John Wilson Education Society's

Wilson College, Mumbai

(Autonomous)

Wilson College informs all concerned that the recommendations made by the Board of Studies in the subject of Mathematics at its meeting held on February 15, 2024, have been accepted by the Academic Council at its meeting held on _____ vide item no. _____ and that in accordance therewith, the proposed syllabus as per the (CBCS) for the subject of Mathematics: Second Year B.Sc. has been brought into force with effect from the academic year 2024-25, accordingly, the same is made available on the college website: www.wilsoncollege.edu.

MUMBAI 400 007 Principal

Date:

John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Wilson College

Syllabus for S. Y.

(under NEP 2020)

Programme: B. Sc.

Programme Code: WSMATMJ (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
SY	III	WSMATMJ231		Calculus III	2
			I	Riemann Integration	
			II	Indefinite Integrals, Improper Integrals and Applications of Integration	
		WSMATMJ232		Introduction to Vector spaces and Linear Transformations	2
			I	Vector spaces over $\mathbb{R}$	
			II	Linear transformations	
		WSMATMJ233		Mathematics Practical 3	2
	IV	WSMATMJ241		Multivariable Calculus I	2
			I	Limits and Continuity of Scalar and Vector Fields	
			II	Differentiation of Scalar and Vector Fields with Applications of Differentiability of Scalar Fields	
		WSMATMJ242		Inner Product Spaces and Diagonalization of matrices	2
			I	Inner product spaces	
			II	Eigenvalues, eigenvectors and diagonalization	
		WSMATMJ243		Mathematics Practical 4	2

PROGRAMME SPECIFIC OUTCOME (PSOs)

At the end of the course the learner will be able to:

PSO 1: Utilize the skills of logical thinking in problem solving and inculcate the habit of self-learning.
PSO 2: Formulate and use quantitative models arising in social science,business and other contexts.
PSO 3: Analyze the mathematical results and apply them in various problems appearing in different branches of mathematics and related fields.
PSO 4: Recognize patterns and to distinguish between essential and irrelevant aspects of the problems.
PSO 5: Employ technically oriented skills to solve specific theoretical and applied problems in mathematics and other domains.
PSO 6: Translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.
PSO 7: Identify unethical behavior such as misrepresentation of data, unbiased and truthful actions in all aspects.
PSO 8: Solve mathematical problems using analytical methods.
PSO 9: Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

PREAMBLE:

Keeping in view the new National Education Policy, Wilson College Mumbai under autonomy revised the syllabi as per the Choice Based Credit System (CBCS) for the Second year B.Sc. Programme in Mathematics from the academic year 2024-2025.

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the Board of Studies in Mathematics of Wilson College Mumbai has prepared the syllabus of S.Y.B.Sc. Mathematics.

The syllabi of S.Y.B.Sc. Mathematics for Semester III and Semester IV has been designed so that the students learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of S.Y.B.Sc. Mathematics. would consist of two semesters and each semester would comprise two courses. Course I is 'Calculus III and Multivariable Calculus I'. Calculus is applied and needed in every conceivable branch of science. Course II is 'Introduction to Vector spaces and Linear Transformations and Inner Product Spaces and Diagonalization of matrices' which develops mathematical reasoning and logical thinking and has applications in science and technology.

PROGRAMME: B. Sc.		SEMESTER: III	
Course: Calculus III		Course Code: WSMATMJ231	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination (Marks- 60)
2 Lectures (2 Hours)	2	40	60

Course Objectives:

1. To enable the learner to understand the concept of Riemann Integration using upper and lower sums.
2. To enable the learner to check the integrability of a function.
3. To enable the learner to understand the concept of indefinite and improper integrals.
4. To enable the learner to check the convergence of improper integrals
5. To introduce the learner to evaluate area and volume using integration

Course Outcomes:

CO1: State the definitions of partitions, upper and lower sum, upper and lower integrals.
CO2: Identify Riemann integrable functions
CO3: Recall the properties of Riemann integrable functions.
CO4: Evaluate indefinite and improper integrals
CO5: Test the convergence of improper integrals.
CO5: Prove fundamental theorem of calculus
CO6: Evaluate the areas and volumes using integration.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WSMATMJ231	**I**		**Riemann Integration**	**15 Lectures**
		1.1	Approximation of area, Upper and Lower Riemann sums and their properties with examples, Upper and Lower Integrals with examples. Definition of Riemann Integral on a closed and bounded interval, Riemann Criterion for Integrability and examples.	
		1.2	Properties of Riemann Integration: • If $f, g \in R[a,b]$ then $f \pm g \in R[a,b]$ and $\int_a^b f \pm g = \int_a^b f \pm \int_a^b g$ If $f \in R[a,b]$ and $\lambda \in R$ then $\lambda f \in R[a,b]$ and $\int_a^b \lambda f = \lambda \int_a^b f$ • If $f \in R[a,b]$ then $\lvert f \rvert \in R[a,b]$ and $\left\lvert \int_a^b f \right\rvert \leq \int_a^b \lvert f \rvert$	
	II		**Indefinite Integrals, Improper Integrals and Applications of Integration**	**15 Lectures**
		2.1	Indefinite integrals $F(x) = \int_a^x f(t)dt$ where $f \in R[a,b]$, continuity of $F(x) = \int_a^x f(t)dt$, Fundamental theorem of Integral Calculus. Mean Value Theorems for integrals, Integration by parts, Leibnitz rule, Change of variables formula.	
		2.2	Definition of two types of Improper integrals, necessary and sufficient condition for convergence of improper integrals, absolute convergence, tests for convergence.	

			Area between the two curves, length of plane curves. Surface area of surfaces of revolution, Volume of solids of revolution.	

References:

(1) Apostol, Tom M. Calculus Volume I, Wiley & Sons (Asia) Pvt. Ltd, 1991.
(2) Bartle, Robert G., and Donald R. Sherbert. Introduction to Real Analysis, 3rd Edition. Wiley, 1999.
(3) Binmore, K. G. Mathematical Analysis : A Straightforward Approach. Cambridge University Press, 2001.
(4) Courant, Richard. Introduction to Calculus and Analysis: Volume One. Interscience Publishers, 1965.
(5) Ghorpade, Sudhir R. and Limaye, Balmohan V. A Course in Calculus and Real Analysis, Springer International Ltd, 2006.
(6) Goldberg, Richard R. Methods of Real Analysis. Blaisdell Pub. Co.; Oxford And IBH, 1964.
(7) Kumar, Ajit, and S. Kumaresan. A Basic Course in Real Analysis. Chapman and Hall/CRC, 2014, https://doi.org/10.1201/b16440.
(8) Stewart, J. Calculus, Third Edition, Brooks/Cole Publishing Company, 1994.
(9) S C Malik and Savita Arora, Mathematical Analysis, New Age Publishers, Fifth Edition.

PROGRAMME: B. Sc.		SEMESTER III	
COURSE: Introduction to Vector spaces and Linear Transformations		COURSE CODE: WSMATMJ232	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	Continuous Internal Assessment (CIA)	Semester End Examination
2 lectures (2 hours)	2	40 marks	60 marks

Course Objectives:

1. To enable the learner to understand the concepts of vector spaces over $\mathbb{R}$.
2. To enable the learner to check the linear independence and dependence of subsets of a vector space.
3. To enable the learner to understand the concepts of basis of a vector space and dimension of a vector space.
4. To enable the learner to understand linear transformations and the matrix associated with it.
5. To enable the learner to understand orthogonality of vectors in an inner product space.
6. To enable the learner to learn the Gram-Schmidt orthogonalization process.

Course Outcome:

The learner will be able to:

CO1: Recall the definitions of a vector space, subspace of a vector space and a linear transformation.

CO2: Identify vector spaces and linear transformations.

CO3: Determine the linear independence and dependence of a given subset of a vector space.

CO4: Evaluate the basis of a given vector space; the dimension of a vector space; the kernel and image of a linear transformation; and the nullity and rank of a linear transformation.

CO5: Construct the matrix associated with a linear transformation given a basis and after a change of basis of the domain vector space.

CO6: Apply the Rank-Nullity theorem.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WSMATMJ232	**I**		**Vector spaces over $\mathbb{R}$**	**15 Lectures**
		1.1	Definition of a vector space over $\mathbb{R}$. Subspaces and criterion for a non-empty subset to be a subspace of a vector space. Standard and important examples of vector spaces.	
		1.2	Intersections and sums of subspaces. Direct sum of vector spaces. Quotient space of a vector space by its subspace. Linear combination of vectors. Linear span of a subset of a vector space. Definition of finitely generated vector space. Linear dependence and independence of subsets of a vector space.	
		1.3	Basis of a vector space, Only statements of results such as any two bases of a finitely generated vector space have the same number of elements. Dimension of a vector space. Examples. Basis of a vector space is a maximal independent set and a minimal generating set (only statement).	
	II		**Linear transformations**	**15 Lectures**
		2.1	Definition of a linear transformation between vector spaces and examples. Algebra of linear transformations. Composite of linear transformations. Determination of a linear transformation between vector spaces by its action on an ordered basis of the domain vector space.	
		2.2	Kernel and image of a linear transformation. Nullity and rank of a linear transformation. Rank-Nullity theorem. First theorem of	

			isomorphism. Matrix associated with a linear transformation between finite dimensional vector spaces. Matrix associated with composite of linear transformations. Invertible linear transformations. Effect of change of basis on matrices of a linear transformation.	
		2.3	Equivalence of the rank of a matrix and the rank of the associated linear transformation. Similar matrices.	

References:

1. Serg Lang, Introduction to Linear Algebra, Springer..
2. S. Kumeresan, Linear Algebra -A Geometric Approach, PHI Learning.
3. Sheldon Axler, Linear Algebra done right, Springer..
4. Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.
5. Howard Anton and Chris Rorres, Elementary Linear Algebra, Wiley Student Edition.
6. David W. Lewis, Matrix Theory, World Scientific Publishing Co. Pvt. Ltd..

PROGRAMME: B. Sc.		SEMESTER III	
COURSE: Mathematics Practical 3		COURSE CODE: WSMATMJ233	
Teaching Scheme		Evaluation Scheme	
Practicals (hours/week)	Credits	Continuous Internal Assessment (CIA)	Semester End Examination
4 hours per batch	2	40 marks	60 marks

Course Objectives:

1. To enable the learner to understand the concept of Riemann Integration using upper and lower sums.
2. To enable the learner to check the integrability of a function.
3. To enable the learner to understand the concept of indefinite and improper integrals.
4. To enable the learner to check the convergence of improper integrals
5. To introduce the learner to evaluate area and volume using integration
6. To enable the learner to understand the concepts of a vector space, an inner product space and linear transformation and the matrix associated with a linear transformation.
7. To enable the learner to learn the basis of a vector space and its properties, learn the concept of dimension of a vector space.
8. To enable the learner to understand the significance of Rank-Nullity theorem.

Course Outcome:

The learner will be able to:

CO1: Identify Riemann integrable functions using Riemann criteria.
CO2: Evaluate indefinite and improper integrals
CO3: Test for convergence of improper integrals.
CO4: Evaluate the areas and volumes using integration.
CO5: Identify vector spaces and linear transformations.
CO6: Determine the linear independence and dependence of a given subset of a vector space.
CO7: Evaluate the basis; dimensions; the kernel and image of a linear transformation.
CO8: Construct the matrix associated with a linear transformation given a basis and after a change of basis of the domain vector space.
CO9: Apply the Rank-Nullity theorem.

Practical	Credits
SECTION-1	**2**
1.Calculation of upper sum, lower sum and Riemann integral.	
2.Problems on properties of Riemann integral.	
3.Problems on fundamental theorem of calculus, mean value theorems, integration by parts, Leibnitz rule.	
4. Convergence of improper integrals, different tests for convergence.	
5. Calculation of areas and volumes using SageMath/SciLab	
6. Calculation of Surface areas of surface of revolution using SageMath/SciLab	
SECTION-2	
1. Vector spaces, subspaces and linear span	
2. Linear independence and dependence, basis and dimension of a vector space.	
3. Linear transformations. Kernel and image of a linear transformation. Rank-Nullity theorem.	
4. Linear isomorphism and matrix associated with a linear transformation.	
5. Effect of change of basis of a linear transformation	
6. Geometry of linear transformations on two/three dimensional vector spaces using Scilab/SageMath	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Presentation	20
	TOTAL	40

B. **External Examination- 60%- 60 marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

a. There shall be 3 questions each of 20 marks.
b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two questions each of **8 marks** (or attempt any two of four questions each of **4 marks**) **Part B:** Attempt any three of five questions each of **4 marks**	20	Unit I
2	**Part A:** Attempt any one of two questions each of **8 marks** (or attempt any two of four questions each of **4 marks**) **Part B:** Attempt any three of five questions each of **4 marks**	20	Unit II
3	Attempt any four of six questions each of **5 marks**	20	Unit I & II
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Section-I	Section-II
Journal	05	05
Quiz	10	10
Participation	05	05
Total	20	20

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	SECTION-I	SECTION-II
Laboratory work	25	25
Viva	05	05
Total	30	30

PRACTICAL BOOK/JOURNAL

The students are required to perform in class 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal or a certificate of satisfactorily completed work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester III

Course Code	Internal marks	External marks	Total marks
WSMATMJ231	40	60	100
WSMATMJ232	40	60	100
WSMATMJ233	40	60	100
		Grand Total	300

PROGRAMME: B. Sc.		SEMESTER: IV	
Course: Multivariable Calculus I		Course Code: WSMATMJ241	
Teaching Scheme		Evaluation Scheme	
Lectures (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester End Examination
2 Lectures (2 Hours)	2	40	60

Learning Objectives:

1. To enable the learner to study the properties of inner product and norm
2. To enable the learner to discuss the continuity and differentiability of scalar fields
3. To enable the learner to discuss the continuity and differentiability of vector fields
4. To enable the learner to apply Taylor's Theorem and Method of Lagrange Multiplier

Course Outcomes:

CO1: Discuss the limit, continuity and differentiability of functions of several variables.
CO2: Find the directional derivative and gradient of a function.
CO3: Discuss the mean value theorems, chain rule and tangent planes for scalar and vector fields
CO4: Evaluate the partial derivatives of a vector valued function.
CO5: Apply second order Taylor's formula for scalar fields.
CO6: Find Hessian matrix, Jacobian matrix, maxima, minima, critical point and saddle point of a vector valued function
CO7: Apply the method of Lagrange Multipliers.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WSMATMJ241	**I**		**Limits and Continuity of Scalar and Vector Fields**	**15 Lectures**
		1.1	Euclidean space R^n, norm, inner product, distance between two points, Functions from R^n to R (scalar fields) and functions from R^n to R^m (vector fields), component functions, level sets, limits and continuity of scalar fields and vector fields, iterated limits.	
		1.2	Algebra of limits and continuity of scalar fields and vector fields. Partial derivatives, directional derivatives, Mean value theorem of scalar fields.	
	II		**Differentiation of Scalar and Vector Fields with Applications of Differentiability of Scalar Fields**	**15 Lectures**
		2.1	Differentiability of a scalar field at a point (in terms of linear transformation), the total derivative, Basic results including continuity and differentiability, partial derivative and differentiability, directional derivative and differentiability. Gradient of a scalar field, chain rule, Higher order partial derivatives and mixed partial derivatives.	
		2.2	Differentiablilty of vector fields, differentiablity of vector field implies continuity, Jacobian matrix, relation between total derivative and Jacobian matrix, chain rule. The maximum and minimum rate of change of scalar fields, Taylor Theorem, local maxima, local minima, saddle points. Derivative tests, Method of Lagrange's Multiplier, Hessian Matrix.	

References:

(1) Apostol, Tom M. Calculus Volume I, Wiley & Sons (Asia) Pvt. Ltd, 1991.
(2) Bartle, Robert G., and Donald R. Sherbert. Introduction to Real Analysis, 3rd Edition. Wiley, 1999.
(3) Binmore, K. G. Mathematical Analysis : A Straightforward Approach. Cambridge University Press, 2001.
(4) Courant, Richard. Introduction to Calculus and Analysis: Volume One. Interscience Publishers, 1965.
(5) Ghorpade, Sudhir R. and Limaye, Balmohan V. A Course in Calculus and Real Analysis, Springer International Ltd, 2006.
(6) Goldberg, Richard R. Methods of Real Analysis. Blaisdell Pub. Co.; Oxford And IBH, 1964.
(7) Kumar, Ajit, and S. Kumaresan. A Basic Course in Real Analysis. Chapman and Hall/CRC, 2014, https://doi.org/10.1201/b16440.
(8) Stewart, J. Calculus, Third Edition, Brooks/Cole Publishing Company, 1994.
(9) S C Malik and Savita Arora, Mathematical Analysis, New Age Publishers, Fifth Edition.

PROGRAMME: B. Sc.		SEMESTER IV	
COURSE: Inner Product Spaces and Diagonalization of matrices		COURSE CODE: WSMATMJ242	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	Continuous Internal Assessment (CIA)	Semester End Examination
2 lectures (2 hours)	2	40 marks	60 marks

Course Objectives:

1. To enable the learner to understand the concepts of inner product spaces, eigenvalues and eigenvectors.
2. To enable the learner to understand the notion of angle between vectors of a vector space.
3. To enable the learner to learn Gram-Schmidt orthogonalization process.
4. To enable the learner to understand diagonalizable matrix/linear transformation.
5. To enable the learner to learn how to diagonalize a given diagonalizable matrix.

Course Outcome:

The learner will be able to:

CO1: Recall the definitions of inner product spaces, eigenvalues and eigenvectors of a matrix/linear transformation.

CO2: Evaluate the angle between vectors; orthogonal complement and orthogonal projections.

CO3: Evaluate the eigenvalues and eigenvectors; characteristic polynomials; and the algebraic and geometric multiplicity of eigenvalues.

CO4: Determine the diagonalizability of a given matrix/linear transformation.

CO5: Apply the Gram-Schmidt orthogonalization process, Cayley Hamilton theorem and the procedure to diagonalize a given diagonalizable matrix.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WSMATMJ242	I		**Inner product spaces over $\mathbb{R}$**	15 Lectures
		1.1	Definition of inner product spaces over $\mathbb{R}$. Examples like Euclidean space, the space of real-valued continuous functions on a closed and bounded interval. Norm associated with an inner product. Cauchy-Schwarz inequality (without proof). Triangle inequality (without proof).	
		1.2	Angle between two vectors. Orthogonality of vectors. Pythagoras theorem, orthonormal sets. Gram-Schmidt orthogonalization process (without proof). Orthogonal basis and orthonormal basis for a finite dimensional inner product space.	
		1.3	Orthogonal complement of any set of vectors in an inner product space. Orthogonal complement of a set is a vector subspace of the inner product space. Orthogonal projection of a vector onto a line (one dimensional subspace). Orthogonal projection of an inner product space onto its subspace. Orthogonal decomposition theorem (only statement).	
	II		**Eigenvalues, eigenvectors and diagonalization**	15 Lectures
		2.1	Eigenvalues and eigenvectors of a linear transformation of a vector space into itself and of square matrices. Eigenvectors corresponding to distinct eigenvalues of a linear transformation are linearly independent (only statement). Eigenspaces. Algebraic and geometric multiplicity of an eigenvalue. Characteristic polynomial. Properties of	

			characteristic polynomials (only statements). Examples. Cayley Hamilton theorem and its applications. Invariance of the characteristic polynomial and eigenvalues of similar matrices.	
		2.2	Definition of a diagonalizable matrix and linear transformation. Characterizations of diagonalizable matrices and linear transformations. Procedure for diagonalizing a matrix.	
		2.3	Spectral theorem for real symmetric matrices (statement only). Examples of orthogonal diagonalization of real symmetric matrices. Applications to quadratic forms and classification of conic sections.	

References:

1. S Kumaresan, Linear Algebra - A Geometric Approach, PHI Learning.
2. Serge Lang, Introduction to Linear Algebra, Springer.
3. Sheldon Axler, Linear Algebra done right, Springer.
4. Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).
5. Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.
6. David W. Lewis, Matrix theory

PROGRAMME: B. Sc.		SEMESTER IV	
COURSE: Mathematics Practical 4		COURSE CODE: WSMATMJ243	
Teaching Scheme		Evaluation Scheme	
Practicals (hours/week)	Credits	Continuous Internal Assessment (CIA)	Semester End Examination
4 hours per batch	2	40 marks	60 marks

Course Objectives:

1. To enable the learner to study the properties of inner product and norm
2. To enable the learner to discuss the continuity and differentiability of scalar fields
3. To enable the learner to discuss the continuity and differentiability of vector fields
4. To enable the learner to apply Taylor's Theorem and Method of Lagrange Multiplier
5. To enable the learner to understand the concepts of inner product spaces, eigenvalues and eigenvectors and the notion of angle between vectors of a vector space.
6. To enable the learner to understand diagonalizability of matrices.

Course Outcome:

The learner will be able to:

CO1: Discuss the limit, continuity and differentiability of functions of several variables.
CO2: Find the directional derivative and gradient of a function.
CO3: Discuss the mean value theorems, chain rule and tangent planes for scalar and vector fields
CO4: Evaluate the partial derivatives of a vector valued function.
CO5: Apply second order Taylor's formula for scalar fields.
CO6: Find Hessian matrix, Jacobian matrix, maxima, minima, critical point and saddle point of a vector valued function
CO7: Apply the method of Lagrange Multipliers.
CO8: Evaluate the angle between vectors; orthogonal complement and orthogonal projections.
CO9: Evaluate the eigenvalues and eigenvectors; characteristic polynomials; and the algebraic and geometric multiplicity of eigenvalues.
CO9: Determine the diagonalizability of a given matrix/linear transformation.
CO10: Apply the Gram-Schmidt orthogonalization process, Cayley Hamilton theorem and the procedure to diagonalize a given diagonalizable matrix.

Practical	Credits
SECTION-1	**2**
1.Limits and continuity of scalar fields and vector fields, using definition and otherwise, iterated limits.	
2. Computing directional derivatives, partial derivatives and mean value theorem of scalar fields.	
3. Differentiability of scalar field, Total derivative, gradient, level sets and tangent planes.	
4. Chain rule, higher order derivatives and mixed partial derivatives of scalar fields using SageMath/Scilab	
5. Maximum and minimum rate of change of scalar fields. Taylor's Theorem. Finding Hessian/Jacobian matrix using SageMath/Scilab. Differentiation of a vector field at a point. Chain Rule for vector fields	
6.Finding maxima, minima and saddle points. Second derivative test for extrema of functions of two variables and method of Lagrange multipliers.	
SECTION-2	
1. Inner product spaces and orthogonal complement of a subspace.	
2. Orthogonal and orthonormal sets. Orthogonal projections onto a subspace.	
3. Gram-Schimdt orthogonalization process.	
4. Eigenvalues, eigenvectors and eigenspaces	
5. Algebraic and geometric multiplicities of eigenvalues	
6. Diagonalization of a matrix/linear transformation	
7. Characteristic polynomial of a matrix, Cayley Hamilton theorem	
8. Evaluate eigenvalues and eigenvectors of matrices and orthogonal projections; Gram Schmidt orthogonalization using Scilab/SageMath	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Presentation	20
	TOTAL	40

B. **External Examination- 60%- 60 marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:

c. There shall be 3 questions each of 20 marks.
d. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two questions each of **8 marks** (or attempt any two of four questions each of **4 marks**) **Part B:** Attempt any three of five questions each of **4 marks**	20	Unit I
2	**Part A:** Attempt any one of two questions each of **8 marks** (or attempt any two of four questions each of **4 marks**) **Part B:** Attempt any three of five questions each of **4 marks**	20	Unit II
3	Attempt any four of six questions each of **5 marks**	20	Unit I, & II
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Marks
Journal	10
Quiz	20
Participation	10
Total	**40**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Marks
Laboratory work	50
Viva	10
Total	**60**

PRACTICAL BOOK/JOURNAL

The students are required to perform in class 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal or a certificate of satisfactorily completed work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester IV

Course Code	Internal marks	External marks	Total marks
WSMATMJ241	**40**	**60**	**100**
WSMATMJ242	**40**	**60**	**100**
WSMATMJ243	**40**	**60**	**100**
		Grand Total	**300**


Wilson College
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विश्वास आशा प्रेम

John Wilson Education Society's
Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for S. Y. B. Sc. (Minor)

Programme: B. Sc.

Programme Code: WSMATMN (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
SY	III	WSMATMN231		Vector Algebra and Integrals	2
			I	Vector Algebra and Line integrals	
			II	Surface and Volume Integrals	
		WSMATMN232		Vector Algebra and Integrals Practical	2
	IV	WSMATMN241		Gradient and Integral Theorems	2
			I	Gradient, Curl and Divergence	
			II	Integral Theorems	
		WSMATMN242		Gradient and Integral Theorems Practical	2

PROGRAMME SPECIFIC OUTCOME (PSOs)

At the end of the course the learner will be able to:

PSO 1: Utilize the skills of logical thinking in problem solving and inculcate the habit of self-learning.

PSO 2: Formulate and use quantitative models arising in social science,business and other contexts.

PSO 3: Analyze the mathematical results and apply them in various problems appearing in different branches of mathematics and related fields.

PSO 4: Recognize patterns and to distinguish between essential and irrelevant aspects of the problems.

PSO 5: Employ technically oriented skills to solve specific theoretical and applied problems in mathematics and other domains.

PSO 6: Translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PSO 7: Solve mathematical problems using analytical methods.

PSO 8: Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

PREAMBLE:

Keeping in view the new National Education Policy, Wilson College Mumbai under autonomy revised the syllabi as per the Choice Based Credit System (CBCS) for the Second Year B.Sc. Programme in Mathematics from the academic year 2024-2025.

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the Board of Studies in Mathematics of Wilson College Mumbai has prepared the syllabus of S.Y.B.Sc. Mathematics.

The syllabi of S.Y.B.Sc. Mathematics for Semester III and Semester IV has been designed so that the students learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of S.Y.B.Sc. Mathematics. would consist of two semesters and each semester would comprise a single course. Course for Semester Three is 'Vector Algebra And Integrals' and for Semester Four 'Gradient and Integral Theorems'. Vector Calculus is applied and needed in every conceivable branch of science, which develops mathematical reasoning and logical thinking and has applications in science and technology.

PROGRAMME: B.Sc.		SEMESTER III	
COURSE: Vector Algebra and Integrals		COURSE CODE: WSMATMN231	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	CIA	Semester End Examination
2 lectures (2 hours)	2	40 marks	60 marks

Course Objectives:

1. To learn fundamental concepts of vector algebra.
2. To understand line integral and it's applications.
3. To analyze the surface and volume Integrals.

Course Outcome:

The learner will be able to

CO1: Identify the vector differential operators.

CO2: Apply theorems relating to line, volume and surface integrals.

CO3: Calculate integration of functions involving vectors.

CO4: Evaluate multiple Integrals.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WSMATMN231	I		**Vector Algebra and Line Integrals**	15 Lectures
		1.1	Definition of vector and scalar, Addition of vector, components of vector. Application of Dot product and Cross product, Scalar and Vector product.	
		1.2	Introductory example: Work done against a force, Evaluation of line integral, Conservative vector fields, others forms of line integrals.	
	II		**Surface and Volume Integrals**	15 Lectures
		2.1	Methods of integration : Examples, integration by substitution and integration by parts.	
		2.2	Surface integrals: Introductory example-Flow through a pipe, Evaluation of surface integrals, others forms of surface integrals, and evaluation of Volume integral.	

References:

1.T.M Apostal,Calculus Vol.II(IInd edition),John Willey ,New York (1967)

2. John M.H Olmsted ,Advanced Calculus,Eurasia ,Publishing House ,NewDelhi,1970.

3.Vector Calculus, Springer International Edition, PC Matthews.

PROGRAMME: B.Sc.		SEMESTER III	
COURSE: Vector Algebra and Integrals Practical		COURSE CODE: WSMATMN232	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	CIA – (Continuous Internal Assessment)	Semester End Examination
4 hours per batch	2	40 marks	60 marks

Course Objectives:

1. To learn fundamental concepts of vector algebra.
2. To understand line integral and it's applications.
3. To analyze the surface and volume Integrals.

Course Outcome:

The learner will be able to

CO1: Identify the vector differential operators.

CO2: Apply theorems relating to line, volume and surface integrals.

CO3: Calculate integration of functions involving vectors.

CO4: Evaluate multiple Integrals.

Practical	Credits
1. Problems on Scalar and Vector Fields	**2**
2. Problems on DOT and CROSS Product	
3. Line Integral of Scalar and Vector Fields	
4.Conservative Fields and Applications.	
5. Problems on Work done.	
6. Method of Integration using Vector Calculus.	
7. Evaluation of Surface integrals.	
8. Evaluation of Surface Volume integrals.	

PROGRAMME: B.Sc.		SEMESTER IV	
COURSE: Gradient And Integral Theorems		COURSE CODE: WSMTMN241	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	CIA	Semester End Examination
2 lectures (2 hours)	2	40 marks	60 marks

Course Objectives:

1. To understand fundamental concepts of gradient, divergence and curl.
2. To get introduced to integral theorems.
3. To learn vector calculus with derivatives, Taylor series, gradient, divergence and curl.

Course Outcome:

The learner will be able to

CO1: Integrate functions involving vectors.

CO2: Apply theorems linking line, volume and surface integrals.

CO3: Evaluate integrals using Divergence theorem, Stokes' theorem and related integral theorems.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
	I		**Gradient, Divergence and Curl**	15 Lectures
		1.1	Partial differentiation and Taylor series in more than one variable, Gradient of a scalar field, Conservative fields and potentials, Physical applications of gradient	
		1.2	Divergence of a vector field, Physical interpretation of divergence, Curl of a vector field, Physical interpretation of curl, Relation between curl and rotation.	
	II		**Integral Theorems**	15 Lectures
		2.1	Divergence Theorem and applications, Greens' theorem, Conservation of mass for a fluid. Stokes Theorem and applications	
		2.2	Theorems linking surface and volume integrals. Theorems linking line and surface integrals.	

References:

1. T. M. Apostal, Calculus Vol. II (IInd edition), John Willey, New York (1967)

2. John M. H. Olmsted, Advanced Calculus, Eurasia, Publishing House , NewDelhi,1970.

3. P. C. Matthews, Vector Calculus, Springer International Edition.

4. Murray R. Spiegel, Schaum's outline series-Theory and problems of Vector Analysis and an introduction to Tensor analysis (SI (Metric) Edition, McGraw-Hill International Book company, Singapore.

PROGRAMME: B.Sc.		SEMESTER IV	
COURSE: Gradient and Integral Theorems Practical		COURSE CODE: WSMATMN242	
Teaching Scheme		Evaluation Scheme	
Lectures (hours/week)	Credits	CIA – (Continuous Internal Assessment)	Semester End Examination
4 hours per batch	2	40 marks	60 marks

Course Objectives:

1. To learn fundamental concepts of vector algebra.
2. To understand line integral and it's applications.
3. To analyze the surface and volume Integrals.

Course Outcome:

The learner will be able to

CO1: Identify the vector differential operators.

CO2: Apply theorems relating to line, volume and surface integrals.

CO3: Calculate integration of functions involving vectors.

CO4: Evaluate multiple Integrals.

Practical	Credits
1. Gradient of a scalar field	**2**
2. Divergence and curl of a vector field	
3. Evaluating Line integrals using scalar and vector field	
4. Green's theorem, Conservative fields and applications	
4. Finding area and line integrals of independent paths using Green's theorem	
5. Stokes and Gauss divergence theorem.	
6. Problems on linking surface and volume integrals	

Modality of Assessment
(for both semesters III and IV)

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 marks per paper**

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Presentation**	**20**
TOTAL		**40**

B. **External Examination- 60%- 60 marks per paper**
Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be 3 questions each of 20 marks.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two questions each of **8 marks** (or attempt any two of four theory questions each of **4 marks**) **Part B:** Attempt any three of five questions each of **4 marks**	20	Unit I
2	**Part A:** Attempt any one of two questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	20	Unit II
3	Attempt any four of six questions each of **5 marks**	20	Unit I, & II
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Marks
Journal	05
Quiz	30
Participation	05
Total	**40**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Marks
Laboratory work	50
Viva	10
Total	**60**

PRACTICAL BOOK/JOURNAL

The students are required to perform in class 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal or a certificate of satisfactorily completed work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester III and IV

Course				Grand Total
	Internal	External	Total	
Theory	40	60	100	100
Practical	40	60	100	100

John Wilson Education Society's
Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for S.Y.B.Sc

SKILL ENHANCEMENT COURSE

(under NEP)

Programme: B. Sc.

Programme Code: WSMATSE (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
SY	III	WSMATSE231		Solving Polynomial using MATLAB/SCILAB	2
			I	Errors Analysis, Transcendental & Polynomial Equations	
			II	Interpolation with MATLAB/SCILAB	

SKILL ENHANCEMENT COURSE		SEMESTER III
COURSE: Solving Polynomial using MATLAB/SCILAB		**COURSE CODE: WSMATSE231**
Teaching Scheme		**Evaluation Scheme**
Practical (hours/week)	**Credits**	**Semester End Practical Examination**
4 hours per batch	**2**	**60 marks**

Course Objectives:

1. **To develop the skills of programming language.**
2. **To introduce the learner with new techniques of courses using programming language.**
3. **To make the learner employable.**
4. **To develop software proficiency among the learners.**

Course Outcome:
The learner will be able to

1. **Write a program for a given problem in MATLAB/SCILAB Coding.**
2. **Evaluate the numerical integration by interpolating polynomial.**
3. **Compare different methods in numerical analysis using MATLAB/SCILAB**
4. **Implement relevant numerical technique for equal and unequal intervals.**

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Hours: \ 2 Credits/ 30 Lectures
WSMATSE231	I		**Errors Analysis, Transcendental & Polynomial Equations**	15 hours
		1.1	Measures of Errors using MATLAB/SCILAB: Relative, absolute and percentage errors. Types of errors: Inherent error, Round-off error and Truncation error. Taylor's series example. Significant digits and numerical stability. Concept of simple and multiple roots.	
		1.2	Taylor's series example. Significant digits and numerical stability. Concept of simple and multiple roots.	
	II		**Interpolation with MATLAB/SCILAB**	15 hours
		2.1	Polynomial Interpolation Theory, Newton Divided Difference Interpolation polynomial errors and its polynomials	
		2.2	Applied Problems based on Gregory Newton forward Divided Differences, Gregory Backward Divided Differences	
		2.3	Lagrange interpolating polynomial for linear, quadratic and cubic.	

References:

1.McGraw Hill, Numerical Method using MATLAB, Third Edition.

2. McGraw Hill, New York, Numerical Method for Engineers by S.C Chapra And R.P Canale ,5TH Edition 2006.

3.Wiley, Applied Numerical Method using MATLAB, Second Edition

3.H. M. Antia, Numerical Analysis, Hindustan Publications

Practical
1. Installation of MATLAB/SCILAB and its Algorithms.
2.Numerical approximation of derivatives using finite differences
3. Basics of computer arithmetic (e.g. machine precision and rounding errors
4.Plotting the Vectors, Functions and solving the polynomial of Newton's Method Loops Controlling Error and Conditional Statements
5.Finding the roots of Bisection Method, Locating Roots, Secant Methods, Regula Falsi Method, Iterative Methods and its Symbolic Computation**.**
6. Solving the Newton Divided Difference Interpolation polynomial and its errors.
7.Problems based on Gregory Newton forward Divided Differences, Gregory Backward Divided Differences
8. Solving the Lagrange interpolating polynomial for linear, Quadratic and cubic.

Modality of Assessment

(For semester III)

Semester End Practical Examination of 60 marks for duration of 2 hours will be conducted where six questions of 10 marks each will be asked, of which four questions are to be attempted. The learner is expected to write the program for the given question, execute the program and get the desired output. Attendance and viva will carry a total of 10 marks and 10 marks for journal. **The learners are required to perform in class 75% of the practical for the journal to be duly certified. The learners are required to present a duly certified journal or a certificate of satisfactorily complete work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.**

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Syllabus for S.Y.B.Sc

VOCATIONAL SKILL COURSE

(Under NEP)

Programme: B.Sc
Programme Code: WSMATVS (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
SY	IV	WSMATVS241		Numerical Methods using MATLAB/SCILAB	2
			I	Numerical Method using MATLAB/SCILAB	
			II	MATLAB /SCILAB and Solving Equations	

VOCATIONAL SKILL COURSE		SEMESTER IV
COURSE: NUMERICAL METHODS I USING MATLAB/SCILAB		COURSE CODE: WSMATVS241
Teaching Scheme		Evaluation Scheme
Practical (hours/week)	Credits	Semester End Practical Examination
4 hours per batch	2	60 marks

Course Objectives:

1. To develop the skills of computers and programming.
2. To introduce the learner with math's using computers.
3. To make the learner employable.
4. To develop software proficiency among the learners.

Course Outcome:

The learner will be able to

1. Apply numerical technique in MATLAB/SCILAB Language.
2. Derive Trapezoidal Rule, Simpson's Rule.
3. Evaluate the numerical integration by Trapezoidal and Simpson's Rule.
4. Implement relevant numerical technique for equal and unequal intervals

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ hours: 2 Credits/ 30 hours
WSMATVS241	I		Numerical Method using MATLAB/SCILAB	15 hours
		1.1	Introduction to Numerical Analysis Using MATLAB/SCILAB	
		1.2	Gauss Elimination Method, LU Decomposition Methods, Doolittle's Decomposition Method, Cholesky's Decomposition	
		1.3	Numerical methods for solving nonlinear equations (e.g. bisection and Newton's method) Matrix factorization methods for solving systems of linear equations Curve fitting and interpolation (e.g. using monomial, Lagrange and Newton basis)	
		1.4	Integration by Numerical Methods the Trapezoidal Rule and Simpson's rules	
	II		MATALAB/SCILAB and Solving Equations	15 hours
		2.1	Numerical approximation for finite difference operators, their errors and algorithms using MATLAB/SCILAB, (e.g. machine precision And rounding errors)	
		2.2	Vectors, Functions, and Plots in MATLAB/SCILAB ,Newton's Method and Loops , Controlling Error and Conditional Statements	
		2.3	The Bisection Method and Location Roots secant Method, Regula Falsi Method ,Iterative method and its symbolic computations	

References:

1. **Kendall E. and Atkinson, An Introduction to Numerical Analysis, Wiley.**
2. **M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.**
3. **S.D. Comte and Carl de Boor, Elementary Numerical Analysis, An algorithmic approach, McGraw Hill International Book Company.**
4. **S. Sastry, Introductory methods of Numerical Analysis, PHI Learning.**
5. **Hildebrand F.B., Introduction to Numerical Analysis, Dover Publication, NY.**
6. **Scarborough James B., Numerical Mathematical Analysis, Oxford University Press, New Delhi**

Practical
1.Solving the Gauss Elimination Method, LU Decomposition Methods using MATLAB/SCILAB
2.Finding the Doolittle's Decomposition Method, Cholesky's Decomposition using MATLAB/SCILAB
3.Solving non-linear equations using numerical method
4.Solving systems of linear equations, Curve fitting interpolation and Matrix factorization methods
5. Measures of Errors using MATLAB/SCILAB
6. Finding the concept of simple and multiple roots**.**
7. Taylors series example on significant digits and numerical stability.
8. Solving the Error analysis of direct methods

Modality of Assessment

(For semester IV)

Semester End Practical Examination of 60 marks for duration of 2 hours will be conducted where six questions of 10 marks each will be asked, of which four questions are to be attempted. The learner is expected to write the program for the given question, execute the program and get the desired output. Attendance and viva will carry a total of 10 marks and 10 marks for journal. **The learners are required to perform in class 75% of the practical for the journal to be duly certified. The learners are required to present a duly certified journal or a certificate of satisfactorily complete work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.**

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UNIVERSITY OF MUMBAI

Syllabus for S. Y.
(Under NEP)

OPEN ELECTIVE

Programme Code: WAMATOE (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
SY	III	WAMATOE231	The Mathematics in Symmetries		2
			I	Basics of symmetries	
			II	Planar symmetries	
	IV	WAMATOE241	Descriptive Statistics		2
			I	Types of Data and Data Condensation	
			II	Classification of Data and Measures Of Central Tendency	

PROGRAMME SPECIFIC OUTCOME (PSOs)

At the end of the course the learner will be able to:

PSO 1: Utilize the skills of logical thinking in problem solving and inculcate the habit of self-learning.

PSO 2: Formulate and use quantitative models arising in social science,business and other contexts.

PSO 3: Analyze the mathematical results and apply them in various problems appearing in different branches of mathematics and related fields.

PSO 4: Recognize patterns and to distinguish between essential and irrelevant aspects of the problems.

PSO 5: Employ technically oriented skills to solve specific theoretical and applied problems in mathematics and other domains.

PSO 6: Translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PSO 7: Solve mathematical problems using analytical methods.

PSO 8: Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

PREAMBLE:

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Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the Board of Studies in Mathematics of Wilson College Mumbai has prepared the syllabus of S.Y.B.Sc. Mathematics.

The syllabi of S.Y.B.Sc. Mathematics for Semester III and Semester IV has been designed so that the students learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of S.Y.B.Sc. Mathematics. would consist of two semesters and each semester would comprise a single course. The course for Semester III is 'The Mathematics in Symmetries' which can be considered under the category of recreational Mathematics and applicable for artistic designs. The course for Semester IV is 'Descriptive Statistics', aimed at equipping the students with basic knowledge of understanding the data related to industries and society, identifying problems and working towards solutions by means of various analytical and statistical techniques. Additionally it also makes students aware of interdisciplinary sciences such as Actuarial Sciences, Biostatistics, Bioinformatics etc.

<table>
<tr><td colspan="2">OPEN ELECTIVE</td><td>SEMESTER III</td></tr>
<tr><td colspan="2">COURSE: The Mathematics in Symmetries</td><td>COURSE CODE: WAMATOE231</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Evaluation Scheme</td></tr>
<tr><td>Lectures (hours/week)</td><td>Credits</td><td rowspan="2">Class Assignments
60 marks</td></tr>
<tr><td>2 lectures
(2 hours)</td><td>2</td></tr>
<tr><td colspan="3">Course Objectives:
The course will enable the learner to
1. Learn about the symmetries found in nature and everyday life
2. Understand the mathematics involved in the different types of symmetries.
3. Understand the mathematical theory to design symmetric patterns.</td></tr>
<tr><td colspan="3">Course Outcome:
The learner will be able to
CO1: Recognize the symmetries found in nature and in everyday life around them.
CO2: Classify symmetric objects on the basis of their lines of symmetries and the plane rigid motions.
CO3: Determine the lines of symmetry and the number of lines of symmetry.
CO4: Design symmetric patterns for rangoli, wallpaper and tiling.</td></tr>
</table>

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WAMATOE231	I		**Symmetries in everyday life**	15 Lectures
		1.1	Symmetry and examples in everyday life and nature. Line or axis of symmetry. Figures with multiple lines of symmetry. Symmetries of the English alphabet. Rangoli and Mandala patterns.	
	II		**Planar symmetries**	15 Lectures
		2.1	Permutations. Proper and improper rigid motions. Classification of rigid motions. Symmetries of a square and regular polygon. Rosette patterns. Tilings and wallpaper patterns.	

References:

1. Kristopher Tapp, Symmetry - A Mathematical Exploration, Springer.
2. Michael Field and Martin Golubitsky, Symmetry in Chaos - A Search for Pattern in Mathematics, Art and Nature, Second Edition, SIAM.

Modality of Assessment
(Semester III)

Assignments	60 Marks
1. Lines of symmetry	
2. Rangoli and mandala patterns	
3. Tiling and wallpaper patterns	

<table>
<tr><td colspan="2">OPEN ELECTIVE</td><td>SEMESTER IV</td></tr>
<tr><td colspan="2">COURSE: Descriptive Statistics</td><td>COURSE CODE: WAMATOE241</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Evaluation Scheme</td></tr>
<tr><td>Lectures (hours/week)</td><td>Credits</td><td rowspan="2">Class Assignments
60 marks</td></tr>
<tr><td>2 lectures (2 hours)</td><td>2</td></tr>
<tr><td colspan="3">Course Objectives:
The course will enable the learner to
1. Learn about the technique of data collection and its presentation.
2. Emphasize the need for numerical summary measures for data analysis</td></tr>
<tr><td colspan="3">Course Outcome:
The learner will be able to
CO1: Define concepts of sample, sampling frame, sampling distribution, types of sampling.
CO2: List types of scales, types of data and attributes.
CO3: Classify data.
CO4: Estimate mean, median and mode.</td></tr>
</table>

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 30 Lectures
WAMATOE241	I		**Types Of Data and Data Condensation**	15 Lectures
		1.1	Concept of population and sample. Types of population. SRS,SRSWOR,SRSWR. Different types of scales: nominal, ordinal, interval and ratio. Collection of Primary data,Secondary data. Types of data. Attributes.	
	II		**Classification of Data and Measures Of Central Tendency**	15 Lectures
		2.1	Classification of Data: univariate (discrete,continuous,cumulative frequency distribution). Graphical representation. Concepts of central tendency of Data. Median, Mode, Quartile, Deciles, Percentiles. Mathematical averages. Empirical relation between mean median mode (numericals).	

References:

1. A.M, Goon, et al. *Fundamentals of Statistics*. Vol. 2, Calcutta, The World Press Private Limited,1971.
2. B.L, Agarwal. *Basic Statistics*. New Age International Ltd, 2018.
3. C.R, Kothari. *Research Methodology*. Wiley Eastern Limited,1985.
4. J, Medhi. *Statistical Methods, An Introductory Text*. 2nd ed., Wiley,1992.
5. M.R, Spiegel. *Theory and Problems of Statistics*. Schaum's Publications series. Tata McGraw-Hill,1961.
6. P.G, Hoel. *Introduction to Mathematical Statistics*.Wiley,1961.
7. S.C, Gupta, and V.K, Kapoor. *Fundamentals of Mathematical Statistics*. Sultan Chand &Sons.

Modality of Assessment
(Semester IV)

Class Assignments:

A. **Assignment 1: 30 Marks -** based on the unit I will be given.
B. **Assignment 2: 30 Marks -** based on the unit II will be given.