimensions**, *Von Steuben*
   Unit 1: Sections: 8.4.
2. **Analytical Solid Geometry**, *Shantinarayan*, S. Chand and Company Ltd., New Delhi, 1998.
   Unit 2: Sections: 1.6, 1.7, 2.1 to 2.7; **Unit 3:** Sections: 3.1 to 3.4, 3.7;
   Unit 4: Sections: 6.1 to 6.6.

Reference Books:

1. Analytical Geometry of 2D and 3D, *P. R. Vittal*, Pearson, 2013.
2. A Textbook of Two Dimensional Geometry, *Sat Pal* and *Harbans Lal*, New Age International Publishers.
3. Textbook of Analytical Geometry of Three Dimensions, *P. K. Jain* and *Khalil Ahmad*, New Age International Publishers.
4. Theory and Problems of Plane and Solid Analytic Geometry, *Joseph H. Kindle*, Schaum's Outline Series.

Class: F.Y. B. Sc. (Semester- II) **Title of Paper:** Calculus and Differential Equations
Paper Code: USMT122 **Credit:** 2
Paper: II **No. of lectures:** 36

Unit 1: Differentiation [12 lectures]

1.1 The Derivative:

The definition of derivative at a point, relationship between differentiability and continuity, Rules for Differentiation, Caratheodory's Theorem (without Proof), The Chain Rule, Derivative of inverse function.

1.2 The Mean Value Theorem:

Interior Extremum Theorem, Rolle's Theorem, Mean Value Theorem, Cauchy Mean Value Theorem, Intervals of increasing and decreasing functions, First Derivative Test for Maxima, Intermediate Value Theorem, Darboux's Theorem.

Unit 2:L'Hospital's Rule and Successive Differentiation [14 lectures]

2.1 L'Hospital Rule: Indeterminate Forms, L'Hospital Rules (without proof)

2.2 Taylor's Theorem: Taylor's Theorem (without proof), MacLaurin's theorem with Lagrange's form remainder

2.3 Successive Differentiation: The n^{th} derivative and Leibnitz theorem for successive differentiation.

Unit 3: Ordinary Differential Equations [10 lectures]

3.1 First Order Differential Equations: First order linear differential equation, separable equations, Homogeneous equations

3.2 Orthogonal Trajectories: Formation of Differential equation, orthogonal trajectory, Existence and uniqueness of solutions

3.3 Exact Equations: Exact differential equations, Integrating Factors.

Textbooks:

1. Introduction to Real Analysis by R.G. Bartle and D.R. Sherbert, John Wiley and Sons Inc, Fourth Edition.
   Unit 1: Sec 6.1 and Sec. 6.2, Unit 2: Sec 6.3 and Sec. 6.4
2. Differential Equations by George F. Simmons, Steven G. Krantz, Tata McGrawHill.
   Unit 3: Sec 1.3 to Sec 1.8

Reference books:

1. Introduction to Real analysis, William F.Trench, Free edition, 2010.
2. Calculus of a single variable Ron Larson, Bruce Edwards, tenth edition.
3. Elementary Analysis, The Theory of Calculus, Kenneth A. Ross, Springer Publication, second edition.
4. Calculus and its Applications, Marvin L. Bittinger, David J. Ellenbogen and Scott A. Surgent, Addison Wesley, tenth edition.
5. Ordinary and Partial Differential Equation, by M.D.Raisinghania, S.Chand and Company LTD, 2009.
6. Daniel Murray, Introductory Course in Differential Equations, Orient Longman

Class: F.Y. B. Sc. (Semester- II) **Title of Paper:** Practical Based on USMT121 & USMT122
Paper Code: USMT123 **Credit:** 2
Paper: III **No. of lectures:** 48

Title of Experiments:

Geometry-

1. Analytical Geometry of two dimensions
2. Planes in three dimensions
3. Lines in three dimensions
4. Sphere
5. History of Geometry
6. Geometry using Maxima Software

Calculus and Differential Equations-

7. Differentiation
8. Mean Value Theorem
9. L'Hospital's Rule
10. Successive Differentiation
11. Ordinary Differential Equations
12. Differentiability using Maxima Software

Class: F.Y.B.Sc. (Semester – II)
Course Code: USMT121
Course: 1 **Title of the Course:** Geometry
Credit: 2 **No. of Lectures:** 36

A) Course Objectives:

1. Understand an apply the concept of locus of points in analytical geometry.
2. Master the techniques of translating and rotating coordinate axes.
3. Analyze and determine the centre of a conic.
4. Apply techniques for reducing equation to standard form.
5. Acquire skills in working with rectangular Cartesian coordinates in three dimensions.
6. Learn to find direction cosines and angle between lines using direction cosines.
7. Master the determination of planes under given conditions and understand the concept of system of planes
8. Develop the ability of finding the shortest distance between skew lines and length of perpendicular from point to line.
9. Understand the fundamental concepts and properties of spheres.
10. Develop the ability to determine and apply the equation of a tangent plane to a sphere, demonstrating a clear understanding of this geometric concept.

B) Course Outcomes:

1. Students will be able to demonstrate proficiency in performing translations and rotations of coordinate axes.
2. Students will be able to reduce equations to standard forms and determine various properties associated with them.
3. Students will understand rectangular Cartesian coordinates in three dimensions and use them in various scenarios.
4. Students will be able to calculate direction cosines and angle between lines using coordinate geometry techniques.
5. Students will be able to find the shortest distance between skew lines and length of perpendicular from points to lines in three dimensions.
6. Students will be able to analyze plane sections of spheres and solve problems involving the intersection of two spheres.
7. Students will be able to determine and apply the equation of tangent plane to a sphere, illustrating a high-level proficiency in this advanced geometric concept.

Mapping of Program Outcomes with Course Outcomes

Class: FYBSc (Sem II) **Subject:** Mathematics
Course: Geometry **Course Code:** USMT121
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2							1
CO 2	3	2							
CO 3	2	3			1				1
CO 4	3	2							
CO 5	3	2							
CO 6	3	3				1		1	
CO 7	3	2		1	2				1

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Student will demonstrate proficiency in performing translations and rotations of coordinate axes.
CO2: Student will be able to determine the nature of conic and reduce its equation to standard form.
CO3: Student will be able to use three-dimensional Cartesian coordinate system in different scenarios.
CO4: Student will be able to calculate direction cosines and angle between lines using coordinate geometry techniques.
CO5: Student will be able to understand difference between coplanar and skew lines.
CO6: Student will understand intersection of sphere with line, plane and sphere.
CO7: Student will apply the equation of tangent plane to a sphere, illustrating a high-level proficiency in this advanced geometric concept.

PO2: Critical Thinking and Problem Solving
CO1: Student will apply their knowledge of coordinate geometry to solve problems involving the translation and rotation of geometric figures.
CO2: Student will apply their knowledge of conic section to solve problems involving the manipulation of geometric figures.
CO3: Student will be able to use three-dimensional Cartesian coordinate system in different scenarios.
CO4: Student will apply the calculation of direction cosines and angles between lines in coordinate geometry to enhance their critical thinking and problem-solving skills by understanding spatial relationships and solving geometric problems in three-dimensional space.
CO5: Mastering spatial reasoning in three dimensions enhances a student's capacity to analyze intricate geometric relationships, crucial for solving real-world problems across diverse fields.

CO6: Exploring plane sections of spheres sharpens critical thinking through in-depth analysis of intricate three-dimensional relationships, honing spatial reasoning and mathematical problem-solving skills.
CO7: Proficiency in tangent plane equations for spheres sharpens critical thinking and problem-solving, illuminating local behavior and spatial relationships in environmental contexts.

PO4: Research-related skills and Scientific temper
CO7: Proficiency in spherical geometry empowers student to analyze Earth's curvature, navigate celestial objects, and process geospatial data, enhancing their scientific acumen in three-dimensional studies.

PO5: Trans-disciplinary Knowledge
CO3: Student will use three-dimensional Cartesian geometry to analyze and model complex physical phenomena in fields like physics, engineering, and computer science, enabling them to solve real-world problems involving spatial relationships and dimensions.
CO7: Proficiency in spherical geometry empowers student to navigate and analyze complex spatial phenomena in diverse fields like physics, astronomy, geography, and geology.

PO6: Personal and Professional Competence
CO6: Spherical geometry enriches competence with spatial reasoning, problem-solving, and a 3D perspective, vital in astronomy, navigation, and computer graphics.

PO8: Environment and Sustainability
CO6: Proficiency in spherical geometry enhances comprehension and analysis of global environmental phenomena, enabling accurate measurements and precise modeling for sustainable solutions.

PO9: Self-directed and Life-long Learning
CO1: Analytical geometry in two dimensions cultivates spatial reasoning for independent problem-solving across diverse fields, promoting lifelong learning.
CO3: Proficiency in three-dimensional Cartesian coordinates empowers student with a crucial spatial analysis toolset, fostering lifelong learning and enabling precise problem-solving in real-world contexts.
CO7: Studying spherical geometry fosters a broader understanding of spatial relationships, enhancing self-directed and life-long learning by providing a unique perspective on non-Euclidean geometries and applications in fields like astronomy and navigation.

Class: F.Y.B.Sc.
Paper Code: USMT122
Title of Paper: Calculus and Differential Equations

Course Outcomes:

CO1:Students will able to understand definition of differentiation using limits.
CO2:Students will apply these concepts for advanced study in Mathematics (Real Analysis, Complex Analysis, topology).
CO3:Students can develop the theoretical as well as applied, computational skills and gains the confidence in proving theorems and solving problems.
CO4:Students will able to calculate limits of a function using Hospital Rule.
CO5:Students will able to find n^{th} derivatives of product of function using Leibnitz Rule.
CO6:Students will able to solve first order differential equation of various methods.
CO7:Students will able to relate graphs and theoretical concepts in calculus efficiently.

Choice Based Credit System Syllabus (2023 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: F.Y.B.Sc. (Sem II) **Subject:** Mathematics
Course: Calculus & Differential Equation **Course Code:** MAT-152-MJM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes(POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2							
CO 2	3	2		2	2				
CO 3	3	2		2					
CO 4	3	2							
CO 5	3								
CO 6	3	2							
CO 7	3			2	2	2			2

Justification for the mapping

PO 1: Disciplinary Knowledge:
All of these COs contribute to development of students disciplinary knowledge.For example,CO1, CO2,CO3 requires to think students critically to apply differentiation,behaviour of functions in various fields .
CO5,CO6 and CO7 requires to develop deep understanding of integration ,dependent variable and independent variables in view of differential equation and use it to solve real world problems.

PO2:Critical Thinking and Problem Solving:
CO1,CO2 and CO4 requires to development of students knowledge of derivative,Mean Value theorems , integration to find orthogonal trajectory, critical points of a function,to solve problems related to accuracy,area calculation etc.
CO3, CO6 contribute to development of students understanding to solve real world problems in different fields by using differentiation.

PO4: Research-related skills and Scientific temper:
CO2,CO3,CO7 requires to develop students research related skills.Students will able to apply the tools of calculus to various real world problems in different areas.

PO5:Trans-disciplinary Knowledge:
CO7:Students will apply mathematical concept such as Mean Value Theorem, Series, Integration, orthogonal trajectory and solving differential equation to solve complex problems. These concepts are useful in many different fields such as Physics,engineering ,chemistry and economics.

PO6:Personal and professional competence:
CO7 requires to demonstrate the students ability to apply mathematical concept such as derivative, integration in practical manner. This ability is essential for personal and professional development.

PO9:Self-directed and Life-long learning:
CO7:Students will demonstrate the ability to apply the concept of calculus and differential equations in practical context. This ability will enable them to continue learning and developing skills throughout life.

Class : F.Y. B. Sc. (Semester- II)
Paper Code: USMT123
Paper : III **Title of Paper :**Practical based on USMT121 & USMT122

Course Objectives for Mathematics Practical:

Geometry:

- Develop proficiency in applying algebraic methods to solve problems in two-dimensional and three-dimensional geometry.
- Gain practical skills in visualizing and manipulating geometric objects in space.
- Master the use of Maxima software to solve geometric problems and visualize mathematical concepts.
- Strengthen spatial reasoning and analytical thinking abilities through geometrical exercises.

Calculus II:

- Deepen the understanding of continuity and differentiability of functions.
- Acquire practical skills in performing differentiation techniques and exploring their applications.
- Gain familiarity with Taylor's series and its role in approximating functions.
- Utilize Maxima software to perform symbolic and numerical calculations in calculus.
- Enhance problem-solving abilities through diverse calculus applications.

Course Outcomes for Mathematics Practical:

Geometry:
CO1: Analyze and manipulate lines, circles, conics, and other geometric shapes using algebraic equations.
CO2: Determine the intersection points, distances, and other relationships between geometric objects in two and three dimensions.
CO3: Visualize and represent geometric concepts using graphical techniques and Maxima software.
CO4: Apply geometric principles to solve practical problems in diverse fields.

Calculus II:
CO5: Recognize and evaluate continuous functions based on their properties and graphical representations.
CO6: Master differentiation techniques such as product rule, chain rule, and implicit differentiation, and apply them to solve optimization problems.
CO7: Explain and utilize Taylor's series to approximate functions and analyze their behavior.
CO8: Solve differential equations and apply calculus concepts to problems in physics, engineering, and other disciplines.
CO9: Leverage Maxima software to perform symbolic and numerical differentiation, integration, and other calculus operations.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3				2			3
CO 2	3	3				2			3
CO 3		3	2						3
CO 4					2				3
CO 5	3	3				2			3
CO 6	3	3		2		2			3
CO 7		3							3
CO 8	3	3		2	2				3
CO 9			2			2			3

PO 1: Disciplinary Knowledge:
COs 1, 2, 5, 6, and 8 involve analyzing and manipulating equations, geometric objects, and calculus concepts. Students gain practical experience applying these concepts to solve problems.

PO2:Critical Thinking and Problem Solving:
COs 1, 2, 3, 5, 6, 7 and 8 require analyzing situations, formulating solutions, and applying mathematical tools to solve problems in various contexts. Students learn to think critically, reason logically, and develop creative approaches to tackling complex problems.

PO 3: Communication and Team work:
COs 3 and 9 involve visualizing and representing mathematical concepts using graphs, diagrams, and software. Students may collaborate on group projects or discussions, presenting their findings and interpretations.

PO4: Research-related skills and Scientific temper:
COs 6 and 8 involve applying calculus concepts to real-world problems in other disciplines, like physics and engineering. Students learn to analyze data, draw conclusions, and develop a scientific approach to investigating mathematical applications.

PO5:Trans-disciplinary Knowledge:
COs 4 and 8 showcase the applicability of geometric and calculus principles in diverse fields like architecture, computer graphics, and optimization problems. Students learn to utilize mathematical tools to solve problems beyond pure mathematics.

PO6:Personal and professional competence:
COs 1, 2, 5, 6 and 9 require independent work, applying algorithms, and analyzing results. Students develop time management skills, self-reliance, and the ability to work effectively under pressure.

PO9:Self-directed and Life-long learning:
All COs promote independent learning, exploration, and curiosity. Students learn to actively seek information, solve new problems, and adapt to new mathematical concepts, fostering lifelong learning skills.

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