Royal College of Arts Science andCommerce (Autonomous)

Affiliated to University of Mumbai

Program: S. Y. B. Sc

Course: Mathematics

Syllabus for Semester: III and IV

Syllabus for Undergraduate Programme as per National Education Policy (NEP-2020) with effect from the academic year 2025-2026

NEP Credit Structure for Science

Level	Sem	Major		Minor	OE	VSC	SEC	AEC	IKS	VEC	OJT/FP /RP/CC /CEP	Cumulative Credits	
		DSC	DSE										
4.5	I	6 (4Th + 2 Pr)		4+2 (4Th + 2 Pr)	2	2		2	2	2		22	**UG Certificate Cumulative Credit:44**
	II	6 (4Th + 2 Pr)		4+2 (4Th + 2 Pr)	2		2	2		2	2	22	
Exit Option: Award of UG Certificate in Major with 40 -44 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5	III	8 (6Th + 2 Pr)		4 (2 Th + 2 Pr)	2+2		2	2			2	22	**UG Diploma Cumulative Credit:88**
	IV	8 (6Th + 2 Pr)		4 (2 Th + 2 Pr)	2+2		2	2			2	22	
Exit Option: Award of UG Diploma in Major and Minor with 80-88 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5.5	V	10 (8Th + 2 Pr)	4 (2Th + 2 Pr)			4					4	22+	**UG Degree Cumulative Credit:132**
	VI	10 (8Th + 2 Pr)	4 (2Th + 2 Pr)			4					4	22	
	Total	**48**	**8**	**20**	**12**	**10**	**6**	**8**	**2**	**4**	**14**	**132**	

List of All Courses offered from Semesters I – VI in SCIENCE

Level	Sem	Major subject Course titles	Minor subject Course titles	Elective Course titles	OE Course titles	VSC Course title/s	SEC Course title/s
4.5 100-199	I	Calculus – I Linear Algebra - I	-	-	Data analysis and visualization	-	-
	II	Calculus – II Linear Algebra - II	-	-	Data analysis and forecasting	-	-
5 200-299	III	-	Calculus – III	-	Mathematics for competitive examination - I	-	-
	IV	-	Calculus - IV	-	Mathematics for competitive examination - II	-	-
5.5 300-399	V	-	-	-	-	-	-
	VI		-	-	-	-	-

Course/ Paper Title	**CALCULUS - III**
Course offered as	**Minor**
Course Code	**RUSMAMN301**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**2 L**

Sr No.	Course Learning Objectives
CLO1	To explore the properties and applications of Beta and Gamma functions.
CLO2	To develop a rigorous understanding of limits and continuity for scalar and vector fields.
CLO3	To introduce concept of differential equation, order, degree, solution of differential equation and its applications
CLO4	To solve first order first degree differential equations

Course Outcomes:

	On completing the course, the student will be able to:
CO1	Analyze and solve problems involving Beta and Gamma functions, including their properties, interrelationships, and applications in Physical Sciences.
CO2	Evaluate the limit and continuity of scalar and vector fields, partial and directional derivatives of scalar and vector fields, and apply the Mean Value Theorem to analyze the behavior of functions in higher dimensions.
CO3	Apply knowledge of first order first degree differential equation and solve problems.

Detailed Syllabus:

Module	Title with content	No. of lectures
I	**Improper integrals and beta gamma functions:** Continuity of the function $F(x) = \int_a^x f(t)\,dt, x \in [a,b]$, when $f: [a,b] \to \mathbb{R}$ is Riemann integrable. First and second Fundamental Theorem of Calculus. Improper integrals of Type – I and Type – II and their convergence. Gamma and Beta functions and their properties. **Limits and continuity of scalar and vector fields:** Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$ and basic notions such as addition, scalar multiplication, inner product, norm, distance. Real valued function of several variables (scalar fields), vector valued functions of several variables (vector fields). Limits and continuity of scalar fields. Algebra of Limits and Continuity, Iterated limits. Limits and continuity of vector fields. Algebra of limits and continuity vector fields. Partial and directional derivatives of scalar fields. Mean Value Theorem of scalar fields.	15 Hours
II	**First order, first degree differential equations:** Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and non linear ODE. Solution of homogeneous and non homogeneous differential equations of first order and first degree. Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for Mdx + Ndy = 0 to be exact. Non-exact equations: Rules for finding integrating factors for non exact equations Linear and reducible linear equations of first order, finding solutions of first order differential equations of the type for applications to orthogonal trajectories, population growth, and finding the current at a given time. Reduction of order: (i) If the differential equation does not contain only the original function y, that is equations of Type $F(x, y', y'') = 0$ (ii) If the differential equation does not contain the independent variable x that is, equations of Type $F(y, y', y'') = 0$	15 Hours

Reference Books:

1. T. Apostol; Calculus Vol. 2; John Wiley.
2. G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.

Additional Reference Books:

1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.
2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.
3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.

Course/ Paper Title	**PRACTICAL – III**
Course offered as	**Minor**
Course Code	**RUSMAMNP3**
Semester	**III**
No. of Credits	**2**
No. of lecture Hours/week	**2 P (4 Hrs)**

Sr No.	Course Learning Objectives:
CLO1	To explore the properties and applications of improper integrals and Fundamental theorem of Integral Calculus.
CLO2	To develop a rigorous understanding of limits and continuity for scalar and vector fields.
CLO3	To develop problem solving skills on first order first degree differential equations
CLO4	To analyze and model real life example into first order first degree ordinary differential equation

Course Outcomes:

	On completing the course, the student will be able to:
CO1	Analyze and solve problems on improper integrals and Fundamental theorem of Integral Calculus.
CO2	Evaluate the limit and continuity of scalar and vector fields, partial and directional derivatives of scalar and vector fields, and apply the Mean Value Theorem to analyze the behavior of functions in higher dimensions.
CO3	Model and solve first order first degree ordinary differential equation

Regular experiments:

Sr No.	Practical topics for CALCULUS III
1	Fundamental theorem of Integral Calculus
2	Convergence of improper integrals.
3	Type – I and Type -II integrals.
4	Beta Gamma Functions.
5	Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$, inner product, norm, distance.
6	Limits and continuity of scalar fields and vector fields, iterated limits.
7	Computing directional derivatives, partial derivatives.
8	Mean value theorem for scalar fields
9	Homogeneous differential equations
10	Non- homogeneous differential equations
11	Exact differential equations
12	Integrating factor
13	Linear first order differential equations
14	Solving reducible linear differential equations of first order

**Demonstrations using Mathematical softwares wherever required.

Royal College of Arts, Science and Commerce

(Autonomous)

Theory Examination Pattern for

(Minor)

The performance of the learners shall be evaluated in two parts.

- Internal Continuous Assessment of 20 marks.
- Semester End Examination of 30 marks.
- A separate head of passing is required for internal and semester-end examinations

I	**Internal Assessment**	20 Marks
a	One class test (Short answers/Objectives/ Multiple Choice)	10 marks
b	Assignment/ Project/ Presentation/Book or research paper Review/	10 marks
II	**Semester End Examination**	30 Marks
	Duration	1 Hour

Question Paper Pattern (Class test):

Q 1)	Fill in the blanks/True or False	4 Marks
Q 2)	Attempt any 2/3 descriptive questions	6 Marks

Question Paper Pattern (Sem end Examination):

Q 1)	Module 1 & 2	MCQ: Attempt any 6 out of 8 questions	6 Marks
Q 2)	Module 1	Attempt any 3 out of 5 questions	12 Marks
Q 3)	Module 1I	Attempt any 3 out of 5 questions	12 Marks

Practical exam (CALCULUS III)

External Assessment for Practical	**50 Marks**
Module – I	20 Marks
Module – II	20 Marks
Viva	05 Marks
Journal	05 Marks

Course/ Paper Title	**CALCULUS - IV**
Course offered as	**Minor**
Course Code	**RUSMAMN401**
Semester	**IV**
No. of Credits	**2**
No. of lecture hours/week	**2L**

Sr No.	Course Learning Objectives:
CLO1	To introduce the concept of differentiability for scalar and vector fields and the role of partial derivatives in determining differentiability.
CLO2	To explore the gradient of scalar fields, its geometric interpretation and its applications in optimization and level surface analysis.
CLO3	To introduce the concept of higher order linear differential equations
CLO4	To explore different methods of solving higher order linear differential equations

Course Outcomes:

	On completing the course, the student will be able to:
CO1	Analyze the differentiability of scalar and vector fields, and apply the concepts of partial derivatives, gradient, and Jacobian matrix to solve problems in multivariable calculus.
CO2	Interpret the geometric and physical significance of the gradient and Jacobian matrix, and apply these concepts to optimization.
CO3	Analyze and solve higher order linear differential equations

Detailed Syllabus:

Module	Title with content	No. of lectures
I	**Differentiability of scalar and vector fields:** Differentiability of scalar fields and vector fields. Uniqueness of total derivative of a differentiable function at a point. functions of two or three variables. Increment Theorem. Basic properties including (i) continuity at a point of differentiability, (ii) existence of partial derivatives at a point of differentiability, and (iii) differentiability when the partial derivatives exist and are continuous. Gradient of a scalar field, chain rule and Jacobian of a vector field. Level curves and tangent planes. Higher order partial derivatives. Mixed partial theorem ($n = 2$). Maximum and minimum rate of change of scalar fields, Taylor's Theorem for twice continuously differentiable functions and applications. Notions of local maxima, local minima and saddle points, Hessian matrix, second derivative test for functions of two variables. Method of Lagrange's Multiplier.	15 Hours

II	**Higher order Linear Differential equations:** The general n^{th} order linear differential equations, Linear independence, Existence and uniqueness theorem, the Wronskian, Classification: homogeneous and non-homogeneous, General solution of homogeneous and non-homogeneous LDE, The Differential operator and its properties. Higher order homogeneous linear differential equations with constant coefficients, the auxiliary equations, Roots of the auxiliary equations: real and distinct, real and repeated, complex and complex repeated. The method of undetermined coefficients, method of variation of parameters. The inverse differential operator and particular integral, Evaluation of $\frac{1}{f(D)}$ for the functions like e^{ax}, $\sin ax$, $\cos ax$, x^m, $x^m \sin ax$, $x^m \cos ax$, $e^{ax}V$ and xV, where V is any function of x, Higher order linear differential equations with variable coefficients: The Cauchy's equation, The Legendre's equation	15 Hours

Reference Books:

1. T. Apostol; Calculus Vol. 2; John Wiley.
2. G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.

Additional Reference Books:

1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.
2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.
3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.

Course/ Paper Title	**PRACTICAL – IV**
Course offered as	**Minor**
Course Code	**RUSMAMNP4**
Semester	**IV**
No. of Credits	**2**
No. of lecture Hours/week	**2 P (4Hrs)**

Sr No.	Course Learning Objectives:
CLO1	To introduce the concept of differentiability for scalar and vector fields and the role of partial derivatives in determining differentiability.
CLO2	To explore the gradient of scalar fields, its geometric interpretation and its applications in optimization and level surface analysis.
CLO3	To develop problem solving skills on higher order linear differential equations

Course Outcome:

	On completing the course, the student will be able to:
CO1	Analyze the differentiability of scalar and vector fields, and apply the concepts of partial derivatives, gradient, and Jacobian matrix to solve problems in multivariable calculus.
CO2	Interpret the geometric and physical significance of the gradient and Jacobian matrix, and apply these concepts to optimization.
CO3	Solve problems on higher order linear differential equations.

Regular experiments:

Sr No.	Practical topics for CALCULUS IV
1	Differentiability of scalar field, Total derivative.
2	Gradient, level sets and tangent planes
3	Higher order partial derivatives.
4	Differentiability of vector fields, Jacobian matrix.
5	Taylor's theorem and applications
6	Hessian matrix
7	Maxima, Minima and saddle points
8	Higher order homogeneous linear differential equations with constant coefficients
9	Method of undetermined coefficients
10	Method of variation of parameters.
11	Differential operator method
12	Higher order linear differential equations with variable coefficients: The Cauchy's equation, The Legendre's equation

**Demonstrations using Mathematical software wherever required.

Royal College of Arts, Science and Commerce

(Autonomous)

Theory Examination Pattern for

(Minor)

The performance of the learners shall be evaluated in two parts.

- Internal Continuous Assessment of 20 marks.
- Semester End Examination of 30 marks.
- A separate head of passing is required for internal and semester-end examinations

I	**Internal Assessment**	20 Marks
a	One class test (Short answers/Objectives/ Multiple Choice)	10 marks
b	Assignment/ Project/ Presentation/Book or research paper Review/	10 marks
II	**Semester End Examination**	30 Marks
	Duration	1 Hour

Question Paper Pattern (Class test):

Q 1)	Fill in the blanks/True or False	4 Marks
Q 2)	Attempt any 2/3 descriptive questions	6 Marks

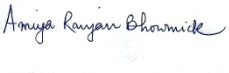
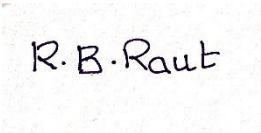
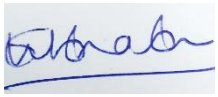
Question Paper Pattern (Sem end Examination):

Q 1)	Module 1 & 2	MCQ: Attempt any 6 out of 8 questions	6 Marks
Q 2)	Module 1	Attempt any 3 out of 5 questions	12 Marks
Q 3)	Module 1I	Attempt any 3 out of 5 questions	12 Marks

Practical exam (CALCULUS IV)

External Assessment for Practical	**50 Marks**
Module – I	20 Marks
Module – II	20 Marks
Viva	05 Marks
Journal	05 Marks

Board of studies in Mathematics

	Category	Name and Designation	Affiliation	Signature
1	Chairperson (Head of Department)	Mrs Komal Pravin Wategaonkar, Assistant Professor.	University of Mumbai	
2	Full time teacher of the Department	Mrs Rugma Pramod Nair, Assistant Professor.	University of Mumbai	
3	Two subject experts fromoutside the Parent University nominated by the Academic Council.	Dr Ananthnarayan Hariharan, Associate Professor.	I.I.T., Bombay	
		Dr. Amiya Bhowmick, Assistant Professor.	ICT Mumbai	
4	One expert nominated by the Vice-Chancellor froma panel of six recommended by the College Principal.	Dr. Rajesh Raut Assistant Professor, R. D. National college.	University of Mumbai	
5	One expert nominated by the college Principal	Mr. Subhash Krishnan Associate Professor, Vice Principal, K J Somaiya college of Science and Commerce.	University of Mumbai	
6	One representative from industry/corporate sector/allied area relating to placement.	Mr. Arbaz Sayed Data Scientist	Wipro, Hyderabad, Telangana	
7	One postgraduate meritorious alumnus nominated by the Principal.	Ms. Harshita Rathore, Supply Chain Fulfillment Manager,	Microsoft, Austin, Texas, USA	

Appendix B

Justification for B.Sc. (MATHEMATICS)

1.	Necessity for starting the course:	B.Sc. (Mathematics) is introduced aiming to develop students' analytical skills, provide a foundation for scientific inquiry. The curriculum provides a strong base in both theoretical and applied aspects of Mathematics.
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	The course has already commenced in the university and in the academic year 25-26, it is restructured under NEP 2020
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available:	This course is aided based on sanction given by University of Mumbai to affiliated colleges time to time.
5.	To give details regarding the duration of the Course and is it possible to compress the course?	The duration of the program is two years (4 semesters). It is not possible to compress the program.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	The intake capacity is 120 at the entry level based on sanction received from the University.
7.	Opportunities of Employability / Employment available after undertaking these courses:	B.Sc. (Mathematics) provides robust analytical, problem-solving, and logical reasoning skills that are highly valued in many industries. Graduates can find opportunities in various fields, including data science, finance, academia, and government, with career options expanding further through postgraduate studies.

Kwategaonkar

Mrs. Komal Wategaonkar
Chairperson
BOS in Mathematics

Prof. (Dr.) Kalpana Patankar Jain
Principal
Royal College of Arts, Science and Commerce (Autonomous)
Mira Road

ROYAL COLLEGE OF ARTS SCIENCE & COMMERCE
PENKAR PADA, MIRA ROAD,
DIST : THANE. PIN : 401107.