


**Department of Mathematics**  
**Faculty of Science, The Maharaja Sayajirao University of Baroda**

Sr. No.	Course Code	Course Title	Credits	Page No.
<b>Semester – I</b>				
<b>Major: Mathematics</b>				
1	MAT	Algebra and Number Theory	L-3 + 1-P	2
2	MAT	Calculus	L-3 + 1-P	4
<b>Minor: Mathematics</b>				
1	MAT	Algebra and Calculus	4	5
<b>SEC (Skills Enhancement Course): Mathematics</b>				
1	MAT	Mathematics Practicals – I	P-2	7
<b>MDC (Multi – Disciplinary Course): Mathematics</b>				
1	MAT	Algebra and Calculus	4	8
<b>IKS (Indian Knowledge System): Mathematics</b>				
1	MAT	History of Indian Mathematics	2	10
2	MAT	Problem Solving and Indic Mathematics – I	P-2	11
<b>Semester – II</b>				
<b>Major: Mathematics</b>				
1	MAT	Elementary Analysis and Differential Equations	L-3 + 1-P	12
2	MAT	Geometry	L-3 + 1-P	14
<b>Minor: Mathematics</b>				
1	MAT	Sequence, Series, Differential Equations and Geometry	4	15
<b>SEC (Skills Enhancement Course) Mathematics</b>				
1	MAT	Mathematics Practicals – II	P-2	17
<b>MDC (Multi – Disciplinary Course): Mathematics</b>				
1	MAT	Sequence, Serie Differential Equations and Geometry	4	19
<b>VAC (Value Added Course): Mathematics</b>				
1	MAT	Problem Solving and Indic Mathematics – II	P-2	21

## Syllabus for B. Sc. Semester – I, Mathematics

	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in			From Academic Year 2023-2024
<b>B.Sc. : Regular Programme</b>				
Year	I	<b>Major: Mathematics</b> <b>Paper – 1: Algebra and Number Theory</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2023	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Elementary operations and Elementary matrices, Rank of a matrix, Invariance of rank under elementary operations, Homogeneous and Non-homogeneous linear equations, Eigen values and Eigen vectors of a matrix, Orthogonality of eigen vectors associated with distinct eigen values, Properties of eigen vectors of a real symmetric matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes, Cayley-Hamilton theorem (without proof).			15 hrs
Unit – 2	Complex Numbers: Normal form and trigonometric form, De Moivre's theorem (Proof for rational index) and its applications, $n^{\text{th}}$ roots of a complex number, Statement of fundamental theorem of algebra, Multiple roots and test for multiplicity Relation between roots and coefficients, Imaginary roots of an equation with real coefficients, Descarte's rule of sign, Solution of cubic equations (Cardan's Method) and biquadratic equations (Ferrari's Method).			15 hrs
Unit – 3	Division algorithm, Greatest common divisor and least common multiple, Primes, composite numbers and their properties, Fundamental theorem of arithmetic, Euclid's Lemma, Congruences: Definitions and elementary properties, Results about linear congruence equations, Euler phi-function and examples.			15 hrs

Unit – 4	<p><b><u>Practicals on Matrices:</u></b></p> <ul style="list-style-type: none"> <li>• Problems on elementary matrices.</li> <li>• Problems of rank of a matrix.</li> <li>• Problems on linear system of equations.</li> <li>• Problems on Eigen values and Eigen vectors of a matrix.</li> <li>• Problems related to diagonalization of a symmetric matrix and its applications.</li> </ul> <p><b><u>Practicals on Theory of Equations:</u></b></p> <ul style="list-style-type: none"> <li>➤ Problems on De Moivre's theorem and its applications.</li> <li>➤ Problems on <math>n^{th}</math> - roots of complex numbers.</li> <li>➤ Problems on multiple roots of a polynomial.</li> <li>➤ Problems on the relation between roots and coefficients of a polynomial.</li> <li>➤ Problems on imaginary roots of an equation with real coefficients,</li> <li>➤ Examples using Cardan's Method and Ferrari's Method.</li> </ul> <p><b><u>Practicals on Number Theory:</u></b></p> <ul style="list-style-type: none"> <li>▪ Problems on division algorithm.</li> <li>▪ Problems on greatest common divisor and least common multiple.</li> <li>▪ Problems on congruences, linear congruence equations.</li> <li>▪ Problems related to Euler phi-function.</li> </ul>	30 hrs
<b>REFERENCES</b>		
1.	David Burton, Elementary Number Theory, Tata Mc Graw Hill Publishers, 2006.	
2.	J. N. Kapur and M. K. Singal, Matrices, R. Chand & Co., 1996	
3.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West	
4.	Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2005.	
5.	S. K. Patel, B. P. Patel, H. R. Kataria and B. L. Ghodadra, Calculus and Matrix Algebra, University Book Production Board, Gujarat State, 2015.	
6.	S. D. Telang, Number Theory, Tata Mc Graw Hill Publishers, 2004	
7.	J. V. Uspensky, Theory of Equations, Mc Graw Hill Publishers, 1948.	



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FROM  
 ACADEMIC  
 YEAR  
 2023 – 2024

**B.Sc. : Regular Programme**


Year	I	<b>Major: Mathematics</b> <b>Paper – 2: Calculus</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2023	Max marks / Grade	100

**COURSE CONTENT / SYLLABUS**


Unit – 1	Successive differentiation, Leibnitz’s theorem, Lagrange’s and Cauchy’s mean value theorems and their geometrical interpretations, Increasing decreasing functions.	15 hrs
Unit – 2	Indeterminate forms, L. Hospital’s rules (proof for 0/0 case only), Taylor’s and Maclaurin’s theorems (Lagrange’s form of remainder), Taylor’s polynomial and approximation, Power series expansion of $\sin x, \cos x, \exp(x)$ , for $x \in \mathbb{R}$ and of $(1 + x)^m, \log(1 + x)$ for $ x  < 1$ (Assuming the validity of expansions), Reduction formulas for $\int_0^{\pi/2} \sin^m x \, dx, \int_0^{\pi/2} \cos^m x \, dx, \int_0^{\pi/2} \sin^m x \cos^n x \, dx, m, n \in \mathbb{N}$ .	15 hrs
Unit – 3	Asymptotes, Curvature and radius of curvature for Cartesian curves, Curve tracing for $y = f(x)$ only, Arc length, Surface area.	15 hrs
Unit – 4	<b><u>Practicals on Calculus:</u></b> <ul style="list-style-type: none"> <li>• Problems on Successive differentiation.</li> <li>• Problems on Leibnitz’s theorem and Mean Value Theorems.</li> <li>• Problems on increasing decreasing functions,</li> <li>• Problems on L. Hospital’s rules.</li> <li>• Problems on power series expansion.</li> <li>• Problems on reduction formulas.</li> <li>• Problems on asymptotes, curvature and radius of curvature for cartesian curves, curve tracing, arc length, surface area.</li> </ul>	30 hrs


**REFERENCES**

1.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.
2.	Shanti Narayan, Differential Calculus, S. Chand & Co. Ltd, 1996
3.	Shanti Narayan, Integral Calculus, S. Chand & Co. Ltd, 1999.
4.	S. K. Patel, B. P. Patel, H. R. Kataria and B. L. Ghodadra, Calculus and Matrix Algebra, University Book Production Board, Gujarat State, 2015.
5.	V. M. Shah, Introductory Calculus, Acharya Book Depot, 1980
6.	G. B. Thomas Jr. and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley Publications, 1999

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<b>B.Sc. : Regular Programme</b>					
Year	I	<b>Minor: Mathematics Algebra and Calculus (4 Credits Theory)</b>		Credit / Hrs per week	4 / 4
Semester	I	Year of Introduction: 2023		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Elementary operations and Elementary matrices, Rank of a matrix, Invariance of rank under elementary operations, Homogeneous and Non-homogeneous linear equations, Eigen values and Eigen vectors of a matrix, Orthogonality of eigen vectors associated with distinct eigen values, Properties of eigen vectors of a real symmetric matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes, Cayley-Hamilton theorem (without proof).				15 hrs
Unit – 2	Complex Numbers: Normal form and trigonometric form, De Moivre's theorem (Proof for rational index) and its applications, $n^{\text{th}}$ roots of a complex number, Statement of fundamental theorem of algebra, Multiple roots and test for multiplicity Relation between roots and coefficients, Imaginary roots of an equation with real coefficients, Descartes's rule of sign, Solution of cubic equations (Cardan's Method) and biquadratic equations (Ferrari's Method).				15 hrs
Unit – 3	Successive differentiation, Leibnitz's theorem, Lagrange's and Cauchy's mean value theorems and their geometrical interpretations, Increasing decreasing functions.				15 hrs
Unit – 4	Indeterminate forms, L. Hospital's rules (Without proof), Taylor's and Maclaurin's theorems (without proof), Taylor's polynomial and approximation, Power series expansion of $\sin x, \cos x, \exp(x)$ , for $x \in \mathbb{R}$ and of $(1+x)^m, \log(1+x)$ for $ x  < 1$ (Assuming the validity of expansions), Reduction formulas for $\int_0^{\pi/2} \sin^m x dx, \int_0^{\pi/2} \cos^m x dx, \int_0^{\pi/2} \sin^m x \cos^n x dx, m, n \in \mathbb{N}$ . Asymptotes, Curvature and radius of curvature.				15 hrs
<b>REFERENCES</b>					
1.	J. N. Kapur and M. K. Singal, Matrices, R. Chand & Co., 1996				
2.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.				
3.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.				
4.	Shanti Narayan, Differential Calculus, S. Chand & Co. Ltd, 1996				
5.	Shanti Narayan, Integral Calculus, S. Chand & Co. Ltd, 1999.				

6.	Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2005.
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<b>B.Sc. : Regular Programme</b>					
Year	I	<b>SEC (Skills Enhancement Course) Mathematics Practicals – I</b>		Credits Hrs per week	2 / 4
Semester	I	Year of Introduction: 2023		Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	<b>Practical Problems on Matrices, Algebra, Number Theory and Calculus</b> Elementary operations and elementary matrices, Rank of a matrix, Row reduced Echelon form, Homogeneous and Non-homogeneous linear equations, Eigen values and Eigen vectors of a matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes.  Complex Numbers: Normal form and trigonometric form, De Moivre's theorem and its applications, $n^{\text{th}}$ roots of a complex number, Multiple roots, and test for multiplicity, Relation between roots and coefficients, Imaginary roots of an equation with real coefficients, Examples using Cardan's Method and Ferrari's Method.				30 hrs
Unit – 2	Successive differentiation, Leibnitz's theorem, Lagrange's and Cauchy's mean value theorems, Increasing decreasing functions, L. Hospital's rules, Taylor's and Maclaurin's theorems, Power series expansion, Reduction formulas, Asymptotes, curvature and radius of curvature.				30 hrs
<b>REFERENCES</b>					
1.	J. N. Kapur and M. K. Singal, Matrices, R. Chand & Co., 1996				
2.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.				
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<b>B.Sc. : Regular Programme</b>					
Year	I	<b>Multi – Disciplinary: Mathematics Algebra and Calculus (4 Credits Theory)</b>		Credit / Hrs per week	4 / 4
Semester	I	Year of Introduction: 2023		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Elementary operations and Elementary matrices, Rank of a matrix, Invariance of rank under elementary operations, Homogeneous and Non-homogeneous linear equations, Eigen values and Eigen vectors of a matrix, Orthogonality of eigen vectors associated with distinct eigen values, Properties of eigen vectors of a real symmetric matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes, Cayley-Hamilton theorem (without proof).				15 hrs
Unit – 2	Complex Numbers: Normal form and trigonometric form, De Moivre's theorem (Proof for rational index) and its applications, $n^{\text{th}}$ roots of a complex number, Statement of fundamental theorem of algebra, Multiple roots and test for multiplicity Relation between roots and coefficients, Imaginary roots of an equation with real coefficients, Descarte's rule of sign, Solution of cubic equations (Cardan's Method) and biquadratic equations (Ferrari's Method).				15 hrs
Unit – 3	Successive differentiation, Leibnitz's theorem, Lagrange's and Cauchy's mean value theorems and their geometrical interpretations, Increasing decreasing functions.				15 hrs
Unit – 4	Indeterminate forms, L. Hospital's rules (Without proof), Taylor's and Maclaurin's theorems (without proof), Taylor's polynomial and approximation, Power series expansion of $\sin x, \cos x, \exp(x)$ , for $x \in \mathbb{R}$ and of $(1+x)^m, \log(1+x)$ for $ x  < 1$ (Assuming the validity of expansions), Reduction formulas for $\int_0^{\pi/2} \sin^m x dx, \int_0^{\pi/2} \cos^m x dx, \int_0^{\pi/2} \sin^m x \cos^n x dx, m, n \in \mathbb{N}$ . Asymptotes, Curvature and radius of curvature.				15 hrs
<b>REFERENCES</b>					
1.	J. N. Kapur and M. K. Singal, Matrices, R. Chand & Co., 1996				
2.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.				
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From  
 Academic  
 Year  
 2023-2024

**B.Sc. : Regular Programme**


Year	I	<b>IKS (Indian Knowledge System): Mathematics History of Indian Mathematics (2 Credits Theory)</b>	Credit / Hrs per week	2 / 2
Semester	I	Year of Introduction: 2023	Max marks / Grade	50

**COURSE CONTENT / SYLLABUS**


Unit – 1	Ancient Indian mathematicians and their contribution: Lagadha, Bodhayana: Geometry in Sulbasutras, Expressions for surds in Sulbasutra texts, Methods for obtaining perpendicular bisectors, Bodhyana method for constructing square, The Bodhyana - Pythagorean theorem. Ancient number system, Square roots and cube roots, Suryasidhanta, Pingala and his Meruprastara (Pascal's triangle), Indian mathematicians after 5 <sup>th</sup> century AD: Aryabhata: Aryabhata's numeral system, square root and cube roots, value of $\pi$ , sine table.	15 hrs
Unit – 2	Varahamihira and his works, Brahmagupta: Pell's equation, Brahmagupta's identity, solution of linear, quadratic equations, cyclic quadrilateral. Bhaskaracharya (Bhaskara-II) and his treatise Lilavati. Area of triangle, circle, volume of cube, Area and volume of sphere, Trigonometric results. Madhavacharya and his works. Modern mathematicians.	15 hrs

**REFERENCES**

1.	Ramakalyani V, and ita Sunder Ram, History and Development of Mathematics in India, Samiksika Series 16, 2022.
2.	B. Datta and A. N. Singh, History of Hindu Mathematics, Parts I and II, Asia Publishing House, 1962
3.	Howard Eve, An introduction to the history of mathematics, Saunders College Publishing, 1983
4.	B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R. N., Introduction to Indian Knowledge System, Concepts and Applications, PHI Learning Private Ltd., 2022.


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<b>B.Sc. : Regular Programme</b>					
Year	I	<b>IKS (Indian Knowledge System): Mathematics Problem Solving and Indic Mathematics – I</b>		Credits Hrs per week	2 / 4
Semester	I	Year of Introduction: 2023		Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	<b>Practical Problems on Matrices, Algebra, Number Theory and Calculus</b> Elementary operations and elementary matrices, Rank of a matrix, Row reduced Echelon form, Homogeneous and Non-homogeneous linear equations, Eigen values and Eigen vectors of a matrix, Diagonalization of a symmetric matrix, application to reductions of quadrics to principal axes.  Complex Numbers: Normal form and trigonometric form, De Moivre's theorem and its applications, $n^{\text{th}}$ roots of a complex number, Multiple roots, and test for multiplicity, Relation between roots and coefficients, Imaginary roots of an equation with real coefficients, Examples using Cardan's Method and Ferrari's Method.				30 hrs
Unit – 2	Successive differentiation, Leibnitz's theorem, Lagrange's and Cauchy's mean value theorems, Increasing decreasing functions, L. Hospital's rules, Taylor's and Maclaurin's theorems, Power series expansion, Reduction formulas, Asymptotes, curvature and radius of curvature.				30 hrs
<b>REFERENCES</b>					
1.	J. N. Kapur and M. K. Singal, Matrices, R. Chand & Co., 1996				
2.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.				
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## Syllabus for B. Sc. Semester – II, Mathematics

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<b>B.Sc. : Regular Programme</b>				
Year	I	<b>Major: Mathematics</b> <b>Paper – 1: Elementary Analysis and Differential Equations</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2023	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Sequences, bounded and unbounded sequences, convergent sequences, algebra of convergent sequences, convergence of monotonic real sequences, Cauchy criterion for convergence of real sequences, convergence and divergence of infinite series, series of positive terms, Comparison test, integral test, alternating series, absolute convergence, ratio test and root test (statements only of test and their applications).			15 hrs
Unit – 2	Graphical representation of subsets of $\mathbb{C}$ . Geometrical significance of complex functions: $z + \beta$ , $az$ , $z$ , $\bar{z}$ , $\frac{1}{z}$ , $Re(z)$ , $Im(z)$ , $ z $ and $az + \beta$ , exponential, trigonometric, hyperbolic and logarithmic functions of complex variable and their elementary properties.			15 hrs
Unit – 3	Differential equations of first order and first degree: Geometric interpretation of first order equations, Isoclines, Bernoulli's equation, Exact differential equations, Integrating factors, Applications of first order equations: mixture problem, orthogonal trajectories. Linear differential equations of higher order, Linear independence, Fundamental theorem (without proof), Differential operators, Homogeneous and non-homogeneous linear differential equations with constant coefficients, Inverse operators, Operational methods for solving linear differential equations, Euler form of linear differential equations with variable coefficients.			15 hrs
Unit – 4	<p><b><u>Practicals on Sequence and Series:</u></b></p> <ul style="list-style-type: none"> <li>• Problems on sequences.</li> <li>• Problems on infinite series and series of positive terms.</li> <li>• Problems on comparison test, integral test, alternating series, absolute convergence, ratio test and root test.</li> </ul> <p><b><u>Practicals on subsets of the set of complex numbers and functions of complex variable:</u></b></p> <p>➤ Problems on subsets of the set of complex numbers, <math>\mathbb{C}</math>.</p>			30 hrs

	<p>➤ Problems related to complex functions: <math>z + \beta</math>, <math>\alpha z</math>, <math>z</math>, <math>\bar{z}</math>, <math>\frac{1}{z}</math>, <math>Re(z)</math>, <math>Im(z)</math>, <math> z </math> and <math>\alpha z + \beta</math>.</p> <p>➤ Problems on elementary complex functions: The exponential, trigonometric, hyperbolic and logarithmic functions of complex variable.</p> <p><b><u>Practicals on Differential Equations:</u></b></p> <ul style="list-style-type: none"> <li>▪ Problems on differential equations of first order and first degree.</li> <li>▪ Problems on Bernoulli's equation.</li> <li>▪ Problems on exact differential equations and integrating factors.</li> <li>▪ Applications of first order equations.</li> <li>▪ Problems on differential operators and inverse operators.</li> <li>▪ Problems on operational methods for solving linear differential equations.</li> <li>▪ Problems on Euler form of linear differential equations.</li> </ul>	
<b>REFERENCES</b>		
1.	Zafar Ahsan, Differential Equations and their Applications, Prentice Hall of India, 2004.	
2.	R. V. Churchill and J. W Brown, Complex variable and applications, Mc Graw Hill Publishing Company, 2009.	
3.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.	
4.	Wilfred Kaplan, Elements of Differential Equations, Addison-Wesley Publishing Co., 1964.	
5.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.	
6.	Shanti Narayan, Integral Calculus, S. Chand & Co. Ltd., 1999.	

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<b>B.Sc. : Regular Programme</b>					
Year	I	<p align="center"><b>Major Mathematics Paper – 2: Geometry</b> (3 Credits Theory and 1 Credit Practicals)</p>		Credit / Hrs per week	3 / 3 & 1 / 2
Semest	II	Year of Introduction: 2023		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Polar co-ordinate system, relations between polar and Cartesian coordinates, graphs of polar equations, aids in graphing polar equations, special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics. Definition of a sphere, general equation of a sphere, sphere through four given points, plane section of a sphere.				15 hrs
Unit – 2	Intersection of two spheres, sphere through a given circle, intersection of a sphere and a line, tangent plane to a sphere. Definition of a cone, equation of a cone with a conic as guiding curve, quadric cones with vertex at origin and homogeneous equation in x, y and z. Definition of right circular cone, equation of right circular cone.				15 hrs
Unit – 3	Definition of a cylinder, equation of a cylinder with generators parallel to a given line and intersecting a conic. Definition of a right circular cylinder, equation of a right circular cylinder. Definition of a conicoid, central conicoids, identification and properties of standard quadrics namely ellipsoids, hyperboloids of one sheet, hyperboloids of two sheets, elliptic paraboloids and hyperbolic paraboloids. Spherical and cylindrical coordinates of space points and their relationship with Cartesian coordinates.				15 hrs
	<p><b><u>Practicals on Geometry:</u></b></p> <ul style="list-style-type: none"> <li>• Problems on polar co-ordinate system.</li> <li>• Problems on special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics.</li> <li>• Problems on sphere.</li> <li>• Problems on cone.</li> <li>• Problems on right circular cone.</li> <li>• Problems on central conicoids.</li> <li>• Problems on spherical and cylindrical coordinates of space points.</li> </ul>				30 hrs
<b>REFERENCES</b>					
1.	P. Balasubramanyam, K. G. Subramaniam and G.R. Venkatraman, Coordinate Geometry of Two and Three Dimension, Tata Mc Graw Hill Publ. Co., 1994.				
2.	Gordon Fuller and Robert M. Parker, Analytic Geometry and Calculus, East-West Press Pvt. Ltd., 1967.				
3.	Shanti Narayan, Analytic Solid Geometry, S. Chand & Co. Ltd., 1988.				

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<b>B.Sc. : Regular Programme</b>					
Year	I	<p align="center"><b>Minor: Mathematics</b>  <b>Sequence, Series, Differential Equations and Geometry</b>  (4 Credits Theory)</p>		Credit / Hrs per week	4 / 4
Semester	II	Year of Introduction: 2023		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Sequences, bounded and unbounded sequences, convergent sequences, algebra of convergent sequences, convergence of monotonic real sequences, Cauchy criterion for convergence of real sequences, convergence and divergence of infinite series, series of positive terms, Comparison test, integral test, alternating series, absolute convergence, ratio test and root test (statements only of test and their applications).				15 hrs
Unit – 2	Differential equations of first order and first degree: Geometric interpretation of first order equations, Isoclines, Bernoulli's equation, Exact differential equations, Integrating factors, Applications of first order equations: mixture problem, orthogonal trajectories. Linear differential equations of higher order, Linear independence, Fundamental theorem (without proof), Differential operators, Homogeneous and non-homogeneous linear differential equations with constant coefficients, Inverse operators, Operational methods for solving linear differential equations, Euler form of linear differential equations with variable coefficients.				15 hrs
Unit – 3	Polar co-ordinate system, relations between polar and Cartesian coordinates, graphs of polar equations, aids in graphing polar equations, special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics. Definition of a sphere, general equation of a sphere, sphere through four given points, plane section of a sphere. Definition of a cone, equation of a cone with a conic as guiding curve, quadric cones with vertex at origin and homogeneous equation in x, y and z.				15 hrs
Unit – 4	Definition of right circular cone, equation of right circular cone. Definition of a cylinder, equation of a cylinder with generators parallel to a given line and intersecting a conic. Definition of a right circular cylinder, equation of a right circular cylinder. Definition of a conicoid, central conicoids, identification and properties of standard quadrics namely ellipsoids, hyperboloids of one sheet, hyperboloids of two sheets, elliptic paraboloids and hyperbolic paraboloids. Spherical and cylindrical coordinates of space points and their relationship with Cartesian coordinates.				15 hrs

## REFERENCES

1.	Zafar Ahsan, Differential Equations and their Applications, Prentice Hall of India, 2004.
2.	P. Balasubramanyam, K. G. Subramaniam and G.R. Venkatraman, Coordinate Geometry of Two and Three Dimension, Tata Mc Graw Hill Publ. Co., 1994.
3.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
4.	Gordon Fuller and Robert M. Parker, Analytic Geometry and Calculus, East-West Press Pvt. Ltd., 1967.
5.	Wilfred Kaplan, Elements of Differential Equations, Addison-Wesley Publishing Co., 1964.
6.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.
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FROM  
 ACADEMIC  
 YEAR  
 2023 – 2024

**B.Sc.: Regular Program**


Year	I	<b>SEC (Skill Enhancement course) Mathematics Practicals – II</b>	Credit / Hrs per week	2 / 4
Semester	II	Year of Introduction: 2023	Max marks/ Grade	50

**COURSE CONTENT / SYLLABUS**

Unit – 1	<p><b>Practical Problems on Elementary Analysis, Differential Equations and Geometry:</b>          Sequences, bounded and unbounded sequences, convergent sequences, convergence of monotonic real sequences, convergence and divergence of infinite series, series of positive terms, Comparison test, integral test, alternating series, absolute convergence, ratio test and root test.</p> <p>Differential equations of first order and first degree, Bernoulli's equation, Exact differential equations, Integrating factors, Applications of first order equations: mixture problem, orthogonal trajectories. Linear differential equations of higher order, Linear independence.</p> <p>Differential operators, Inverse operators, Operational methods for solving linear differential equations, Euler form of linear differential equations with variable coefficients.</p>	30 hrs
Unit – 2	<p>Polar co-ordinate system, special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics.          General equation of a sphere, sphere through four given points, plane section of a sphere.</p> <p>Equation of a cone with a conic as guiding curve, quadric cones with vertex at origin and homogeneous equation in x, y and z.</p> <p>Equation of right circular cone. Equation of a cylinder with generators parallel to a given line and intersecting a conic, right circular cylinder.</p> <p>Central conicoids, Spherical and cylindrical coordinates of space points and their relationship with Cartesian coordinates.</p>	30 hrs

## REFERENCES

1.	Zafar Ahsan, Differential Equations and their Applications, Prentice Hall of India, 2004.
2.	P. Balasubramanyam, K. G. Subramaniam and G.R. Venkatraman, Coordinate Geometry of Two and Three Dimension, Tata Mc Graw Hill Publ. Co., 1994.
3.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
4.	Gordon Fuller and Robert M. Parker, Analytic Geometry and Calculus, East-West Press Pvt. Ltd., 1967.
5.	Wilfred Kaplan, Elements of Differential Equations, Addison-Wesley Publishing Co., 1964.
6.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.
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<b>B.Sc. : Regular Programme</b>						
Year	I	<p align="center"><b>Multi – Disciplinary: Mathematics</b>  <b>Sequence, Series, Differential Equations and Geometry</b>  (4 Credits Theory)</p>			Credit / Hrs per week	4 / 4
Semester	II	Year of Introduction: 2023			Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>						
Unit – 1	Sequences, bounded and unbounded sequences, convergent sequences, algebra of convergent sequences, convergence of monotonic real sequences, Cauchy criterion for convergence of real sequences, convergence and divergence of infinite series, series of positive terms, Comparison test, integral test, alternating series, absolute convergence, ratio test and root test (statements only of test and their applications).					15 hrs
Unit – 2	Differential equations of first order and first degree: Geometric interpretation of first order equations, Isoclines, Bernoulli's equation, Exact differential equations, Integrating factors, Applications of first order equations: mixture problem, orthogonal trajectories. Linear differential equations of higher order, Linear independence, Fundamental theorem (without proof), Differential operators, Homogeneous and non-homogeneous linear differential equations with constant coefficients, Inverse operators, Operational methods for solving linear differential equations, Euler form of linear differential equations with variable coefficients.					15 hrs
Unit – 3	Polar co-ordinate system, relations between polar and Cartesian coordinates, graphs of polar equations, aids in graphing polar equations, special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics. Definition of a sphere, general equation of a sphere, sphere through four given points, plane section of a sphere. Definition of a cone, equation of a cone with a conic as guiding curve, quadric cones with vertex at origin and homogeneous equation in x, y and z.					15 hrs
Unit – 4	Definition of right circular cone, equation of right circular cone. Definition of a cylinder, equation of a cylinder with generators parallel to a given line and intersecting a conic. Definition of a right circular cylinder, equation of a right circular cylinder. Definition of a conicoid, central conicoids, identification and properties of standard quadrics namely ellipsoids, hyperboloids of one sheet, hyperboloids of two sheets, elliptic paraboloids and hyperbolic paraboloids. Spherical and cylindrical coordinates of space points and their relationship with Cartesian coordinates.					15 hrs

## REFERENCES

1.	Zafar Ahsan, Differential Equations and their Applications, Prentice Hall of India, 2004.
2.	P. Balasubramanyam, K. G. Subramaniam and G.R. Venkatraman, Coordinate Geometry of Two and Three Dimension, Tata Mc Graw Hill Publ. Co., 1994.
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4.	Gordon Fuller and Robert M. Parker, Analytic Geometry and Calculus, East-West Press Pvt. Ltd., 1967.
5.	Wilfred Kaplan, Elements of Differential Equations, Addison-Wesley Publishing Co., 1964.
6.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.
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FROM  
 ACADEMIC  
 YEAR  
 2023 – 2024

**B.Sc.: Regular Program**

Year	I	<b>VAC (Value Added Course) Problem Solving and Indic Mathematics – II</b>	Credit / Hrs per week	2 / 4
Semester	II	Year of Introduction: 2023	Max marks/ Grade	50

**COURSE CONTENT / SYLLABUS**

Unit – 1	<p><b>Practical Problems on Elementary Analysis, Differential Equations and Geometry:</b>          Sequences, bounded and unbounded sequences, convergent sequences, convergence of monotonic real sequences, convergence and divergence of infinite series, series of positive terms, Comparison test, integral test, alternating series, absolute convergence, ratio test and root test.</p> <p>Differential equations of first order and first degree, Bernoulli's equation, Exact differential equations, Integrating factors, Applications of first order equations: mixture problem, orthogonal trajectories. Linear differential equations of higher order, Linear independence.</p> <p>Differential operators, Inverse operators, Operational methods for solving linear differential equations, Euler form of linear differential equations with variable coefficients.</p>	30 hrs
Unit – 2	<p>Polar co-ordinate system, special types of equations: limacon, rose curves, and lemniscates, polar equations of lines, circles and conics.          General equation of a sphere, sphere through four given points, plane section of a sphere.</p> <p>Equation of a cone with a conic as guiding curve, quadric cones with vertex at origin and homogeneous equation in x, y and z.</p> <p>Equation of right circular cone. Equation of a cylinder with generators parallel to a given line and intersecting a conic, right circular cylinder.</p> <p>Central conicoids, Spherical and cylindrical coordinates of space points and their relationship with Cartesian coordinates.</p>	30 hrs

## REFERENCES


1.	Zafar Ahsan, Differential Equations and their Applications, Prentice Hall of India, 2004.
2.	P. Balasubramanyam, K. G. Subramaniam and G.R. Venkatraman, Coordinate Geometry of Two and Three Dimension, Tata Mc Graw Hill Publ. Co., 1994.
3.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
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5.	Wilfred Kaplan, Elements of Differential Equations, Addison-Wesley Publishing Co., 1964.
6.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.
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**Department of Mathematics**  
**Faculty of Science, The Maharaja Sayajirao University of Baroda**


Sr. No.	Course Code	Course Title	Credits	
<b>Semester – III</b>				
<b>Major</b>				
1	MAT	Linear Algebra	T-3 + P – 1	
2	MAT	Multivariate Differential Calculus and its Applications	T-3 + P – 1	
3	MAT	Differential Equations and its applications	T-3 + P – 1	
<b>MDC (Multi – Disciplinary Course) For any Students</b>				
1	MAT	Graph Theory	T-3 + P – 1	
<b>MDC (Multi – Disciplinary Course) For Non – Mathematics Students</b>				
1	MAT	Multivariate Differential and Integral Calculus	T-3 + P – 1	
<b>SEC (Skills Enhancement Course): Mathematics</b>				
1	MAT	Numerical Analysis – I	T-1 + P – 1	
<b>IKS (Indian Knowledge System): Mathematics</b>				
1	MAT	Trigonometry	T – 2	
<b>Semester – IV</b>				
<b>Major: Mathematics</b>				
1	MAT	Group Theory – I	T-3 + P – 1	
2	MAT	Multivariate Integral Calculus and its Applications	T-3 + P – 1	
3	MAT	C++ Programming – I	T-2 + P – 2	
<b>Minor (For non – Mathematics)</b>				
1	MAT	Group Theory and Linear Algebra	T-3 + P-1	
<b>SEC (Skills Enhancement Course)</b>				
1	MAT	Numerical Analysis – II	T-1 + P-1	
<b>VAC (Value Added Course)</b>				
1	MAT	Latex: Introduction to Scientific Writing	T-1 + P-1	


## Syllabus for B. Sc. Semester – III


	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in			FROM ACADEMIC YEAR 2024 – 2025
<b>B.Sc. : Regular Programme</b>				
Year	II	<b>Major : Mathematics</b> <b>Paper – I : Linear Algebra</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2024	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Definition of a field and examples, Vector spaces over a field and elementary consequences of its axioms, Subspaces, Linear span, Quotient spaces, Internal and external direct sum of vector space.			15 hrs
Unit – 2	Linear dependence and Independence, Properties of linearly independent vectors, Basis and its existence, Dimension of a vector space. Inner product spaces, Schwarz inequality, Orthogonal complement and orthonormal sets, Gram Schmidt orthogonalization process and examples.			15 hrs
Unit – 3	Linear transformations. Range and Kernel of a linear map, Rank-Nullity theorem, The space of linear transformations, Composition of linear transformations, Matrix associated with a linear map and linear map associated with a matrix.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units.			30 hrs
<b>REFERENCES</b>				
1.	C. W. Curtis, Linear Algebra, Springer, 1984.			
2.	I. N. Herstein, Topics in Algebra, 2 <sup>nd</sup> Edition, Wiley Publication, 2017.			
3.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.			
4.	Serge Lang, Introduction to Linear Algebra, Springer, 1986.			
5.	I. K. Rana, An Introduction to Linear Algebra, Ane Books Pvt. Ltd, 2010.			

	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in			FROM ACADEMIC YEAR 2024 – 2025
	<b>B.Sc. : Regular Programme</b>			
Year	II	<b>Major : Mathematics</b> <b>Paper-II : Multivariate Differential Calculus and its Applications</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2024	Max Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Domain and range of multivariate functions, Limit, Continuity and Partial derivatives of multivariate functions and its higher derivatives, Equality of mixed partial derivatives of order two. Differentiability: Definition and examples.			15 hrs
Unit – 2	Total differentials and Approximation, Chain rule, Gradient of scalar fields, Curl and Divergence of vector fields, Directional derivatives, Equation of tangent plane and normal line of surfaces, Tangent line of a space curve.			15 hrs
Unit – 3	Euler's theorem on homogeneous function and its converse, Jacobian matrix and its properties, Implicit differentiation, Taylor's theorem. Maxima-Minima of multivariate functions, Second derivative test for local extrema, Method of Lagrange multiplier, Envelopes of family of plane curves and of family of surfaces.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units			30 hrs
<b>REFERENCES</b>				
1.	Tom Apostol, Calculus (Volume II), Wiley Eastern Ltd, 1980.			
2.	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons Inc, 1983.			
3.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.			
4.	G. B. Thomas Jr. and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley Publishers, 1999.			
5.	David V. Widder, Advanced Calculus, Prentice-Hall of India, 1989.			
6.	Shanti Narayan and P. K. Mittal, Differential Calculus, S.Chand and Company Ltd.			

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	<b>B.Sc. : Regular Programme</b>				
Year	II	<p align="center"><b>Major: Mathematics</b>  <b>Paper – II : Differential Equations and its Applications</b>  (3 Credits Theory and 1 Credit Practicals)</p>		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2024		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Differential equations of first order and degree > 1: Equations solvable for $p$ , $x$ and $y$ , Lagrange's equations, Clairaut's equations, Singular locus and singular solutions. System of linear differential equations with constant coefficients. Application of system of linear differential equations with constant coefficients to Mechanics, Electric circuits and Mixture problems.				15 hrs
Unit – 2	Simultaneous differential equations of form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ : Geometrical interpretation and methods of solving. Pfaffian differential equations in three variables: Necessary and sufficient conditions for Integrability and methods of solving.				15 hrs
Unit – 3	The Laplace transform, properties of Laplace transform, Laplace transform of unit step function and periodic functions, Inverse Laplace transform, The convolution, Solution of linear differential equation and system of linear differential equation using Laplace transform.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	Shepley L. Ross, Differential Equations, John Wiley and Sons, 2004.				
2.	Zafar Ahsan, Differential Equations and their applications, Prentice-Hall of India, 2004.				
3.	M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand and Company Ltd., 2006.				
4.	William E. Boyce and Richard C. Di Prima, Elementary Differential Equations and Boundary Value Problems, John Wiley and Sons Inc., 2003.				
5.	T. Amarnath, An elementary course in partial differential equations, Narosa Publ. Co, 2000.				
6.	Ian Sneddon, Elements of Partial Differential Equations, Mc Graw Hill International, 1972.				

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<b>B.Sc. :Regular Programme</b>					
Year	II	<b>Multi – Disciplinary Course (MDC) : Mathematics  Graph Theory</b> (3 Credits Theory and 1 Credit Practicals)		Credit /Hrs Per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2024		Max marks/ Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit–1	Elementary properties of graphs, Applications of graphs, Isomorphism of graphs, Subgraphs, Walks, Paths and circuits, Connected graphs disconnected graphs and components, Euler graphs, Operations on graphs, Hamiltonian circuits. Definition and properties of tree, Centers in a tree, Rooted and Binary tree. Spanning trees, Fundamental circuits, cut set and its properties.				15 hrs
Unit – 2	Planar graphs and Kuratowski's two graphs, Representation of planar graphs, Geometric dual, combinatorial dual. Chromatic number, chromatic partitioning, chromatic polynomial, matchings.				15 hrs
Unit–3	Four – Color Problem. Incidence matrix for a graph, sub – matrices and subgraphs, circuit matrix, fundamental circuit matrix and rank of circuit matrix, cut – set matrix, relationship between incidence matrix fundamental circuit matrix and cut – set matrix.				15 hrs
Unit–4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.				
2.	Narsingh Deo, Graph theory with applications to Engineering and Computer Science, Prentice-Hall of India, 1993.				
3.	Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2 <sup>nd</sup> Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.				
4.	J. P. Trembley and R. Manohar, Discrete Mathematical Structure with applications to Computer Science, McGraw Hill Book Company, 2001.				

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<b>B.Sc. : Regular Programme</b>					
Year	II	<b>Multi – Disciplinary Course (MDC) : Mathematics  (For Students other than Mathematics Major)  Multivariate Differential and Integral Calculus  (3 Credits Theory and 1 Credit Practicals)</b>		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2024		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Domain and range of multivariate functions, Limit, Continuity and Partial derivatives of multivariate functions and its higher derivatives. Equality of mixed partial derivatives of order two (without proof). Differentiability, Total differentials and Approximation, Chain rule (without proof).				15 hrs
Unit – 2	Euler's theorem on homogeneous function and its converse. Taylor's theorem and examples. Maxima-Minima of multivariate functions, Second derivative test for local extrema, Method of Lagrange multiplier. Double Integrals: Definition, properties and evaluation as Iterated integrals, Change of order, change of variables, application to area and volume.				15 hrs
Unit – 3	Triple Integrals: Definition and evaluation. Application to volume. Line integrals: Definition, properties and evaluation, The Green's theorem in plane (proof for special regions), Path independence. Surface integrals: Definition and evaluation, Application to surface area and mass.				15 hrs
Unit –4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	David V. Widder, Advanced Calculus, Prentice-Hall of India, 1989.				
2.	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons Inc, 1983.				
3.	G. B. Thomas Jr. and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley Publishers, 1999.				
4.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.				
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<b>B.Sc. : Regular Programme</b>				
Year	II	<b>Skill Enhancement Course (SEC) : Mathematics</b> <b>Numerical Analysis – I</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	I	Year of Introduction: 2024	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Errors in Numerical Calculation, Solution of an equation in one variable: Bisection method, Regula – Falsi method, Newton – Raphson’s method and General iteration method. Convergence and order of convergence for these methods. Solution of linear system of equations: Gauss elimination method, Crout’s method and Gauss–Seidel iterative method. Solution of nonlinear system of equations: Newton–Raphson’s method. Numerical solution of ordinary differential equation (order one with initial conditions): Picard’s method, Runge–Kutta methods – 2 <sup>nd</sup> Order and classical 4 <sup>th</sup> order methods.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit			30 hrs
<b>REFERENCES</b>				
1.	S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India, 2006.			
2.	H. C. Saxena, Finite Differences and Numerical Analysis, S. Chand and Co, 2005.			
3.	P. C. Biswal, Numerical Analysis, Prentice-Hall of India, 2008.			



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FROM  
ACADEMIC  
YEAR  
2024 – 2025

**B.Sc. : Regular Programme**

Year	II	<b>IKS: Mathematics</b> <b>Trigonometry</b> (2 Credits Theory)	Credit / Hrs per week	1 / 1
Semester	I	Year of Introduction: 2024	Max marks / Grade	50

**COURSE CONTENT / SYLLABUS**


Unit – 1	Trigonometric functions, Trigonometric function values and angle measures, Radian Measure, The unit circle and Sine, Cosine functions, Graphs of the Sine, Cosine, Tangent, Cotangent, Secant and Cosecant Functions.	15 hrs
Unit – 2	Fundamental Identities, Verifying trigonometric identities, sum and difference identities, double – angle and half – angle identities, trigonometric equations.	15 hrs


**REFERENCES**


1.	M. Dugopolski, Trigonometry, 5 <sup>th</sup> Edition, Pearson, 2020
2.	M. L. Lial, J. Hornsby, D. I. Schneider, C. J. Daniels, College Algebra and Trigonometry, 6 <sup>th</sup> Edition, Pearson, 2017.*


## Syllabus for Semester - IV


	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in			FROM ACADEMIC YEAR 2024 – 2025
<b>B.Sc. : Regular Programme</b>				
Year	II	<b>Major : Mathematics</b> <b>Paper – I : Group Theory – I</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2024	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Equivalence relation and equivalence class, congruence modulo $n$ , Definition and examples of groups, Elementary properties of a group, finite groups and their tables, Subgroups.			15 hrs
Unit – 2	Centralizers and normalizers, Subgroups generated by a set, Cyclic groups, order of an element. Coset, Lagrange's theorem and its applications, Fermat's Theorem, Euler's Theorem,			15 hrs
Unit – 3	Homomorphisms and isomorphisms, Permutation group, symmetries of equilateral triangle, rectangle, circle, square, transposition & cycles, Even & Odd permutations, Alternating Groups $A_n$ , Cayley's theorem			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units			30 hrs
<b>REFERENCES</b>				
1.	Michael Artin, Algebra, Prentice Hall of India, 1994.			
2.	G. Birkhoff and S. MacLane, A Survey of Modern Algebra, University Press, 2003.			
3.	J. B. Fraleigh, A First Course in Abstract algebra, Pearson Education, Inc., 2006.			
4.	J. A. Gallien, Contemporary Abstract Algebra, Narosa Publishing House, 1998.			
5.	N. S. Gopalakrishnan, University Algebra, New Age International Pvt. Ltd., 2004.			
6.	I. N. Herstein, Topics in Algebra, 2 <sup>nd</sup> Edition, Wiley Publication, 2017.			
7.	I. H. Sheth, Abstract Algebra, Prentice Hall of India, 2009.			

	<p align="center"><b>The Maharaja Sayajirao University of Baroda</b>  Faculty of Science, Department of Mathematics,  Sayajigunj, Vadodara 390002, Phone: 0265-2795329,  head-math@msubaroda.ac.in</p>			<p align="center">FROM  ACADEMIC  YEAR  2024 – 2025</p>	
	<b>B.Sc. : Regular Programme</b>				
Year	II	<p align="center"><b>Major : Mathematics</b>  <b>Paper–II : Multivariate Integral Calculus and its Applications</b>  (3 Credits Theory and 1 Credit Practicals)</p>		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2024		Max marks Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Double Integrals: Definition, properties and evaluation as Iterated integrals, Change of order, change of variables, applications to Area, Surface area and Volume. Gamma function and Beta Function: Definitions, properties, Duplication formula, relation between them and examples.				15 hrs
Unit – 2	Triple Integrals: Definition, properties and evaluation, Change of order, change of variables. Dritchlet's Theorem and Liouville's extension of Dritchlet's Theorem. Applications to Volume, Mass and Center of Mass. Line integrals: Definition, properties and evaluation, The Green's theorem in plane (proof for special regions), Path independence.				15 hrs
Unit – 3	Applications of Line Integral: Work done by a Force, Fluid's flow along the curve and Flux across a plane curve. Surface integrals: Definition and evaluation. Application to surface area, mass and flux. The Stoke's theorem and its applications. The Gauss' Divergence theorem and its applications.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons Inc, 1983.				
2.	G. B. Thomas Jr. and R. L. Finney, Calculus and Analytic Geometry, Addison-Wesley Publishers, 1999.				
3.	Louis Leithold, The Calculus with Analytic Geometry, Harper-Collins Publishers, 1981.				
4.	Shanti Narayan and P. K. Mittal, Integral Calculus, S.Chand and Company Ltd.				

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	<b>B.Sc. : Regular Programme</b>			
Year	II	<b>Major : Mathematics</b> <b>Paper – III : C++ Programming – I</b> (2 Credits Theory and 2 Credit Practicals)	Credit / Hrs per week	2 / 2 & 2 / 4
Semester	II	Year of Introduction: 2024	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Definition of preliminary language constructs, Keywords, Identifiers and Constants, Basic Data types, Variables, declaration of variables, Operators: Special, arithmetic, relational, logical, input and output, Precedence of operators. Simple and formatted input/output, expressions and statements. Library functions, Header files. Control statements: Selection: if, if-else, and switch statements. Loops: while, do-while, for. Arrays: One and two dimensional arrays, processing arrays, initializing an array.			15 hrs
Unit – 2	Functions: declaration and definition, types of functions, local and global variables, , Default arguments, Functions and arrays, Function overloading, Reference operator, passing arguments to functions by value and by reference, address operator, Pointers, Pointers and arrays, Pointers and functions.			15 hrs
Unit – 3	Relevant Practical (programs) based on the topics from unit-1 including numerical methods for solving an equation.			30 Hrs
Unit – 4	Relevant Practical (programs) based on the topics from unit-2 including numerical methods for solving Initial value problem using Runge – Kutta method of second order and fourth order.			30 hrs
<b>REFERENCES</b>				
1.	E Balagurusamy, Object Oriented Programming with C++, Tata McGraw-Hill Publishing Company Ltd., 2020			
2.	John R. Hubbard, Programming with C++ , McGraw Hill international Edition 2000.			
3.	Robert Lafore, Object Oriented programming in Turbo C++, Galgotia Publications Pvt. Ltd, 2009.			

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<b>B.Sc. : Regular Programme</b>					
Year	II	<b>Minor: Mathematics</b> <b>(For students other than Mathematics Major)</b> <b>Group Theory and Linear Algebra</b> (3 Credits Theory and 1 Credit Practicals)		Credit / Hrs Per week	3/ 3 & 1 / 2
Semester	II	Year of Introduction: 2024		Max marks/ Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit–1	Binary relation, equivalence relation and equivalence class, congruence modulo $n$ . Definition of a binary operation, properties of binary operation, definition of a group and examples of group, elementary properties of a group, subgroups, cyclic groups, order of an element, cosets, Lagrange's theorem (without proof). Definition of vector spaces (Real/Complex) and elementary consequences of its axioms.				15 hrs
Unit – 2	Definition of a subspace, necessary and sufficient condition for a non-empty set to be a subspace, definition of span of a set and properties of span of a set, intersection and direct sum of subspaces, definition of linear dependence and independence and results related to it. Definition of basis, dimension and results related to it. Inner product in $\mathbb{C}^n$ .				15 hrs
Unit–3	Length of a vector and angle between two vectors, Schwarz inequality. Orthogonality and Gram-Schmidt orthogonalization process. Orthonormal basis. Definition of linear transformation and its properties, range and kernel of a linear map, Rank-Nullity Theorem (without proof), matrix associated with a linear map and linear map associated with a matrix.				15 hrs
Unit–4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	I. N. Herstein, Topics in Algebra, 2 <sup>nd</sup> Edition, Wiley Publication, 2017.				
2.	Kenneth Hoffman and Ray Kunze, Linear Algebra, Prentice-Hall of India, 2 <sup>nd</sup> ed, 2009.				
3.	V. Krishnamurthy, V. P. Mainra & J. L. Arora, An Introduction to Linear Algebra, East-West Press, 2001.				
4.	I. H. Sheth, Abstract Algebra, Prentice Hall of India, 2009.				

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	<b>B.Sc. : Regular Programme</b>			
Year	II	<b>Skill Enhancement Course (SEC): Mathematics</b> <b>Numerical Analysis – II</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2024	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Interpolation: Ordinary differences, Newton’s forward and backward interpolation formulas. Divided differences, Newton’s divided difference interpolation and Lagrange’s interpolation formulas, Central difference, Gauss’s and Stirling’s central difference interpolation. Error analysis of interpolation, Numerical differentiation by Newton’s Forward, Backward and Stirling’s formula. General quadrature and derivation of Trapezoidal, Simpson’s $\frac{1}{3}$ rd and $\frac{3}{8}$ th, Weddle’s rules.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit			30 hrs
<b>REFERENCES</b>				
1.	P. C. Biswal, Numerical Analysis, Prentice-Hall of India, 2008.			
2.	S. S. Sastry, Introductory methods of Numerical Analysis, Prentice-Hall of India, 2006.			
3.	H. C. Saxena, Finite differences and Numerical Analysis, S. Chand and Co., 2005.			
4.	J. N. Sharma, Numerical Methods for Engineers and Scientists, Narosa Publishing House, 2008.			


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<b>B.Sc. : Regular Programme</b>					
Year	II	<b>Value Added Course (VAC): Mathematics *</b> <b>Latex : An Introduction to Scientific Writing</b> (1 Credit Theory and 1 Credit Practicals)		Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2024		Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	<p><b>The Basics:</b> Installing LaTeX software and Editor, Creating, opening, saving and compiling documents.</p> <p><b>The Document Preparation:</b> Simple typesetting – Fonts, Type size, Document classes, Page style, Page numbering, Formatting lengths, Parts of a document, Dividing the document.</p> <p><b>Table of contents, Index and Glossary:</b> Additional entries in table of contents, typesetting a content list, Multiple table of contents, Index, Glossary.</p> <p><b>Displayed Text:</b> Borrowed words, Poetry in typesetting, Making lists, When order matters, Descriptions and definitions</p> <p><b>Rows and Columns:</b> Keeping tabs, Tables, The array package, the multirow package.</p> <p><b>Typesetting Mathematics:</b> The basics, Custom commands single, group and numbered equations, Matrices, Dots, Putting one over the other, Affixing symbols, Defining new operators, Symbols, Typesetting Theorems, The amsthm package.</p> <p><b>Packages:</b> Use of amsmath, amssymb, asmfonts, color, geometry, graphic.</p> <p><b>Bibliography:</b> Introduction, The natbib package, multiple citations, numerical mode.</p> <p><b>Cross References in LaTeX:</b> Cross reference of section, Cross reference in Mathematics, Pointing to a page—the package varioref, Pointing outside—the package XR.</p> <p><b>Footnotes, Marginpars, and Endnotes:</b> Footnotes in tabular material, customizing footnotes, Footnote style parameters, Marginal notes, Endnotes.</p> <p><b>Floats:</b> The figure environment, The table environment.</p> <p><b>Presentation using Beamer class:</b> Introduction to creating slides, adding frames, dividing the slide into multiple columns, adding different blocks, etc</p>				15 hrs
Unit – 2	Relevant <b>Practicals</b> based on the topics from above unit.				30 hrs
<b>REFERENCES</b>					
1.	George Gratzer, Math into LaTeX – An introduction to LaTeX and AMS – LaTeX, Birkhauser Publisher, Boston, 1995.				
2.	Helmut Kopka and Patrick Daly, A Guide to LaTeX2e, Addison-Wesley, Reading, Massachusetts, 1995.				
3.	E. Krishnan, LaTeX tutorials – a primer, Indian TEX users group, Trivandrum. ( <a href="https://www.tug.org/twg/mactex/tutorials/txprimer-1.0.pdf">https://www.tug.org/twg/mactex/tutorials/txprimer-1.0.pdf</a> )				
4.	Leslie Lamport, LaTeX: A Document Preparation System, Addison-Wesley, Reading, Massachusetts, second edition, 1994.				
5.	Till Tantau, Joseph Wright, Vedran Miletic, The Beamer Class, user guide, 2021. ( <a href="http://tug.ctan.org/macros/latex/contrib/beamer/doc/beameruserguide.pdf">http://tug.ctan.org/macros/latex/contrib/beamer/doc/beameruserguide.pdf</a> )				


\* In view of availability of computer laboratories, maximum 60 students can be accommodated in this course


**Department of Mathematics**  
**Faculty of Science, The Maharaja Sayajirao University of Baroda**  
**Syllabus for Semester – V and Semester – VI**


Sr. No.	Course Code	Course Title	Credits	Page No.
<b>Semester – V</b>				
<b>Major</b>				
1	MAT	Group Theory – II	T–3 + P–1	2
2	MAT	Mathematical Analysis – I	T–3 + P–1	3
3	MAT	Real Analysis – I	T–3 + P–1	4
<b>Minor</b>				
1	MAT	Linear Programming	T–3 + P–1	5
2	MAT	Computer Programming – II / Python Programming	T–2 + P–2	6/7
<b>SEC (Skills Enhancement Course) (Any One)</b>				
1	MAT	Applications of Mathematics in Finance	T–1 + P–1	8
2	MAT	Probability Theory	T–1 + P–1	9
3	MAT	Difference Equations	T–1 + P–1	10
4	MAT	Finite Element Methods	T–1 + P–1	11
<b>Semester – VI</b>				
<b>Major</b>				
1	MAT	Ring Theory	T–3 + P–1	12
2	MAT	Mathematical Analysis – II	T–3 + P–1	13
3	MAT	Real Analysis – II	T–3 + P–1	14
<b>Minor</b>				
1	MAT	Ordinary and Partial Differential Equations	T–3 + P–1	15
<b>AEC (Ability Enhancement Course) (Any One)</b>				
1	MAT	Mathematics of Insurance	T–1 + P–1	16
2	MAT	Combinatorics	T–1 + P–1	17
3	MAT	Discrete Mathematics	T–1 + P–1	18
4	MAT	Finite Volume Methods	T–1 + P–1	19
<b>Internship (4 Credits)</b>				


## Syllabus for B. Sc. Semester – V


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<b>B.Sc. : Regular Programme</b>				
Year	III	<b>Major : Mathematics</b> <b>Paper – I : Group Theory – II</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2025	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	A counting principle, Normal subgroups, Quotient groups, Homomorphisms, Fundamental theorem of homomorphism, Isomorphism theorems, Cauchy's theorem for abelian groups and its applications, Sylow's theorem for abelian groups.			15 hrs
Unit – 2	Automorphism and inner automorphism groups, Automorphism group of finite and infinite cyclic groups, Conjugacy relation, Cauchy's theorem for non-abelian groups, Sylow's theorem for non-abelian groups, Discussion of Sylow subgroups.			15 hrs
Unit – 3	External direct product of a finite number of groups, internal direct product of a finite number of groups, Fundamental theorem on finite abelian groups, discussion of number of non-isomorphic finite abelian groups, Order of an element in product of groups.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units.			30 hrs
<b>REFERENCES</b>				
1.	Michael Artin, Algebra, Prentice Hall of India, 1994.			
2.	G. Birkhoff and S. MacLane, A Survey of Modern Algebra, University Press, 2003.			
3.	J. B. Fraleigh, A First Course in Abstract algebra, Pearson Education, Inc., 2006.			
4.	J. A. Gallien, Contemporary Abstract Algebra, Narosa Publishing House, 1998.			
5.	N. S. Gopalakrishnan, University Algebra, New Age International Pvt. Ltd., 2004.			
6.	I. N. Herstein, Topics in Algebra, Vikas Publishing house Pvt. Ltd., 2004.			
7.	I. H. Sheth, Abstract Algebra, Prentice Hall of India, 2009.			


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	<b>B.Sc. : Regular Programme</b>				
Year	III	<b>Major : Mathematics</b> <b>Paper – II : Mathematical Analysis – I</b> (3 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2025		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Order relation and ordered set, lub and glb of an ordered set, Properties of lub and glb, gaps in the rational number system, least upper bound property, Ordered field and their properties, Existence theorem of an ordered field $\mathbb{R}$ (to be assumed without proof), Archimedean property of $\mathbb{R}$ , Dense property of $\mathbb{Q}$ in $\mathbb{R}$ . Existence of $n^{\text{th}}$ root of positive reals, Extended real number systems, $\mathbb{C}$ is not an ordered field.				15 hrs
Unit – 2	Dictionary order, Unions, intersections and Cartesian products of arbitrary families of sets, Set mappings $f$ and $f^{-1}$ of a function $f^{-1}$ and their properties, Finite sets, Countable sets and uncountable sets, Well ordering theorem for $\mathbb{N}$ , Well ordered sets. Definition and various examples of metric spaces, Neighbourhood of a point, Limit point, Interior point, Isolated point, Open sets and closed sets.				15 hrs
Unit – 3	Relation between open set and closed set in a metric space, perfect sets, Dense sets, Closure of a set, Compact sets in a metric space and their properties, Compactness of $k$ -cell, Heine-Borel theorem, Weierstrass theorem, Perfect sets in $\mathbb{R}^k$ , Cantor set, Connected sets in a metric space, Separable metric space.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 1980.				
2.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.				
3.	Richard Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd, 1970.				
4.	S. C. Malik, Mathematical Analysis, Wiley Eastern Ltd, 1992.				
5.	J. R. Munkres, Topology-A First Course, Prentice-Hall of India, 2000.				
6.	I. K. Rana, Numbers to Analysis, World Scientific, 1998.				
7.	Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill book Co, 1976.				


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	<b>B.Sc. : Regular Programme</b>				
Year	III	<b>Major : Mathematics</b> <b>Paper – III : Real Analysis – I</b> (3 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2025		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Upper and lower limit of a sequence, some special sequences, convergence and divergence of a series, comparison test, series of non-negative terms, Cauchy's condensation test, number e. Root and ratio test (Proofs of test using upper limit).				15 hrs
Unit – 2	Summation by parts, Leibnitz's test, addition and multiplication of series, Rearrangements, Riemann's theorem. Pointwise convergence of sequences and series of functions, Discussion of main problem, Uniform convergence, Uniform convergence and continuity.				15 hrs
Unit – 3	Uniform convergence and differentiation. Power series and its convergence, Abel's theorem. Convergence of improper integrals, Gamma and Beta functions, Relation between them, Stirling's formula.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units.				30 hrs
<b>REFERENCES</b>					
1.	Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 1980.				
2.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.				
3.	Richard Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd, 1970.				
4.	Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill book Co, 1976.				

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<b>B.Sc. : Regular Programme</b>					
Year	III	<b>Minor: Mathematics</b> <b>Paper – I: Linear Programming</b> (3 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	I	Year of Introduction: 2025		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	General discussion of Linear Programming Problems(LPP) and formulation, Graphical method of solving two variables problem, Convex sets, General LPP, LPP in the standard form, Types of solutions, Properties of solutions, Generating extreme point solutions, Development of minimum feasible solutions.				15 hrs
Unit – 2	Simplex method, Artificial basis techniques for solving LPP ( Big M Method ). Duality in linear Programming: Formulation of Dual for Symmetric and Standard forms. Formulation of Dual for mixed form. Duality theorems. Economic interpretation of Dual variables and constrains. Duality and Simplex method.				15 hrs
Unit – 3	Transportation problem (TP): Definition, Transportation Table (TT), loops in TT and their properties. Initial BFS by North-west corner rule, Matrix minima method and Vogel's approximation method, Optimal solution of TP by MODI method. Solution of Unbalanced and Maximization type of TP. Assignment Problem (AP): Solution by Hungarian method. Solution of Unbalanced and Maximization type of AP.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units.				30 hrs
<b>REFERENCE</b>					
1.	S. I. Gass, Linear Programming, Mc Graw Hill Book Company, 1985.				
2.	K. V. Mittal and C. Mohan, Optimization Methods in Operations Research and System Analysis, New Age International Publications, 1996.				
3.	Kanti Swaroop, Man Mohan and P. K. Gupta, Operations Research, Sultan Chand and Sons, 1978.				
4.	Hamdy A. Taha, Operations Research: An introduction, Pearson Education Pvt. Ltd., 2002				
5.	P. M. Karak, Linear Programming and Theory of Games, New Central Book Agency(P) Ltd, 2001.				

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	<b>B.Sc. : Regular Programme</b>				
Year	III	<b>Minor: Mathematics</b> <b>Paper – II : Computer Programming–II (Elective)</b> (2 Credits Theory and 2 Credit Practicals)		Credit / Hrs per week	2 / 2 & 2 / 4
Semester	I	Year of Introduction: 2025		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Object Oriented Programming, basic concepts, benefits and applications. Classes and objects, data member and member functions, access specifiers, constructors and destructors, <b>Operator overloading:</b> friend functions, this pointer, overloading unary, binary and input- output operators. Type conversion.				15 hrs
Unit – 2	<b>Templates:</b> class templates, class templates with multiple parameters, function template, function template with multiple parameters, overloading of template functions. <b>Composition and Inheritance:</b> Defining derived classes, inheritance hierarchies, public, private and protected members under derivation, single inheritance. <b>Working with files :</b> classes for file stream operations, opening and closing a file, file modes, input and output operations, error handling.				15 hrs
Unit – 3	Relevant Practical (programs) based on the topics from unit-1 including numerical methods for integration and interpolation. Program based on real vectors, polynomial and real matrices.				30 Hrs
Unit – 4	Relevant Practical (programs) based on the topics from unit-2 including various sorting methods, complex vectors and complex matrices.				30 hrs
<b>REFERENCES</b>					
1.	E Balagurusamy, Object Oriented Programming with C++, Tata McGraw-Hill Publishing Company Ltd.				
2.	John R. Hubbard, Programming with C++ , McGraw Hill international Edition 2000.				
3.	Robert Lafore, Object Oriented programming in Turbo C++, Galgotia Publications Pvt. Ltd, 2009.				

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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>Major : Mathematics</b> <b>Paper – II : Python Programming (Elective)</b> (2 Credits Theory and 2 Credit Practicals)	Credit / Hrs per week	2 / 2 & 2 / 4
Semester	I	Year of Introduction: 2025	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Python Basics: Syntax and structure, Variables and data types, Input/output operations. Operators: Special, arithmetic, relational, logical, Simple and formatted input/output, expressions and statements. Control structure: conditional statements (if-else, switch). Loops: while, do-while, for. Data structure: tuples, lists, sets, dictionaries, strings. Modules, Functions: declaration and definition, types of functions, local and global variables, anonymous function Lambda.			15 hrs
Unit – 2	Mathematical libraries: NumPy: Arrays, linear algebra, and numerical operations, SymPy: Symbolic computation. Introduction to other Python libraries like, Scikit-learn, Matplotlib, Pandas, TensorFlow, Theano and PyTorch.			15 hrs
Unit – 3	<b>Practicals:</b> Setting up Python environment (Anaconda, Jupyter Notebooks, or IDEs like VSCode). How to analyze and debug Python programs. Use of recursive relation and functions for writing simple programming based on the topics from unit-1.			30 Hrs
Unit – 4	<b>Practicals:</b> Develop programming skill (projects) using the libraries: NumPy: for Linear Algebra (matrix operations, eigenvalues, eigenvectors) SciPy: for Optimization, numerical integration, Interpolation Matplotlib: for Basic plotting, Subplots and multiple plots, 3D plotting Scikit-learn: for Data Preprocessing Pandas: for data manipulation and analysis			30 hrs
<b>REFERENCES</b>				
1.	Matt A. Wood, Python for Scientists and Engineers, Morgan & Claypool Pub., 2015.			
2.	Svein Linge and Hans Petter Langtangen, Programming for Computations – Python, Springer, 2016.			
3.	Jaan Kiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press; 3rd edition, 2013.			


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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>SEC: Mathematics</b> <b>Applications of Mathematics in Finance (Elective)</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	I	Year of Introduction: 2025	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Time Value of Money: Interest rate and Discount rate, Present and Future values of streams, Net Present Value, Internal rate of return, Annuities, Perpetuities, Mortgages. Financial Instruments, Fixed income Securities, Demand deposit, Time deposit, Certificate of deposit, Government securities, Bonds, the yield curve for a bond, The term structure of a bond, Forward rates, Asset return, Random variables, Random returns, Portfolio mean and variance, The Feasible set, The Markowitz model, Market equilibrium, The capital market line, The pricing model, Security market line, Performance evaluation, CAPM as pricing model.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit			30 hrs
<b>REFERENCES</b>				
1.	David G. Leunberger, Investment Science, Oxford University Press, Delhi, 1998.			
2.	Prasanna Chandra, Investment Analysis and Portfolio Management, Tata McGraw Hill, 2008.			
3.	A. K. Gupta and T. Varga, An Introduction to Actuarial Mathematics, Kluwer Academic Publisher, 2002.			
4.	Sheldon M. Ross, An elementary Introduction to Mathematical Finance, Cambridge University Press, 2003.			


		<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in		FROM ACADEMIC YEAR 2025 – 2026	
<b>B.Sc. : Regular Programme</b>					
Year	III	<b>SEC: Mathematics</b> <b>Probability Theory (Elective)</b> (1 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	1 / 1 & 1 / 2
Semester	I	Year of Introduction: 2025		Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Random experiments and sample spaces, Events, relations among events and verbal description of events, Axiomatic definition of probability and its consequences, Conditional probability, The equally likely events, Baye’s theorem, Independence of events, Random variables, Continuous and discrete random variables. Probability distributions: Bernoulli trials and the binomial distribution, Poisson and Normal Distribution, Expectations and moments, Variance and covariance. Sampling distribution, The Central Limit Theorem (without proof).				15 hrs
Unit – 2	Relevant examples/problems based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	N M Kapoor, Fundamentals of Mathematical Statistics, Pitamber Publishing Company(P) Ltd.				
2.	Kanti Swaroop, Man Mohan, P.K. Gupta, Operations Research, Sultan Chand and Sons.				
3.	Ervin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons. Inc.				


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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>SEC: Mathematics</b> <b>Difference Equations (Elective)</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	I	Year of Introduction: 2025	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Difference operators: Definition and notations, difference formulas, symbolic operations, formation of difference equation, Difference equations of simple type and their solution, Linear difference equations of first order, Linear difference equations of order $n$ , Homogeneous linear equations and their properties, Existence and uniqueness of the solution of linear difference equation, Homogeneous linear difference equations with constant coefficients: Seliwanoff's method for solving the equations. Homogeneous linear difference equations of order one with rational coefficients, Equations homogeneous in $u(x)$ , Equations reducible to linear equations with constant coefficients, non-homogeneous linear equations of first order, Method of generating function to solve the first order difference equations, System of linear difference equations and its solution by matrix method.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit.			30 hrs
<b>REFERENCES</b>				
1.	H. C. Saxena, Finite Differences and Numerical Analysis, S. Chand and Co. Ltd., 2003			
2.	Francis B. Hildebrand, Finite-Difference Equations and Simulations, Prentice - Hall Inc., 1968			
3.	C. H. Richardson, An Introduction to the Calculus of Finite Differences, D. Van Nostrand Co., Inc., 1954			


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<b>B.Sc. : Regular Programme</b>				
Year	<b>SEC: Mathematics</b> <b>Finite Element Methods</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2	
Semester	Year of Introduction: 2025	Max marks / Grade	50	
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Introduction to calculus of variations, Approximate methods, Finite Elements, nodes classifications, approximate functions, Solution of Boundary value problems of second order differential equations.  Finite element equations for the heat conduction equation, vibration equation, elliptic problems using Galerkin and Ritz methods.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit.			30 hrs
<b>REFERENCES</b>				
1.	Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.			
2.	M. K. Jain, Numerical Solution of Differential Equations, PHI Ltd.			
3.	A. R. Mitchell and R. Wait, Finite Element methods in partial Differential Equations, Edn. John Wiley, 1977.			
4.	S. S. Rao, Finite Element Methods in Engineering, Butterworth and Heinemann, 2001.			
5.	J. N. Reddy, An Introduction to Finite Element Method, McGraw Hill – 2000.			
6.	L. T. Segerlind, Applied Finite Element Analysis, John-Wiley, 2nd edition, 1984.			


## Syllabus for B. Sc. Semester – VI


	<b>The Maharaja Sayajirao University of Baroda</b> Faculty of Science, Department of Mathematics, Sayajigunj, Vadodara 390002, Phone: 0265-2795329, head-math@msubaroda.ac.in			FROM ACADEMIC YEAR 2025 – 2026
<b>B.Sc. : Regular Programme</b>				
Year	III	<b>Major : Mathematics</b> <b>Paper – I : Ring Theory</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2025	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Definition and examples of a ring, Integral domains, Division rings and Fields, Ring homomorphism and isomorphism, Ideals and Quotient rings, Maximal ideals and quotient rings.			15 hrs
Unit – 2	Field of quotient of an integral domain, Euclidean ring, gcd, units and prime elements in a Euclidean ring, Unique factorization theorem, The ring of Gaussian integers.			15 hrs
Unit – 3	Polynomial ring $F[x]$ and its properties, Polynomials over the rational field, Primitive polynomials, The Eisenstein criterion, Polynomial ring over commutative rings, Unique factorization domains.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units			30 hrs
<b>REFERENCES</b>				
1.	Michael Artin, Algebra, Pearson Education, 2010.			
2.	G. Birkhoff and S. Maclane, A Survey of Modern Algebra, University Press, 2003.			
3.	J. B. Fraleigh, A First Course in Abstract algebra, Pearson Education Inc, 2006.			
4.	Joseph A. Gallien, Contemporary Abstract Algebra, (4th Edition) Narosa Publication House, New Delhi, 1998			
5.	N. S. Gopalakrishnan, University Algebra, New Age International Pvt.Ltd.2004			
6.	I.N. Herstein, Topics in Algebra, Vikas Publishing house Pvt. Ltd. 2006.			
7.	C. Musili, Introduction to Rings and Modules, Narosa Publishing House, 1994.			
8.	I. H. Sheth, Abstract Algebra, Prentice Hall of India, 2009.			


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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>Major : Mathematics</b> <b>Paper – II : Mathematical Analysis – II</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2025	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Convergent sequences in a metric space and their properties, Subsequences and Cauchy sequences in a metric space, Complete metric Spaces, Limit of functions and continuous functions in metric spaces, Continuity and compactness.			15 hrs
Unit – 2	Uniformly continuous functions, Continuity and connectedness, Intermediate value theorem, Discontinuities, Monotonic functions and types of discontinuities, Local maximum and Local Minimum, Generalized mean value theorem, Continuity of derivatives.			15 hrs
Unit – 3	Fixed point and contraction principle, The metric space $C[a, b]$ and its completeness, Equicontinuous families, Totally boundedness and Arzela's theorem.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units			30 hrs
<b>REFERENCES</b>				
1.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.			
2.	R. R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. PVT. LTD., 1970			
3.	S. C. Malik, Mathematical Analysis, Wiley Eastern Ltd., 1992.			
4.	J. R. Munkres, Topology-A First Course, Prentice-Hall of India, 2000.			
5.	I. K. Rana, Numbers to Analysis, World Scientific.1998.			
6.	Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill book Co., 1976.			


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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>Major : Mathematics</b> <b>Paper – III : Real Analysis – II</b> (3 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2025	Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Riemann integral, Definition and existence of Riemann- Stieltjes integral, its properties, The integral as a limit of a sum, Change of variable, Integration and differentiation. Fundamental theorem of Calculus.			15 hrs
Unit – 2	Integration by parts, First and Second Mean-Value theorems, Integral of vector-valued functions, Functions of bounded variation, Uniform convergence and integration. Rectifiable curves, Exponential, Logarithmic and Trigonometric functions, Algebraic completeness of complex field.			15 hrs
Unit – 3	Trigonometric Fourier series and examples. Dirichlet kernel and convergence of Fourier series, Localization theorem, Fejer Kernel and summability of Fourier series, Orthonormal system and Fourier series, Bessel's inequality and Parseval's theorem.			15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units.			30 hrs
<b>REFERENCES</b>				
1.	Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 1985.			
2.	S. R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.			
3.	Richard Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd, 1964			
4.	Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill book Co., 1976.			

		<p align="center"><b>The Maharaja Sayajirao University of Baroda</b>  Faculty of Science, Department of Mathematics,  Sayajigunj, Vadodara 390002, Phone: 0265-2795329,  <a href="mailto:head-math@msubaroda.ac.in">head-math@msubaroda.ac.in</a></p>		<p align="center">FROM  ACADEMIC  YEAR  2025 – 2026</p>	
<b>B.Sc. : Regular Programme</b>					
Year	III	<b>Minor : Mathematics</b> <b>Paper – I: Ordinary and Partial Differential Equations</b> (3 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	3 / 3 & 1 / 2
Semester	II	Year of Introduction: 2024		Max marks / Grade	100
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Second and higher order linear homogeneous equations, Principle of superposition, general solution and fundamental set of solutions, Linear independence and Wronskian, Abel's theorem, Solution of equations using reduction of order, Second and higher order linear non-homogeneous equations, Method of undetermined coefficients.				15 hrs
Unit – 2	Method of variation of parameters, Application of second order equations to mechanical and electrical vibrations. Linear system of first order equations, Homogeneous linear system with constant coefficients, Solution of linear systems for real, complex and repeated eigen values, Non-linear systems, Volterra's Prey-Predator equations.				15 hrs
Unit – 3	Partial differential equation of first order: Origin of the first order partial differential equations, Classification of integrals. Linear partial differential equations of first order, Non-linear partial differential equation of the first order, The Cauchy problem, Compatible system of first order equations, Charpit's method, special types of first order partial differential equations.				15 hrs
Unit – 4	Relevant Practicals based on the topics from above three units				30 hrs
<b>REFERENCES</b>					
1.	William E. Boyce and Richard C. Di Prima, Elementary Differential Equations and Boundary Value Problems, John Wiley and Sons Inc., 2003				
2.	Shepley L. Ross, Differential Equations, John Wiley and Sons, 2004.				
3.	G.F. Simmons, Differential Equations With Applications and Historical Notes, McGraw -Hill Inc., 1991.				
4.	Zafar Ahsan, Differential Equations and their applications, Prentice-Hall of India, 2004.				
5.	T. Amarnath, An elementary course in partial differential equations, Narosa Publ. Co, 2000.				
6.	Ian Sneddon, Elements of Partial Differential Equations, Mc Graw Hill International, 1972.				

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	<b>B.Sc. : Regular Programme</b>				
Year	III	<b>AEC: Mathematics</b> <b>Mathematics of Insurance (Elective)</b> (1 Credits Theory and 1 Credit Practicals)		Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2025		Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>					
Unit – 1	Insurance Fundamentals – Insurance defined. Meaning of loss. Chances of loss, peril, hazard and proximate cause in insurance, Types of insurances. Mortality and survival Time, Actuarial Functions of Mortality and Mortality Tables. Stochastic cash flows, Pure Endowments, Life Insurances, Endowments, Life Annuities.				15 hrs
Unit – 2	Relevant Practicals based on the topics from above units				30 hrs
<b>REFERENCES</b>					
1.	Sheldon M. Ross, An elementary Introduction to Mathematical Finance, Cambridge University Press, 2003.				
2.	A. K. Gupta and T. Varga, An Introduction to Actuarial Mathematics, Kluwer Academic Publisher, 2002.				
3.	Jim Mc Menamin, Financial Management: An Introduction, Oxford University Press, 2000.				
4.	Aswath Damodaran, Corporate Finance–Theory and Practice, John Wiley and Sons, 2001.				

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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>AEC: Mathematics</b> <b>Combinatorics (Elective)</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2025	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Addition principle, multiplication principle, Combinations and permutations, The Pigeonhole Principle, Bell numbers, Stirling numbers, The Inclusion-Exclusion Formula, Forbidden Position Permutations, Generating Functions, Exponential Generating Functions, Partitions of Integers, Recurrence Relations, Catalan Numbers.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above three units			30 hrs
<b>REFERENCES</b>				
1.	D. Guichard, An Introduction to Combinatorics and Graph Theory.			
2.	W. D. Wallis and J. C. George, Introduction to Combinatorics, CRC Press, 2011.			
3.	C. C. Chong and K. K. Meng, Principles and Techniques in Combinatorics, World Scientific Pub. 1992.			
4.	B. Kolman, R. C. Busby, S. Ross, Discrete Mathematical Structures, PHI, 1996.			

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	<b>B.Sc. : Regular Programme</b>			
Year	III	<b>AEC: Mathematics</b> <b>Discrete Mathematics (Elective)</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2024	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Binary relation, Properties of binary relation, Partially ordered sets, Hasse diagram, Lattices, Chains, Principle of duality, Basic properties of algebraic systems defined by lattices, Distributive and Complete lattice, Boolean algebra.  Homomorphism, atoms of a Boolean algebra and its properties, Boolean functions, Boolean expressions, Minterm, Maxterm, Stone's Representation Theorem for finite Boolean algebras.  Applications to logic, Gates and digital circuits.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit.			30 hrs
<b>REFERENCES</b>				
1.	B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.			
2.	Narsingh Deo, Graph theory with applications to Engineering and Computer Science, Prentice-Hall of India, 1993			
3.	C. L. Liu, Elements of Discrete Mathematics, McGraw Hill International Editions, 1985.			
4.	J. P. Trembley and R. Manohar, Discrete Mathematical Structure with applications to Computer Science, Mc Graw Hill Book Company, 2001			

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<b>B.Sc. : Regular Programme</b>				
Year	III	<b>SEC: Mathematics</b> <b>Finite Volume Methods (Elective)</b> (1 Credits Theory and 1 Credit Practicals)	Credit / Hrs per week	1 / 1 & 1 / 2
Semester	II	Year of Introduction: 2025	Max marks / Grade	50
<b>COURSE CONTENT / SYLLABUS</b>				
Unit – 1	Introduction, finite volume method (FVM) for two dimensional diffusion problems, introduction to FVM for convection-diffusion problems.  Steady one dimensional convection and diffusion problem, the central differencing scheme, FVM for One-Dimensional unsteady heat conduction problem, Crank-Nicolson Scheme.			15 hrs
Unit – 2	Relevant Practicals based on the topics from above unit.			30 hrs
<b>REFERENCES</b>				
1.	Jiri Blazek, Computational Fluid Dynamics: Principles and Applications, 3rd Edition, Butterworth-Heinemann, 2015.			
2.	Suhas V. Patankar (first book) Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing, 1980			
3.	H.K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: The finite volume method 3e, Pearson Education, 2007.			