S. P. Mandali's

Ramnarain Ruia Autonomous College

Affiliated to Mumbai University

Program: FYBSc for BSc(Hon.) in Mathematics

(Choice Based Credit System for the academic year 2023-24)

(According to NEP-2020)

Detailed Syllabus

FYBSc

Semester I

Department Specific Course

Subject-1 Course Code:RUSMAT.O101
Course Title: Calculus I
Academic Year: 2023-24

CO	CO Description
CO1	to explain the properties of real numbers.
CO2	to explain the notions of convergent sequences.
CO3	to outline the concepts of limits and continuity.
CO4	to apply the concepts of limits and continuity in the fields of economics, physics and biological sciences.

Unit I: Real Number System (15 Lectures)

Real number system R and order properties of R, Absolute value |.| and its properties.

Bounded sets, statement of l.u.b. axiom, g.l.b. axiom and its consequences, Supremum and infimum, Maximum and minimum, Archimedean property and its applications, density of rationals, Cantors nested interval theorem.

AM-GM inequality, Cauchy-Schwarz inequality, intervals and neighbourhoods, Hausdorff property.

Unit II: Sequences (15 Lectures)

Definition of a sequence and examples, Convergence of sequence, every convergent sequence is

bounded, Limit of a convergent sequence and uniqueness of limit, Divergent sequences. Algebra of convergent sequences, sandwich theorem.

Convergence of standard sequences like

$$\left(\frac{1}{1+na}\right) \ \forall\ a>0, \quad (b^n), \quad |b|<1, \quad \left(c^{1/n}\right) \ \forall\ c>0 \text{ and } \left(n^{1/n}\right),$$

monotone sequences,convergence of monotone bounded sequence theorem and consequences such as convergence of $\left(\left(1+\frac{1}{n}\right)^n\right)$.

Definition of subsequence, subsequence of a convergent sequence is convergent and converges to the same limit. Every sequence in R has a monotonic subsequence. Bolzano-Weierstrass Theorem. Definition of a Cauchy sequence, every convergent sequence is a Cauchy sequence.

Unit III: : Limits and Continuity (15 Lectures)

Brief review: Domain and range of a function, injective function, surjective function, bijective function, composite of two functions (when defined), Inverse of a bijective function.

Graphs of some standard functions such as $|x|$, e^x, $\log x$, ax^2+bx+c, $\frac{1}{x}$, x^n $(n\geq 3)$, $\sin x$, $\cos x$, $\tan x$, $x\sin\left(\frac{1}{x}\right)$, $x^2\sin\left(\frac{1}{x}\right)$ over suitable intervals of $\mathbb{R}$.

$\varepsilon-\delta$ definition of limit of a real valued function of real variable. Evaluation of limit of simple functions using the definition, uniqueness limit if it exists, algebra of limits, limit of composite function, sandwich theorem, left-hand limit $\lim_{x\to a^-} f(x)$, right-hand limit $\lim_{x\to a^+} f(x)$, non existence of limits, $\lim_{x\to-\infty} f(x)$, $\lim_{x\to\infty} f(x)$ and $\lim_{x\to a} f(x)=\pm\infty$.

Continuous functions: Continuity of a real valued function on a set in terms of limits, examples, Continuity of a real valued function at end points of domain, Sequential continuity, Algebra of continuous functions, Discontinuous functions, examples of removable and essential discontinuity.

Practicals Based on Course : Calculus-1	
Sr. No.	Practicals
1	Application based examples of Archimedean property, intervals, neighbourhood.
2	Consequences of l.u.b. axiom, infimum and supremum of sets.
3	Calculating limits of sequences.
4	Cauchy sequences, monotone sequences.
5	Limit of a function and Sandwich theorem.
6	Continuous and discontinuous functions.

Reference Books:

(1) R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.

(2) K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.

(3) R.G. Bartle, D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.

(4) T. M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pvt. Ltd, 1991.

(5) R. Courant, F. John, A Introduction to Calculus and Analysis, Volume I, Springer.

(6) A. Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

(7) J. Stewart, Calculus, Third Edition, Brooks/Cole Publishing Company, 1994.

(8) S. R. Ghorpade, B. V. Limaye, A Course in Calculus and Real Analysis, Springer International Ltd, 2006.

VSC Course Code: RUSVSCMAT.O101
Course Title:Computations with Sagemath
Academic Year: 2023-24

CO	CO Description
CO1	To define and manipulate functions and symbols in Sagemath
CO2	Use Sagemath as a calculator
CO3	Use of graphics in Sagemath

Introduction to SageMath

1. Sage installation and use in various platforms. Using SageMath as an advanced calculator.
2. Defining functions and exploring concept of calculus.
3. Finding roots of functions and polynomials.
4. Plotting graph of 2D and 3D in SageMath.

Practical on VSC :Computations with Sagemath	
Sr. No.	Practicals
1	Defining functions and symbols in Sagemath
2	Plotting graphs using Sagemath
3	Manipulations with polynomials using Sagemath
4	Basic numerical methods using Sagemath

References:

1. George A. Anastassiou, Razvan A. Mezei (auth.)-Numerical Analysis Using Sage-Springer International Publishing (2015)

Modalities of Assessment

Theory Examination Pattern

(A) Internal Assessment - 30 Marks

Sr. No.	Evaluation Type	Marks
1	Test	20
2	Assignment/Viva/Test/Presentation	10
Total: 30 Marks		

(B) External Examination- 45 Marks

1. Duration: These examinations shall be of **two hours duration**.
2. Theory Question Pattern

Question	Marks	Questions Based on
Question 1	15	Unit-I
Question 2	15	Unit-II
Question 3	15	Unit-III

(C) Practical Examination - 50 Marks

Sr. No.	Evaluation Type	Marks
1	Assignment/Viva/Test/Presentation	20
2	Practical Examination	30
Total: 50 Marks		

Overall Examination and Marks Distribution Pattern

Semester-I

Course	RUSMAT.O101			RUSMATP.O101			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	30	45	75	20	30	50	125

Detailed Syllabus

FYBSc

Semester II

Department Specific Course

Subject-1 Course Code: RUSMAT.E111
Course Title: Calculus-II
Academic Year: 2023-24

CO	CO Description
CO1	to analyze the properties of continuous functions.
CO2	to identify differentiable functions.
CO3	to analyze properties of differentiable functions.
CO4	to test the convergence of series.

Unit I: Continuity of a function on an interval (15 Lectures)

Review of the definition of continuity (at a point and on the domain). Uniform continuity, sequential continuity, examples.

Properties of continuous functions such as the following:

1. Intermediate value property
2. A continuous function on a closed and bounded interval is bounded and attains its bounds.
3. If a continuous function on an interval is injective then it is strictly monotonic and inverse function is continuous and strictly monotonic.
4. A continuous function on a closed and bounded interval is uniformly continuous.

Unit II: Differentiability and Applications (15 Lectures)

Differentiation of a real valued function of one variable: Definition of differentiation at a point of an open interval, examples of differentiable and non differentiable functions, differentiable functions are continuous but not conversely, algebra of differentiable functions.

Chain rule, Higher order derivatives, Leibnitz rule, Derivative of inverse functions, Implicit differentiation (only examples).

Rolle's Theorem, Lagrange's and Cauchy's mean value theorems, applications and examples

Taylor's theorem with Lagrange's form of remainder (without proof), Taylor polynomial and applications

Monotone increasing and decreasing function, examples

Definition of local maximum and local minimum, necessary condition, stationary points, second derivative test, examples, concave, convex functions, points of inflection. Applications to curve sketching.

L'Hospital's rule without proof, examples of indeterminate forms.

Unit III: Series (15 Lectures)

Series $\sum_{n=1}^{\infty} a_n$ of real numbers, simple examples of series, Sequence of partial sums of a series, convergence of a series, convergent series, divergent series, Necessary condition: $\sum_{n=1}^{\infty} a_n$ converges $\Rightarrow a_n \to 0$, but converse is not true, algebra of convergent series, Cauchy criterion, divergence of harmonic series, convergence of $\sum_{n=1}^{\infty} \frac{1}{n^p}$ $(p > 1)$, Comparison test, limit comparison test, alternating series, Leibnitz's theorem (alternating series test) and convergence of $\sum_{n=1}^{\infty} \frac{(-1)^n}{n}$, absolute convergence, conditional convergence, absolute convergence implies convergence but not conversely, Ratio test (without proof), Root test (without proof), and examples.

Practicals Based on Subject-1 Calculus-II	
Sr. No.	Practicals
1	Calculating limit of series, Convergence tests.
2	Properties of continuous functions.
3	Differentiability, Higher order derivatives, Leibnitz theorem.
4	Mean value theorems and its applications.
5	Extreme values, increasing and decreasing functions.
6	Applications of Taylor's theorem and Taylor's polynomials.

Reference Books:

(1) R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.

(2) J. Stewart, Calculus, Third Edition, Brooks/cole Publishing Company,1994

(3) T. M. Apostol, Calculus Vol I, Wiley & Sons (Asia).

(4) R. Courant,F. John, A Introduction to Calculus and Analysis, Volume I, Springer.

(5) A. Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

(6) S. R. Ghorpade, B. V. Limaye, A Course in Calculus and Real Analysis, Springer International Ltd, 2006.

(7) K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.

(8) G. B. Thomas, Calculus, 12th Edition, 2009.

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Question 3	15	Unit-III

(C) Practical Examination - 50 Marks

Sr. No.	Evaluation Type	Marks
1	Assignment/Viva/Test/Presentation	20
2	Practical Examination	30
Total: 50 Marks		

Overall Examination and Marks Distribution Pattern

Semester-II

Course	**RUSMAT.E111**			**RUSMATP.E111**			**Grand Total**
	Internal	External	Total	Internal	External	Total	
Theory	30	45	75	20	30	50	125

VSC Course Code: RUSSECMAT.E111
Course Title:Computations with Scilab
Academic Year: 2023-24

CO	CO Description
CO1	To define and manipulate functions and symbols in Scilab
CO2	Use Scilab as a calculator
CO3	to learn basic programming in Scilab

Programming in Scilab

1. Basic introduction to SciLab, using SciLab as an advanced calculator.
2. Defining vectors and matrices and basic operations.
3. Plotting graphs in 2D and 3D in various forms.
4. Programming in Scilab

Practicals Based on Scilab	
Sr. No.	Practicals
1	Use of Scilab as a calculator
2	Plotting of various types of graphs using Scilab
3	Applied linear algebra using Scilab
4	Basic numerical methods using Scilab

References:

1. SciLab Textbook Companion For Higher Engineering Mathematics, B. S. Grewal.
2. SciLab Textbook Companion For Linear Algebra and Its Applications, D. C. Lay.
3. SciLab Textbook Companion For Numerical Methods, E. Balguruswamy.
4. Introduction to SciLab, Sandeep Nagar, Apress.