SNDT Women's University, Mumbai

Bachelor Of Science
(Mathematics)

B.Sc. In Mathematics

As Per NEP – 2020

Semester – I & II

Syllabus
(W.E.F. Academic Year 2025-26)

Terminologies

Vertical	Full-form/Definition	Remarks	Related to Major and Minor Courses
Major (Core)	Subject comprising Mandatory and Elective Courses, Major Specific IKS, Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major	Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses	Related to the Major
Minor Course	Course from same or different Faculty	Minimum 18-20 Credits to be completed in the first three years of UG Programme	Related to the Minor
OEC	Open Elective Courses/ Generic courses	10-12 credits to be offered in I and/or II year. Faculty-wise baskets of OEC to be prepared	OEC is to be chosen compulsorily from faculty other than that of the Major
VSC	Vocational Skill Courses, including Hands on Training corresponding to the Major and/or Minor Subject	8-10 credits, to be offered in first three years, wherever applicable vocational courses will include skills based on advanced laboratory practical's of Major	Related to the Majoror Minor
SEC	Skill Enhancement Courses	06 credits, to be offered in I and II year, to be selected from the basket of Skill Courses approved by university	Related to the Major or Minor any relevant Skill
AEC	Ability Enhancement Courses	08 credits, to be offered in I and II year, English: 04 Credits to be earned in Sem - I, Modern Indian Language of 04 credits to be offered in II year	NA
VEC	Value Education Courses	Understanding India, Environmental science/education, Digital andtechnological solutions, Health & Wellness, Yoga education, sports, and fitness	NA

IKS	Indian Knowledge System	Generic IKS Course: basicknowledge of the IKS to be offered at First Year level	Major-Specific IKS Courses: advanced information about the major, part of the major credit to be offered at second- or third-year level
OJT	On-Job Training (Internship/Apprenticeship)	Corresponding to the Major Subject	Related to the Major
FP	Field projects	Corresponding to the MajorSubject	Related to the Major
CC	Co-curricular Courses	Health and Wellness, Yoga education sports, and fitness,Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts	NA
CE	Community Engagement andservice		Related to Major
RP	Research Project	corresponding to the MajorSubject	Related to Major

Program Template

Degree		B.A. / B.Sc. (Honours / Honours with Research)
Major/ **Program**		Mathematics (2024 Pattern)
Preamble		This program's distinctive approach provides fundamental, high-qualityknowledge in all significant fields of both pure and applied mathematics.In addition, it offers a comprehensive instructionalprogramme with thoughtfully thought-out credit distribution. Fiftypercent of the credits aremade up of the major core courses, major specific elective courses, andrelevant skill courses. Interdisciplinary minors, open electives, and major-specific IKS coursesare added to this course to enhance the curriculum and promote flexibility. Vocational skill courses and skill enhancementcourses are designed to enhance practical skills, whereas ability enhancement courses, IKS, and value education courses emphasize overall growth. Managing our daily lives and minimizing chaos using the help of mathematics is a powerful instrument that not just helps us understand the world around us but also serves as an efficient means of cultivatingmental discipline. It is anticipated that students will acquire life skills including communication, argumentation, and general social values—allof which are essential for leading a fulfilling, wealthy, and successful life. Additionally, the students are in high demand due to their computationalexpertise and mathematical modeling models.
Programme SpecificOutcomes (PSOs)		After completing this program, the learner will be able to,
	1	Demonstrating basic knowledge of mathematical skills, programming,and computational techniques required foremployment.
	2	Applying the foundational understanding of mathematical concepts andprogramming techniques to solve real-life problemseffectively.
	3	Designing mathematical models for real-life situations by utilizingProgramming and computational techniques as required.

	4	Critically analyzing results obtained from mathematical modelsand problem-solving processes, evaluating their effectiveness,and identifyingareas for improvement.
	5	Applying acquired knowledge and skills to solve complex problems,demonstrating the potential to contribute as a researcher in mathematics and related fields.
	6	Demonstrating effective communication skills in both written and verbal forms to convey mathematical concepts, research findings,and problem- solving methodologies clearly and effectively.
Eligibility Criteria for Programme		H.S.C. / (10+2) with mathematics or equivalent from arecognized board **or** 10+3 Diploma (any stream) awarded by any state board oftechnicaleducation.
Intake		

Structure with Course Title

B.Sc. In Mathematics

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
10032301	Algebra – I	Major (Core)	2	50	50	0
		Major (Core)	2	50	50	0
		Major (Core)	2	50	50	0
10432311	A) Mathematics for Business and Management -I	OEC **(Any Two)**	4	100	50	50
10432312	B) Bio-Mathematics I					
10432313	C) Basic Mathematics for competitive examination					
10632301	Foundation Course in Mathematics-I	VSC S1	2	50	50	0
10732301	Basic Course in Excel	SEC	2	50	0	50
10810111	English For Academic Writing-Paper I (For Students of English Medium)	AEC (English) **(Any One)**	2	50	0	50
10810112	English Language and Literature- I (For Students of Non-English medium)					
11051111	Inception of India Knowledge System	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution	VEC	2	50	0	50
11450121	Basics of National Service Scheme	CC **(Any One)**	2	50	50	0
11450221	National Cadets Corps. (NCC) Studies- I					
11450322	Health and Wellness					

11450421	Performing Arts Exploration					
			22	**550**	**300**	**250**

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester II					
20032311	Calculus –I	Major (Core)	2	50	0	50
		Major (Core)	2	50	0	50
		Major (Core)	2	50	0	50
		VSC S2	2	50	50	0
		VSC S3	2	50	50	0
20432311	A) Mathematics for Business and Management II	OEC **(Any Two)**	4	100	50	50
20432312	B) Bio-Mathematics -II					
20432313	C) Advanced Mathematics for Competitive Exam					
20732301	Advanced Course in Excel	SEC	2	50	50	0
20810111	English For Academic Writing-Paper II (For Students of English Medium)	AEC (English) **(Any One)**	2	50	0	50
20810112	English Language and Literature- II (For Students of Non-English medium)					
20952111	Environment Awareness	VEC	2	50	0	50
21450121	Volunteerism and National Service Scheme	CC **(Any One)**	2	50	50	0
21450221	National Cadets Corps. (NCC) Studies- II					
21450323	Yoga Education					
21450421	Fine Art					
			22	**550**	**250**	**300**

Exit with UG Certificate with 4 extra credits (44 + 4 credits)

Syllabus

Semester I

1.1 Major (Core)

Course Title	**Algebra: I**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Recognize** prime numbers, apply Euclid's Lemma, and understand basicproperties of divisibility in integers.
	2. **Demonstrating** a deep understanding of Well-Ordering Principle, FirstPrincipleof Finite Induction and their implications in number theory.
	3. **Demonstrate** the application of equivalence relations in understanding theconcept of partitions.
	4. **Analyze** the properties and relationships between different types offunctions,evaluating the conditions for injectivity, subjectivity, and bijectivity.
Module1(Credit1) - Integers and Divisibility	
Learning Outcomes	After learning the module, learners will be able to
	1. **Construct:** rigorous mathematical proofs for advanced concepts, suchas theWell-ordering principle, Euclid's lemma, and the infinite primes.
	2. **Develop:** advanced problem-solving skills in number theory, show casingproficiency in applying the division algorithm, Euclidean algorithm, and binomialtheorem.

Content Outline	• Well-ordering principle, First principle of finite induction, Binomial theorem for non- negative exponents, Pascal Triangle. • Divisibility in integers, division algorithm, greatest common divisor (G.C.D.) and least common multiple (L. C. M.) of two non-zero integers, basic properties of G.C.D., Euclidean algorithm. • Primes, Euclid's lemma, Fundamental Theorem of arithmetic. • Theorems: The set of primes is infinite; there are arbitrarily large gaps between primes. • Congruence, definition, and elementary properties with examples.
Module2(Credit1) – Relations and Functions	
Learning	After learning the module, learners will be able to
Outcomes	1. **Achieve** mastery in function theory and application, show casing the ability to evaluate, apply, and create functions.
	2. **Apply** the properties of equivalence relations, such as the concept ofequivalence classes and the relationship between partitions and equivalence relations.
Content Outline	• Definition of relation, types of relations, Equivalence relation,Equivalence classes. • Properties such as two equivalence classes are either identical or disjoint, Definition of partition, every partition gives an equivalencerelation and viceversa. • Congruence is an equivalence relation on Z, Residue classes and partitionof Z,Addition modulo n, Multiplication modulo n, examples • Definition of function, domain, co-domain and range of a function, composite functions, examples, inverse image of a function, injective,surjective, bijectivefunctions. • Composite of injective, surjective, bijective functions, invertiblefunctions,bijective functions are invertible and conversely.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students are instructed to choose any five statements associated with the natural number system.Use the principle of finite induction to construct a detailed proof for

it. Make a detailed record of the proof. Submit the report to the course instructor. (CO1)

2. Students are suggested to create their own five equivalence relations using everyday life examples. This could involve identifying relationships between peoples (e.g. friends, siblings) or any other relevant category. Also, determine the equivalence classes. Make the note of all equivalence classes of all five relations. Submit the report to the course instructor. (CO3)

References:

1. Burton D. M., Elementary Number Theory, Seventh Edition, Mc-Graw Hill Education (India)Private Ltd.

2. Norman L. (1989) Discrete Mathematics. Revised Edition. Clarendon Press, Oxford.

3. NivenI, Zuckerman. S.(1972). Introduction to the theory of numbers. Third Edition. WileyEastern New Delhi.

4. Herstein I. N. (2006). Topics in Algebra. John Wiley.

5. Bhattacharya P. B., Jain S. K. and Nagpaul S. R. (1994) Basic Abstract Algebra. New AgeInternational.

6. Anton H., Bivens I. and Davis S. (2016). Calculus. (10 th edition). Wiley India.

1.2 Open Elective Courses/ Generic (OEC)

(Choose Any Two from A, B and C)

A - OEC: Mathematics for Business and Management -I

Course Title	**Mathematics for Business and Management -I**
Course Credits	**2**
Course Outcomes	1. After going through the course, learners will be able to
	2. **Define** and explain basic concepts of averages, ratio, proportion, percentages,profit, and loss.
	3. **Analyze** and solve real-world problems involving advanced applications ofaverages, ratio, proportion, percentages, profit, and loss.
	4. Explain the significance and applications of simple and compound interest,annuity, present value, future value, and EMI calculations.
	5. **Analyze** and apply financial calculations involving simple and compound interest, annuity, present value, future value, and EMI in real-world scenarios.
Module1(Credit1) - Basic Mathematical Concepts	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic mathematical concepts of averages, ratio, proportion,percentages, profit, and loss in problem-solving.
	2. **Analyze** and interpret advanced scenarios involving ratios, percentages, andfinancial calculations.
Content Outline	• Averages • Ratio and proportion • Percentages • Profit and loss
Module2(Credit1) - Financial Calculations and Applications	
Learning Outcomes	After learning the module, learners will be able to

	1. **Apply** financial formulae to compute and interpret basic financial calculations.
	2. **Evaluate** and strategize complex financial scenarios using advanced financialconcepts.
Content Outline	• Simple and compound interest • Annuity • Present Value and Future Value • EMI (Equated Monthly Installments)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Educational Videos Creation

Student groups will collaborate to create educational videos explaining basic concepts in averages, ratio, proportion, percentages, profit, and loss. They will share these videos for peerlearning and discussions, enhancing understanding through engaging multimedia content. (CO1)

2. Complex Problem Solving in Finance

Groups will solve complex real-world problems related to advanced financial calculations andpresent their solutions. They will discuss their problem-solving methods, offer critical evaluations, and engage in discussions to showcase proficiency in applying advanced financialconcepts. (CO2)

3. Interactive Quizzes/ Games

Students will collaborate in groups to create interactive quizzes or games explaining concepts of simple and compound interest, annuity, present/future value, and EMIs. They will engagepeers in learning through these interactive activities, fostering a deeper understanding of financial concepts. (CO3)

4. Financial Modeling

Groups will analyze and apply advanced financial calculations to real-world scenarios involvinginterest, annuity, present/future value, and EMIs. They will present their models, interpretations, and evaluate the reliability and relevance of their solutions. (CO4)

References:

1. Dikshit A., and Jain J. K. *Business Mathematics*.
2. Hazarika P.. *Business Mathematics*. Delhi: Sultan Chand and Sons.
3. Bari. *Business Mathematics*. Mumbai: New Literature Publishing Company.
4. Gupta, J. D., Gupta, P. K., and Mohan, M. (1987). *Mathematics for Business Economics*. TataMc Graw Hill Publishing Co. Ltd.

B - OEC: -Bio-Mathematics-I

Course Title	**Bio-Mathematics-I**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Describe** the basic principles of exponential functions, outlining their fundamental properties and how they differ from other types of functions.
	2. **Analyze** and evaluate the behavior and characteristics of exponential functionsin various contexts, comparing them with other function types anddemonstrating their applications in real-
	3. **Define** and explain the foundational concepts of calculus, including limits,derivatives, and identify the differentiation rules for basic functions.
	4. **Analyze** and apply differentiation techniques to solve complex problemsinvolving various functions and their derivatives.
Module1(Credit1) - Exponential and Logarithmic Functions	
Learning Outcomes	After learning the module, learners will be able to
	1. **Analyze** and apply fundamental functions and their properties.
	2. **Solve** equations involving exponential and logarithmic functions.
Content Outline	• Introduction to exponentials • Functions and graphs • Logarithm, Functions • Constant function, linear function, Quadratic functions, and equations.
Module2(Credit1) - Calculus and Differentiation Techniques	

Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** differentiation rules to various functions.
	2. **Analyze** and interpret derivatives as rates of change.
Content Outline	• Introduction to Calculus • Limits • Derivative, Derivatives as a Rate of Change, • Derivatives of function: Constant function, x_n, e^x, a^x, logx, trigonometricfunctions • Differentiation rules: Scalar multiplication, addition, subtraction, productandquotient, simple examples.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. **Comparative Analysis Presentation (CO1)**

Students will form groups to research and present a comparative analysis illustrating the unique properties of exponential functions compared to linear or polynomial functions. They will show case graphical representations and real-world examples to highlight the distinctions in behavior and characteristics.

2. **Real-life Case Studies (CO2)**

Groups will create case studies demonstrating the behavior and real-world applications of exponential functions in diverse contexts like finance, biology, or physics. They will detailscenariosandexplainhowexponentialfunctionsbehavedifferentlyandtheirsignificancei n practical applications.

3. **Tutorial Creation (CO3)**

Students will collaborate in groups to create tutorials or video presentations explaining calculusconcepts such as limits, derivatives and differentiation rules. The tutorials will aim for comprehensive coverage and clarity to aid fellow students' understanding.

4. **Complex Problem Solving (CO4)**

Groups will solve complex problems involving differentiation techniques applied to functions andtheir derivatives. They will present their solutions, discussing problem-solving strategies and interpretations of results to showcase their comprehensive understanding.

References:

1. Waner S. and Constenoble S. *Applied Calculus* (2nd ed.). Brooks/ Cole Thomson Learning. Anthony
2. M. and Biggs N. (2000). *Mathematics for Economics and Finance: Methods and Modelling*
3. (Cambridge low-priced edition). Cambridge University Press.
4. Dikshit, A. and Jain, J. K. *Business Mathematics*.
5. Hazarika P. *Business Mathematics*. Delhi: Sultan Chand & Sons.

C - OEC: Basic Mathematics for competitive examination

Course Title	**Basic Mathematics for competitive examination**
Course Credits	**2**
Course Outcomes	After completing this course, learner will be able to
	1. **Understand** and apply foundational concepts of the number system, including numerals, place value, basic operations, number series, H. C. F.and L. C. M., as well as simple and decimal fractions, proficiently at a foundational level.
	2. **Analyze**, evaluate, and apply advanced techniques in number manipulation,fraction operations and fast track formulae effectively,demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. **Apply** fundamental arithmetic operations involving squares, cube roots,indices, VBODMAS rule, and simplification techniques in solving basic numericalproblems.
	4. **Analyze** complex mathematical problem-solving strategies integrating squares, surds, word problems, and advanced mathematical concepts todeviseinnovative solutions.
Module1(Credit1) - Numbers	
Learning Outcomes	After learning this module, learner will be able to
	1. **Demonstrate** a comprehensive understanding of the number system, including numerals, place value, face value, basic arithmetic operations, divisibility rules, number series, and types of series.
	2. **Apply** advanced techniques to compute H. C. F. and L. C. M. for largernumbers and polynomials, manipulate complex fractions and decimal operations, and employ sophisticated problem-solving strategies for challenging mathematical questions.

Content Outline	• Number system, Numerals, Face value and place value of the digit in anumber,Operations on numbers, Divisibility of numbers • Number Series, Types of series of numbers • H. C. F. and L. C. M. • Simple and decimal fractions, operations on fractions • Fast track formulae to solve the questions.
Module2(Credit1) - Numerical Aptitude	
Learning Outcomes	After learning this module, learner will be able to
	1. **Demonstrate** proficiency in performing arithmetic operations involving squares, square roots, cubes, cube roots, indices, surds and applying the VBODMAS rule, enabling them to solve mathematical problems accurately.
	2. **Develop** the ability to analyze complex word problems, apply appropriate mathematical techniques involving approximation, simplification by rule, andproperties of numbers, there by devising solutions to real-world scenarios integrating numerical concepts effectively.
Content Outline	• Square and Square roots, Cube and Cube roots • Indices, surds: Properties and operations • VBODMAS rule, simplification by rule • Approximation • Word problems based on numbers

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to solve questions based on above topic from banking examinations
2. VBODMAS rule application

Reference Books:

1. Verma R. Fast Track Objective Arithmetic (Complete revised edition). Arihant Publications(India) Limited.
2. Aggarwal R. S. Quantitative Aptitude for Competitive Examinations.
3. Aggarwal R. S. Objective Arithmetic (SSC and Railway Exam Special).
4. Sharma A. Teach Yourself Quantitative Aptitude.

1.5 Vocational Skill Courses (VSC)

Course Title	**Foundation Course in Mathematics I**
Course Credits	**2**
Course Outcomes	After completing this course, learner will be able to
	1. **Explain** the fundamental concepts of sets, set operations and basicoperationsrelated to complex numbers.
	2. **Demonstrate** advanced analytical skills by critically evaluating complex number theories, including geometric representations, polar forms, and applying sophisticated theorems such as De-Moivre's theorem.
	3. **Grasp** the introductory concepts of geometry, understanding equationsand thegeometrical structures of lines, planes, spheres, and cones
	4. **Analyze** and evaluate the properties and interrelations among various numbersystems, such as natural, integer, rational, irrational, and realnumbers
Module1(Credit1) - Sets and Complex Numbers	
Learning Outcomes	After learning this module, learner will be able to
	1. **Articulate** and elucidate the fundamental principles underlying sets, set operations and the basic operations associated with complex numbers, showcasing a clear and comprehensive understanding of these core mathematical concepts.
	2. **Demonstrate** advanced analytical skills by critically evaluating And synthesizingcomplex number theories, including intricate geometric representations, polar forms, and the application of sophisticated theoremssuch as De-Moivre's theorem,showcasing a high-level understanding and application of complex mathematical concepts.
Content Outline	• Sets; describing a set, Subsets, Set operations, Indexed collection ofsets, Partition, Cartesian product, numerically equivalent sets, Denumerable sets,Uncountable sets. • Cartesian form of complex numbers, Geometrical representation, Sum,Subtraction, Multiplication and Division of complex numbers, Basic algebraic properties,

	Polar form of complex number, Properties of modulus and argument, Complex conjugate, De-Moivre's theorem.
Module2(Credit1) - Number system and Geometry	
Learning Outcomes	After learning this module, learner will be able to
	1. **Differentiate** and apply the properties of natural numbers, integers, rationalandirrational numbers, and real numbers.
	2. **Evaluate** the fundamental concepts of geometry, including equations and thegeometrical structures of lines, planes, spheres, and cones, showcasing an in-depth understanding and the ability to analyze and interpret complex mathematical properties.
Content Outline	• Natural numbers and properties of natural numbers • Integers, Rational and irrational numbers • Real numbers, properties of real numbers • Geometry: Introduction to equation and geometrical structure of line,Plane,Sphere and Cone.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

a. Applications of De-Moivres theorem

b. Various equations of geometrical structures are to be given to the students and ask to findtheir structure.

Reference Books:

1. Chartrand, G., Polimeni, A. D., & Zhang, P. *Mathematical Proofs: A Transition toAdvancedMathematics* (3rd ed.). Pearson.

2. Brown J. W. and Churchill R. V. *Complex Variables and Applications* (7^{th} ed.). McGraw Hill.

3. Stewart I. and Tall, D. *The Foundations of Mathematics* (2^{nd} ed.). Oxford.

4. Joshi M. *Proof Patterns*. Springer.

5. Shantinarayan. *Analytical Solid Geometry*. New Delhi: S. Chand and Company Ltd.

1.6 Skill Enhancement Courses (SEC)

Course Title	**Basic Course in Excel**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Exhibit** an understanding of creating basic charts and graphs and utilizingExcelfunctions to sort data in ascending and descending order.
	2. **Apply** analytical skills to sort data efficiently in ascending and descendingordersusing Excel functions.
	3. **Exhibit** knowledge in basic Excel functions such as MIN, MAX, COUNT, anddemonstrate competency in utilizing Excel tools like sorting, filtering, and auto fillfor efficient data management.
	4. **Evaluate** Excel functions beyond basic levels, exploringand integrating advancedfeatures like Cell Comments, Find and Replace, and Page Layouttools
Module1(Credit1) - Basic Excel Functions and Data Visualization	
Learning Outcomes	After learning the module, learners will be able to
	1. **Utilize** basic Excel functionalities, including performing fundamental arithmetic operations (addition, subtraction, multiplication, division) on variedcell values.
	2. **Demonstrate** expertise in creating visually appealing charts and graphstointerpret intricate data patterns
Content Outline	• Introduction to Excel • Addition, Subtraction, Multiplication, Division of values in different cells [BasicArithmetic Operators] • To prepare basic Charts and Graphs • To create visually appealing charts and graphs to represent datatrends andpatterns. • To sort the data in increasing and decreasing order

Module2(Credit1) - Advanced Excel Tools and Data Management	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic Excel functions (e.g., MIN, MAX, COUNT) and utilize essentialExceltools like sorting, filtering, auto fill, and Fill Handle for efficient data management.
	2. **Display advanced** proficiency in utilizing Excel functions and tools such asCell Comments, Find and Replace, and Page Layout, employing them strategically foradvanced data analysis and manipulation.
Content Outline	• Cell Comments, Find and Replace and Page Layout • Various Functions in Excel like MIN, MAX, COUNT • Use of Sorting and Filtering to display the content from specific group • Use AutoFill to populate a series of numbers or dates • Create a series of months or days using the Fill Handle.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Applications of Basic Arithmetic Operators.
2. Draw charts and graphs
3. Sort data in ascending or descending order
4. Application of MIN, MAX, COUNT
5. Create a series of Months or days.

References:

1. Microsoft Excel Bible: The Comprehensive Tutorial Resource.
2. Excel: Quick Start Guide from Beginner to Expert (Excel, Microsoft Office)
3. Thompson, M. (2021). Excel *2021*.

Semester-II

2.1 Major (Core)

Course Title	**Calculus-I**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Demonstrate** an understanding of the sequence of real numbers and their limits through examples. Explain the concept to absolute value and its role inreal numbers.
	2. **Evaluate** the convergence and divergence of sequences. Assess the significance of monotone and bounded sequence in mathematical analysisand real-world applications.
	3. **Apply** basic algebraic operations to continuous functions and demonstrateunderstanding of bounded-ness.
	4. **Apply** theorems to determine the existence of maximum and minimum values for continuous functions on closed intervals.
Module1(Credit1)- Sequences of Real Numbers	
Learning Outcomes	After learning the module, learners will be able to
	1. **Articulate** a comprehensive understanding of the algebraic and orderproperties of real numbers including the completeness and Archimedeanproperty of real numbers.
	2. **Synthesize** knowledge of limit theorems to formulate and prove statements related to the behavior of sequences. Develop proofs independently for advanced limit theorems.

Content Outline	• Algebraic and order properties of real numbers, absolute value, completenessproperty, Archimedean property, density of rational numbers, • Sequences of real numbers and their limits examples, • Limit theorems (only statements), Limit of some standard sequences • $\frac{1}{n}$ $\forall\ x > 0$; $(x^n)\ \forall\ x\ 0 < x < 1$; $(x)\ \forall\ x > 0$ $\frac{1}{x+n}$ • Monotone and bounded sequences, Subsequences
Module2(Credit1) – Limits and Continuity	
Learning Outcomes	After learning the module, learners will be able to
	1. **Demonstrate** a comprehensive understanding of limits and continuity inreal-valued functions.
	2. **Apply** advanced limit theorems to analyze and solve real-world problemsinvolving functions.
Content Outline	• Limit of a real-valued function and Limit theorems • Right hand limit, Left hand limit, Sequential criteria for limit • Continuous functions • Algebra of continuous functions, discontinuous functions • Boundedness theorem (statement), Maximum-Minimum theorem forcontinuousfunctions (statement), Intermediate value theorem (statement), examples

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students are suggested to create five examples of convergent sequence and five examples of divergent sequence. Make the detail note for the solutions of convergence and divergence of the sequences. Submit the report to course instructor. (CO2)

2. Consider the function $f(x) = \frac{|x-b|}{x-b}$, $x \in R$; $b \in [0, 100] \cap N$

Discuss the continuity of the function at x = b. List all natural values of **b** for which

function f is discontinuous in the prescribed domain. Make the record of detail calculation for any five values of b.Submit the report to the course instructor. (CO3)

References:

1. Goldberg, R. R. (1915) Methods of Real Analysis, Oxford and IBH.
2. Ghorpade S., Limaye B. (2000). A course in Calculus and Real Analysis, Springer InternationalLtd.
3. Binmore, K. G. (1982). Mathematical Analysis. Cambridge University Press.
4. Bartle R., Sherbert D. Introduction to Real Analysis. Third Edition. John Wiley and Sons Inc.
5. Apostol T. M., Calculus Vol. I, John Wiley, New York. Antonn H. Bivens I., Davis.S. (2016).Calculus (10 th edition). Wiley India.

2.6 Open Elective Courses/ Generic (OEC)

(Choose any Two from A, B and C)

A - OEC: Mathematics for Business and Management II

Course Title	**Mathematics for Business and Management II**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain basic concepts in preliminary descriptive statistics, such as frequency tables, histograms and measures of central tendency (mean, mode, median).
	2. **Apply** and critically analyze preliminary descriptive statistics techniques tointerpret and analyze data.
	3. **Define** and explain fundamental concepts in basic probability theory, includingsample space, events, axioms of probability, conditional probability.
	4. **Analyze** and apply fundamental probability concepts to solve complex real-worldproblems.
Module1(Credit1) - Descriptive Statistics and Data Analysis	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic descriptive statistical tools to summarize data.
	2. **Analyze** and interpret data using preliminary descriptive statistics.
Content Outline	• Preliminary Descriptive Statistics • Introduction • Frequency Tables, • Histograms, • Measures of Central Tendency: Mean, Modeand and Median.
Module2(Credit1) - Fundamentals of Probability Theory	

Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic probability concepts to analyze simple scenarios.
	2. **Analyze** and solve complex problems using fundamental probability principles.
Content Outline	• Basic Probability theory, • Introduction, • Sample space and events • Axioms of Probability • Conditional Probability • Addition and Multiplication theorem (without proof) • simple examples.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Descriptive Statistics Fair: Divide students into groups, and assign each group one fundamental concept from descriptive statistics: frequency tables, histograms, mean, mode, or median. The goal is for each group to prepare an engaging and interactive booth or station at a "Descriptive Statistics Fair" to educate others about their assigned concept.

2. Data Analysis Showcase: Students will form groups and be provided with a dataset related to aspecific industry or real-world scenario (e.g., finance, healthcare, marketing).The objective is foreach group to analyze the dataset using descriptive statistics techniques and present their findings in a showcase.

3. Visual Guides Creation: Student groups will create collaborative posters or visual guides detailingbasic descriptive statistics concepts. Theywillpresentthesevisualstotheclasstofacilitategroupdiscussions and deepen understanding.

4. Complex Data Analysis: Groups will analyze complex datasets using preliminary descriptive statistics techniques. They'll present their analyses, discuss implications, limitations, and critically evaluate interpretations to showcase proficiency in applying and analyzing statistical methods.

References

1. Elhance D. N. *Fundamentals of Statistics*.

2. Gupta S. G. *Statistical Methods*. S. Chand & Co.

3. Aggarwal B. *Business Mathematics & Statistics*. An e-Book Pvt. Limited.

4. Schaum Series. *Statistics*.

B - OEC: - Bio Mathematics II

Course Title	**Bio-Mathematics-II**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain the foundational concepts of probability theory, includingsample space, events and basic axioms of probability.
	2. **Apply** conditional probability and probability theorems to solve complexproblems in various scenarios.
	3. **Define** and explain the basic concepts of probability distributions and randomvariables, including discrete and continuous variables.
	4. **Apply** probability distributions and mathematical expectation to model andanalyze real-world problems.
Module1(Credit1) - Basic Probability Concepts and Theorems	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic probability concepts to analyze events.
	2. **Utilize** conditional probability and theorems in probability calculations.
Content Outline	• Basic Probability Theory • Introduction, • Sample space and events, • Axioms of probability, • conditional probability, • addition and multiplication theorem.
Module2(Credit1) - Probability Distributions and Expectations	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** probability distributions to model random phenomena.

	2. **Calculate** and interpret mathematical expectations in probability distributions.
Content Outline	• Probability Distribution • Random variable, • continuous and discrete variables, • mathematical expectation, • Binomial distribution, • Poisson distribution, • Normal distribution

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. **Interactive Presentations (CO1)**
   Student groups will create interactive presentations or info-graphics explaining fundamentalprobability theory concepts. They will design interactive elements to engage the audience,ensuring a comprehensive understanding of these concepts.

2. **Complex Probability Problem Solving (CO2)**
   Students will work collaboratively in groups to tackle complex probability problems involvingconditional probability and theorems. They will present solutions, discuss problem -solving strategies, and critically evaluate their approaches for diverse scenarios.

3. **Educational Visuals Creation (CO3)**
   Groups will collaboratively create educational posters or visual aids explaining probability distributions and random variables. They will present the sevisuals, encouraging interactivediscussionsto ensure a comprehensive grasp of these concepts.

4. **Real-world Modeling (CO4)**
   Students will analyze real-world scenarios and model them using probability distributions and mathematical expectation. They will present their models, interpretations, and implications of findings to demonstrate the application of these concepts in practical scenarios.

References:

1. Walpole R. E. and Myers R. H. *Probability and Statistics for Engineers and Scientists*.

2. Veerarajan T. (2002). *Probability, Statistics and Random Process*. Tata Mc Graw-Hill Education.

3. Grinstead C. and Snell J. (1997). *Introduction to Probability*. American Mathematical Society.

4. Yates, R. D., & Goodman, D.J. (1998). *Probability and Stochastic Processes*. John Wiley and Sons.

C - OEC: - Advanced Mathematics for Competitive Exam

Course Title	**Advanced Mathematics for competitive examination**
Course Credits	**2**
Course Outcomes	After completing this course, learner will be able to
	1. **Demonstrate** a foundational understanding of basic mathematical conceptsincluding Average, Percentage, Profit and Loss, Commission and Discount, Simpleand Compound Interest, and Ratio and Proportion.
	2. **Analyze** and evaluate the intricacies of mathematical concepts such as Average,Percentage, Profit and Loss, Commission and Discount, Simple and Compound Interest, and Ratio and Proportion.
	3. **Demonstrate** a foundational understanding of mathematical concepts including Mixture and Alligation, Partnership, Problems based on ages, Work and Time, Work and wages problems.
	4. **Analyze** and evaluate the intricacies of mathematical principles such as Mixture and Alligation, Partnership, Problems based on ages, Work and Time, and Work and wages problems.
Module1(Credit1) - Numerical Aptitude I	
Learning Outcomes	After learning this module, learner will be able to
	1. **Demonstrate** a proficient understanding of fundamental mathematical conceptssuch as Average, Percentage, Profit and Loss, Commission and Discount, Simpleand Compound Interest, and Ratio and Proportion.
	2. Critically **analyze** and synthesize the intricacies of mathematical principles including Average, Percentage, Profit and Loss, Commission and Discount, Simpleand Compound Interest, and Ratio and Proportion
Content Outline	• Average, Percentage • Profit and Loss • Commission and Discount • Simple and compound interest • Ratio and proportion

Module2(Credit1) - Numerical Aptitude II	
Learning Outcomes	After learning this module, learner will be able to
	1. **Demonstrate** a proficient understanding of fundamental mathematical conceptssuch as Mixture and Alligation, Partnership, Problems based on ages, Work and Time, Work and wages problems.
	2. Critically **analyze** and synthesize the intricacies of mathematical principles including Mixture and Alligation, Partnership, Problems based on ages, Work andTime, and Work and wages problems.
Content Outline	• Mixture and Alligation • Partnership • Problems based on ages • Work and Time • Work and wages

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Problems from banking examinations are to be asked to be solved to the students.

2. Various quantitative aptitude tests can be solved by students.

Reference Books:

1. Verma R. *Fast Track Objective Arithmetic* (Complete revised edition). Arihant Publications(India) Limited.

2. Aggarwal R. S. *Quantitative Aptitude for Competitive Examinations*.

3. Aggarwal R. S..*Objective Arithmetic (SSC and Railway Exam Special)*.

4. Sharma A. *Teach Yourself Quantitative Aptitude*.

2.7 Skill Enhancement Courses (SEC)

Course Title	**Advanced Course in Excel**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Grasp** the concepts of Power Query and Power Pivot, comprehending theirapplications within Excel for data manipulation and analysis.
	2. **Grasp** the concepts of Power Query and Power Pivot, comprehending theirapplications within Excel for data manipulation and analysis.
	3. **Create** combo charts with multiple chart types on a single graph and utilizeSparklines for miniature chart representations within individual cells.
	4. **Apply** critical thinking to explore advanced features of Hyperlinks, showcasingtheir understanding and aptitude for utilizing interactivity within Excel for sophisticated data representation and navigation."
Module1(Credit1) - Power Query and Power Pivot	
Learning Outcomes	After learning the module, learners will be able to
	1. Perform calculations on arrays of data using functions like SUM PRODUCT orarray constants, showcasing and understanding of fundamental data manipulation techniques
	2. Apply Power Query and Power Pivot, demonstrating a high level of understanding and skill in utilizing the tools for complex data analysis and manipulation withinthe Excel environment.
Content Outline	• Introduction, Basic Arithmetic Operators • Perform calculations on arrays of data using functions like SUM PRODUCT or array constants • Power Query and its applications in Excel • Power Pivot and its applications in Excel
Module2(Credit1) - Advanced Charting and Data Interactivity	
Learning	After learning the module, learners will be able to

Outcomes	1. Demonstrate a proficient understanding of Dynamic Arrays in Excel, showcasingthe ability to effectively apply them in various scenarios
	2. Create combo charts combining multiple chart types and implement Sparklines to represent data concisely.
Content Outline	• Dynamic Arrays and its applications in Excel • Create combo charts with multiple chart types on the same graph • Use Spark lines for miniaturized charts within individual cells • Hyperlinks and Interactivity and its Applications

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Collect data from bank, industry, hospitals or shops and apply the functions you learn on thatdata and conclude.

References:

1. Microsoft Excel Bible: The Comprehensive Tutorial Resource.
2. Excel: Quick Start Guide from Beginner to Expert (Excel, Microsoft Office)
3. Thompson M. (2021). *Excel 2021*.