SNDT Women's University, Mumbai

Bachelor of Science (Mathematics)

B.Sc. (Mathematics)

As Per NEP - 2020

Syllabus

(2024-2025)

Credit structure For Under Graduate Programmes in Humanities, Science and Technology and Interdisciplinary Studies Faculties
(2024 May as per GR dated 13/03/2024)

	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total
Subject No 1 (to be treated as Major)	4		12	12	8	10	**46**
Subject No 2 (A and B), so minor	2	2	2		4	4	**14**
Subject No 3		4					**4**
VSC S1	2				2		**4**
VSC S2		2					**2**
VSC S3		2					**2**
Major (Elective)					4	4	**8**
OEC	4	4	2	2			**12**
SEC	2	2		2			**6**
AEC (English)	2	2	2	2			**8**
AEC (Modern Indian Language)			2	2			**4**
VEC	2	2					**4**
CC	2	2	2	2			**8**
IKS (Generic)	2						**2**
IKS (Major-Specific)					2		**2**
FP					2		**2**
OJT						4	**4**
	22	**22**	**22**	**22**	**22**	**22**	**132**

Terminologies

Abbreviation	Full-form	Remarks	Related to Major and Minor Courses
Major (Core)	Main Discipline		
Major (Elective)	Elective Options		related to the Major Discipline
Minor Stream	Other Disciplines (Inter/ Multidisciplinary) not related to the Major	either from the same Faculty or any other faculty	
OEC	Open Elective Courses/ Generic		Not Related to the Major and Minor
VSC	Vocational Skill Courses		Related to the Major and Minor
SEC	Skill Enhancement Courses		Not Related to the Major and Minor
AEC	Ability Enhancement Courses	Communication skills, critical reading, academic writing, etc.	Not Related to the Major and Minor
VEC	Value Education Courses	Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness	Not Related to the Major and Minor
IKS	Indian Knowledge System	I. Generic IKS Course: basic knowledge of the IKS II. II. Subject-Specific IKS Courses: advanced information about the subject: part of the major credit	Subject Specific IKS related to Major
OJT	On-Job Training (Internship/Apprenticeship)	corresponding to the Major Subject	Related to the Major
FP	Field projects	corresponding to the Major Subject	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	Not Related to the Major and Minor
CE	Community Engagement and service		Not Related to the Major and Minor
RP	Research Project	corresponding to the Major Subject	Related to the Major

Programme Template:

Degree		B.A. / B.Sc. (Honours / Honours with Research)
Major/ Program		Mathematics (2024 Pattern)
Preamble		This program's distinctive approach provides fundamental, high-quality knowledge in all significant fields of both pure and applied mathematics. In addition, it offers a comprehensive instructional programme with thoughtfully thought-out credit distribution. Fifty percent of the credits are made up of the major core courses, major specific elective courses, and relevant skill courses. Interdisciplinary minors, open electives, and major-specific IKS courses are added to this course to enhance the curriculum and promote flexibility. Vocational skill courses and skill enhancement courses 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 cultivating mental discipline. It is anticipated that students will acquire life skills including communication, argumentation, and general social values—all of which are essential for leading a fulfilling, wealthy, and successful life. Additionally, the students are in high demand due to their computational expertise and mathematical modeling models.
Programme Specific Outcomes (PSOs)		After completing this program, the learner will be able to,
	1	Demonstrating basic knowledge of mathematical skills, programming, and computational techniques required for employment.
	2	Applying the foundational understanding of mathematical concepts and programming techniques to solve real-life problems effectively.
	3	Designing mathematical models for real-life situations by utilizing Programming and computational techniques as required.
	4	Critically analyzing results obtained from mathematical models and problem-solving processes, evaluating their effectiveness, and identifying areas 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 a recognized board **or** 10+3 Diploma (any stream) awarded by any state board of technical education.
Intake		

Structure with Course Titles

B. Sc Mathematics

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
1.1	Algeba - I	Major (Core)	2	50	50	00
1.2		Major (Core)	2	50	0	50
1.3		Major (Core)	2	50	50	00
1.4	Mathematics for Business and Management -I OR Bio-Mathematics-I OR Basic Mathematics for competitive examination	OEC	4	100	50	50
1.5	Foundation Course in Mathematics-I	VSC	2	50	50	0
1.6	Basic Course in Excel	SEC	2	50	50	0
1.7	English - I	AEC (English)	2	50	0	50
1.8	Inception of India Knowledge System	IKS (Generic)	2	50	0	50
1.9		VEC	2	50	0	50
1.10	Co-curricular activity	CC	2	50	50	0
			22	**550**	**300**	**250**
	Semester II					
2.1	Calculus –I	Major (Core)	2	50	0	50
2.2		Major (Core)	2	50	50	00
2.3		Major (Core)	2	50	00	50
2.4		VSC	2	50	50	0
2.5		VSC	2	50	50	0
2.6	Mathematics for Business and Management II OR Bio Mathematics II OR Advanced Mathematics For Competitive Exam	OEC	4	100	50	50
2.7	Advanced Course in Excel	SEC	2	50	50	0
2.8	English -II	AEC (English)	2	50	00	50
2.9		VEC	2	50	0	50
2.10	Co-curricular activity	CC	2	50	0	50
			22	**550**	**250**	**300**

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

Course Syllabus

Semester I

1.1 Major (Core) - Algebra : I

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 basic properties of divisibility in integers.
	2. **Demonstrating** a deep understanding of Well-Ordering Principle, First Principle of Finite Induction and their implications in number theory.
	3. **Demonstrate** the application of equivalence relations in understanding the concept of partitions.
	4. **Analyze** the properties and relationships between different types of functions, 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, such as the Well-ordering principle, Euclid's lemma, and the infinite primes.
	2. **Develop:** advanced problem-solving skills in number theory, show casing proficiency in applying the division algorithm, Euclidean algorithm, and binomial theorem.
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 of equivalence 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 equivalence relation and vice versa.
	• Congruence is an equivalence relation on Z, Residue classes and partition of 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, bijective functions.
	• Composite of injective, surjective, bijective functions, invertible functions, 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. Wiley Eastern 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 Age International.

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

1.4 Open Elective Courses/ Generic (OEC)   (for 4 credits need 4 modules)

A- OEC: Mathematics for Business and Management -I

Course Title	Mathematics for Business and Management –I
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain basic concepts of averages, ratio, proportion, percentages, profit, and loss.
	2. **Analyze** and solve real-world problems involving advanced applications of averages, ratio, proportion, percentages, profit, and loss.
	3. Explain the significance and applications of simple and compound interest, annuity, present value, future value, and EMI calculations.
	4. **Analyze** and apply financial calculations involving simple and compound interest, annuity, present value, future value, and EMI in real-world scenarios.
Module1(Credit1) -	
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, and financial calculations.
Content Outline	• Averages • Ratio and proportion • Percentages • Profit and loss
Module2(Credit1) -	
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 financial concepts.

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 peer learning 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 and present their solutions. They will discuss their problem-solving methods, offer critical evaluations, and engage in discussions to showcase proficiency in applying advanced financial concepts. (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 engage peers 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 involving interest, 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*. Tata Mc 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 functions in various contexts, comparing them with other function types and demonstrating their applications in real-world scenarios.
	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 problems involving various functions and their derivatives.
Module1(Credit1)	
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)	
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, trigonometric functions
	• Differentiation rules: Scalar multiplication, addition, subtraction, product and quotient, 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 detail scenariosandexplainhowexponentialfunctionsbehavedifferentlyandtheirsignificancein practical applications.

3. **Tutorial Creation(CO3)**

   Students will collaborate in groups to create tutorials or video presentations explaining calculus concepts 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 and their 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 M. and Biggs N. (2000). *Mathematics for Economics and Finance: Methods and Modelling* (Cambridge low-priced edition).Cambridge University Press.

2. Dikshit, A. and Jain, J. K. *Business Mathematics*.

3. 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 numerical problems.
	4. **Analyze** complex mathematical problem-solving strategies integrating squares, surds, word problems, and advanced mathematical concepts to devise innovative 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 larger numbers 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 a number, 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, and properties 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 basic operations related 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 equations and the geometrical structures of lines, planes, spheres, and cones
	4. **Analyze** and evaluate the properties and interrelations among various number systems, such as natural, integer, rational, irrational, and real numbers

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 synthesizing complex number theories, including intricate geometric representations, polar forms, and the application of sophisticated theorems such 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 of sets, 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, rational and irrational numbers, and real numbers.

	2. **Evaluate** the fundamental concepts of geometry, including equations and the geometrical 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):

1. Applications of De-Moivres theorem

2. Various equations of geometrical structures are to be given to the students and ask to find their structure.

Reference Books:

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

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

3. Stewart I. and Tall, D. *The Foundations of Mathematics* (2nd 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 utilizing Excel functions to sort data in ascending and descending order.
	2. **Apply** analytical skills to sort data efficiently in ascending and descending orders using Excel functions.
	3. **Exhibit** knowledge in basic Excel functions such as MIN, MAX, COUNT, and demonstrate competency in utilizing Excel tools like sorting, filtering, and auto fill for efficient data management.
	4. **Evaluate** Excel functions beyond basic levels, exploring and integrating advanced features like Cell Comments, Find and Replace, and Page Layout tools

Module1(Credit1) -

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 varied cell values.
	2. **Demonstrate** expertise in creating visually appealing charts and graphs to interpret intricate data patterns
Content Outline	• Introduction to Excel • Addition, Subtraction, Multiplication, Division of values in different cells [Basic Arithmetic Operators] • To prepare basic Charts and Graphs • To create visually appealing charts and graphs to represent data trends and patterns. • To sort the data in increasing and decreasing order

Module2(Credit1) -

Learning	After learning the module, learners will be able to

Outcomes	1. **Apply** basic Excel functions (e.g., MIN, MAX, COUNT) and utilize essential Excel tools like sorting, filtering, auto fill, and Fill Handle for efficient data management.
	2. **Display advanced** proficiency in utilizing Excel functions and tools such as Cell Comments, Find and Replace, and Page Layout, employing them strategically for advanced 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):

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*.

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 in real numbers.
	2. **Evaluate** the convergence and divergence of sequences. Assess the significance of monotone and bounded sequence in mathematical analysis and real world applications.
	3. **Apply** basic algebraic operations to continuous functions and demonstrate understanding of boundedness.
	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 order properties of real numbers including the completeness and Archimedean property 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, completeness property, Archimedean property, density of rational numbers , • Sequences of real numbers and their limits examples , • Limit theorems (only statements), Limit of some standard sequences • $\frac{1}{1+nx} \ \forall \ x > 0 \,; \ (x^n) \ \forall \ x \ 0 < x < 1; \left(x^{\frac{1}{n}}\right) \ \forall \ x > 0$ • 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 in real-valued functions.

	2. **Apply** advanced limit theorems to analyze and solve real-world problems involving 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 for continuous functions (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 International Ltd.

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)   (for 4 credits need 4 modules)

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 to interpret and analyze data.
	3. **Define** and explain fundamental concepts in basic probability theory, including sample space, events, axioms of probability, conditional probability.
	4. **Analyze** and apply fundamental probability concepts to solve complex real-world problems.
Module1(Credit1) -	
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) -	
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 a specific industry or real-world scenario (e.g., finance, healthcare, marketing).The objective is for each 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 detailing basic descriptive statisticsconcepts.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, including sample space, events and basic axioms of probability.
	2. **Apply** conditional probability and probability theorems to solve complex problems in various scenarios.
	3. **Define** and explain the basic concepts of probability distributions and random variables, including discrete and continuous variables.
	4. **Apply** probability distributions and mathematical expectation to model and analyze real-world problems.
Module1(Credit1) -	
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) -	
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 fundamental probability 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 involving conditional 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 distributionsandrandomvariables.Theywillpresentthesevisuals,encouraging interactive discussions to 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 concepts including Average, Percentage, Profit and Loss, Commission and Discount, Simple and 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 concepts such as Average, Percentage, Profit and Loss, Commission and Discount, Simple and 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, Simple and 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 concepts such 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 and Time, 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 their applications within Excel for data manipulation and analysis. 2. **Grasp** the concepts of Power Query and Power Pivot, comprehending their applications within Excel for data manipulation and analysis. 3. **Create** combo charts with multiple chart types on a single graph and utilize Sparklines for miniature chart representations within individual cells. 4. **Apply** critical thinking to explore advanced features of Hyperlinks, showcasing their understanding and aptitude for utilizing interactivity within Excel for sophisticated data representation and navigation."

Module1(Credit1) –

Learning Outcomes	After learning the module, learners will be able to 1. Perform calculations on arrays of data using functions like SUM PRODUCT or array 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 within the 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) –

Learning	After learning the module, learners will be able to

Outcomes	1. Demonstrate a proficient understanding of Dynamic Arrays in Excel, showcasing the ability to effectively apply them in various scenarios
	2. Create combo charts combining multiple chart types and implement Spark lines 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 that data 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*.