



SNDT Women's University, Mumbai

**Undergraduate Degree / UG
Programme (Syllabus as Per NEP) -
Faculty of Science & Technology**

**Bachelor of Science
(Mathematics) (Non-AEDP)**

B.Sc. (Mathematics) (Non-AEDP)

As Per NEP – 2020

Semester – I to IV

**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 Major or 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	NA

		and Technological Solutions, Health & Wellness, Yoga Education, Sports, And Fitness	
IKS	Indian Knowledge System	Generic IKS Course: Basic Knowledge 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 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	NA
CE	Community Engagement and Service		Related To Major
RP	Research Project	Corresponding To the Major Subject	Related To Major

Programme Template

Faculty		Science and Technology
Programme Degree		B.A. / B.Sc. (Honours / Honours with Research)
Specialization		Mathematics
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		First Year Entry: 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)(Non-AEDP)

Semester - I

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester - I					
10032301	Algebra-I	Major (Core)	2	50	50	0
	Subject 2	Major (Core)	2	50	50	0
	Subject 3	Major (Core)	2	50	50	0
10432311	Mathematics for Business and Management-I	OEC (Any Two)	4	100	50	50
10432312	Bio-Mathematics-I					
10432313	Basic Mathematics for competitive examination					
10632301	Foundation Course in Mathematics-I	VSC S1	2	50	50	0
10732311	Basic Course in Excel	SEC	2	50	0	50
	Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf (Available on Website)	AEC (English) (Any One)	2	50	0	50
10810111	English For Academic Writing - Paper I (For Students of English Medium)					
10810112	English Language and Literature - I (For Students of					

	Non-English medium)					
11051111	Inception of India Knowledge System IKS Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/iks-syllabus/ug-degree/inception-of-indian-knowledge-system.pdf (Available on Website)	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/introduction-to-indian-constitution.pdf (Available on Website)	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

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – II					
20032311	Calculus- I	Major (Core)	2	50	0	50
	Subject 2	Major (Core)	2	50	0	50
	Subject 3	Major (Core)	2	50	0	50
		VSC-S2	2	50	50	0
		VSC-S3	2	50	50	0
20432311	Mathematics for Business and Management-II	OEC (Any Two)	4	100	50	50
20432312	Bio-Mathematics- II					
20432313	Advanced Mathematics for Competitive Exam					
20732301	Advanced Course in Excel	SEC	2	50	50	0
	Ability Enhancement Course (AEC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf (Available on Website)	AEC (English) (Any One)	2	50	0	50
20810111	English For Academic Writing - Paper II (For Students of English Medium)					

20810112	English Language and Literature – II (For Students of Non-English medium)					
20952111	Environment Awareness Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/environment-awareness.pdf (Available on Website)	VEC	2	50	0	50
	Co-Curricular Course (CC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-ii-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
21450121	Volunteerism and National Service Scheme					
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)

Semester – III

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – III					
30132311	Calculus of several variables	Major (Core)	4	100	50	50
30132312	Ordinary Differential Equations	Major (Core)	4	100	50	50
30132323	Practical based on 3.1 and 3.2	Major (Core)	4	100	50	50
30332311	Graph Theory	Minor Stream	2	50	0	50
30432311	Mathematical Techniques for Competitive Examination-I	OEC (Any One)	2	50	0	50
30432312	स्पर्धा परीक्षेसाठी गणित तंत्र-भाग १ Spardha Parikshesathi Ganit Tantra-Bhag 1					
30432313	Reasoning for Competitive Examination Part-I					
30432314	Financial Mathematics					
	Modern Indian Language Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iii.pdf (Available on Website)	AEC (Any One)	2	50	50	0
30810201	શીખો ગુજરાતી - પ્રાથમિક ભાગ ૧: પરિચય, લેખન અને વાચન કૌશલ્ય (ગુજરાતી) Shikho Gujarati – Prathmik Bhag 1:					

	Parichay, Lekhan ane Vachan Kaushalya (Gujarati)					
30810301	रचनात्मक लेखन (हिन्दी) Rachnatmak Lekhan (Hindi)					
30810401	मराठी भाषेचा परिचय भाग १ - (मराठी) Marathi Bhashecha Parichay- Bhaag 1 (Marathi)					
30810501	लौकिक संस्कृत न्यायः (संस्कृत) Contemporary Sanskrit Nyaya (Sanskrit)					
30132304	Metric Space	Major (Core)	2	50	50	0
	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iii-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
31450121	Social issues Advocacy and Action					
31450221	National Cadets Corps. (NCC) Studies – III					
31450321	Traditional Sports and Fitness					
31450421	Unfolding The Beauty of Indian Music					
			22	550	300	250

Semester – IV

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – IV					
40132311	Linear Algebra	Major (Core)	4	100	50	50
40132312	Numerical Analysis	Major (Core)	4	100	50	50
40332321	Practical based on 4.1 and 4.2	Minor Stream	4	100	50	50
40432311	Mathematical Techniques for competitive examination-II	OEC (Any One)	2	50	0	50
40432312	સ્પર્ધા પરીક્ષેસાથી ગણિત તંત્ર-ભાગ ૨ Spardha Parikshesathi Ganit Tantra-Bhag 2					
40432313	Reasoning for Competitive Examination Part-II					
40432314	Basic Statistics					
40732311	Python Programming	SEC	2	50	0	50
	Modern Indian Language Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iv.pdf (Available on Website)	AEC (Any One)	2	50	0	50
40810211	શીખો ગુજરાતી – પ્રાથમિક (ગુજરાતી) Shikho Gujarati – Prathmik (Gujarati)					

40810311	सूचना प्रौद्योगिकी और हिन्दी भाषा (हिन्दी) Suchana Praudyogiki aur Hindi Bhasha (Hindi)					
40810411	मराठी भाषेचा परिचय भाग -२ (मराठी) Marathi Bhashecha Parichay- Bhaag 2 (Marathi)					
40810511	वाल्मीकीयकृत रामायणम् – अयोध्याकाण्डः (संस्कृत) Valmikiyakrut Ramayanam – Ayodhyakanda (Sanskrit)					
40332302	Introduction To Mathematics for Signal Processing	Minor Stream (Any One)	2	50	50	0
40332303	Fluid Dynamics					
40332304	Probability and Statistics					
	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-us-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iv-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
41450121	NSS Volunteers under National service scheme special camp					

41450122	Personality and Leadership Development through National Service Scheme					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450321	Basics of Self Defence and Fitness Training					
41450421	Theatre & Dance					
			22	550	250	300

Exit with UG Diploma with 4 extra credits (44 + 4 credits

Course 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 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, surjectivity, 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 Outcomes	After learning the module, learners will be able to
	1. Achieve mastery in function theory and application, showing 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 viceversa. • Congruence is an equivalence relation on $\mathbb{Z}$, Residue classes and partition of $\mathbb{Z}$, 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. Niven I, 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. (10th edition). Wiley India.

.1.4 A. Open Elective Courses/ Generic (OEC)

Course Title	Mathematics for Business and Management - I
Course Credits	4
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) - Basic Mathematical Concepts 1	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply basic mathematical concepts of averages, ratio, proportion, in problem-solving.
	2. Analyze and interpret advanced scenarios involving ratios.
Content Outline	• Averages • Ratio and proportion • Difference between ratio and proportion • Continued proportion • Direct and indirect proportion • Percentage
Module2(Credit1) - Basic Mathematical Concepts 2	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply basic mathematical concepts of proportion, percentages, profit, and loss in problem-solving.
	2. Analyze and interpret advanced scenarios involving, percentages, and financial calculations.

Content Outline	• Profit and loss • Commission and brokerage
Module3 (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 complex financial scenarios using advanced financial concepts Interest and Annuity.
Content Outline	• Simple Interest • Compound interest • Computation of compound interest when compounded monthly, quarterly, half yearly and annually. • Annuities • Immediate annuity and Annuity Due
Module 4 (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 strategies complex financial scenarios using advanced financial concepts on Present value and EMI.
Content Outline	• Present Value and Future Value • Time value of money • 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.

.1.4 B. Open Elective Courses/ Generic (OEC)

Course Title	Bio-Mathematics-I
Course Credits	4
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) - 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	•Application of mathematics in biology •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, $\log x$, trigonometric functions •Differentiation rules: Scalar multiplication, addition, subtraction, product and quotient, simple examples.
Module3(Credit1) - Graphs and Functions	
Learning Outcomes	After learning the module, learners will be able to
	• 1. Describe graphs of various linear functions , like quadratic function and Exponential functions and periodic functions
	• Analyze the graphs
Content Outline	• Graphs of linear functions , quadratic function and Exponential functions • Periodic functions • Combination of simple functions.
Module4(Credit1) -Differentiation and its applications in biology	
Learning Outcomes	After learning the module, learners will be able to
	• Apply differentiation rules on various situations in biology like enthaply, entropy, curvature.
	• Plot the mathematical functions

Content Outline	● Enthaply and Entropy of Chemical reactions ● Curvature ● Maxima and Minima of a function ● Plotting mathematical functions
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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 scenarios and explain how exponential functions behaved differently and their significance in 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.
2. Anthony M. and Biggs N. (2000). *Mathematics for Economics and Finance: Methods and Modelling* (Cambridge low-priced edition). Cambridge University Press.
3. Dikshit, A. and Jain, J. K. *Business Mathematics*.

4. Hazarika P. *Business Mathematics*. Delhi: Sultan Chand & Sons.

.1.4 C. Open Elective Courses/ Generic (OEC)

Course Title	Basic Mathematics for competitive examination
Course Credits	4
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. • Fast track formulae to solve the questions.
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Module2(Credit1) - Fractions

Learning Outcome	After learning this module, learner will be able to
	• Analyze complex mathematical problem-solving strategies about Fractions
	• Apply operations on fractions

Content Outline	• Simple fraction • decimal fractions • operations on fractions addition, subtraction, multiplication and quotient
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Module3(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 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
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Module4(Credit1) : Approximation and Number problems

Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate proficiency in 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	• 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. Shantinayakan. *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) - 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 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) - Advanced Excel Tools and Data Management	

Learning	After learning the module, learners will be able to
Outcomes	1. Apply basic Excel functions (e.g., MIN, MAX, COUNT) and utilize essential Exceltools 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 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 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 $\frac{1}{n} \forall x > 0 ; (x^n) \forall x > 0 < x < \frac{1}{n}; (x) \forall x > 0$ $\frac{1}{n} \pm \frac{1}{nx}$ - Monotone and bounded sequences, Sub sequences

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

$$f(x) = \frac{|x - b|}{x - b}, x \in \mathbb{R} ; b \in [0, 100] \cap \mathbb{N}$$

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 (10th edition). Wiley India.

.2.6 A. Open Elective Courses/ Generic (OEC)

Course Title	Mathematics for Business and Management II
Course Credits	4
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) - 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
Module2(Credit1) - Measures of Central Tendency	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply basic descriptive statistical tools mean , median and mode to summarize data.
	2. Analyze and interpret data using measures of central tendency.
	• Measures of Central Tendency • Mean, • Mode • Median.
Module3(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
Module4(Credit1) - Conditional Probability	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply conditional probability concepts to analyze simple scenarios.
	2. Analyze and solve complex problems using addition and multiplication theorem.
Content Outline	• 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 data set related to a specific industry or real-world scenario (e.g., finance, healthcare, marketing). The objective is for each group to analyze the data set 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 statistics concepts. They will present these visuals to the class to facilitate group discussions and deep 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*.

.2.6 B. Open Elective Courses/ Generic (OEC)

Course Title	Bio-Mathematics-II
Course Credits	4
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) - 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,
Module2(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	• Axioms of probability, • conditional probability, • addition and multiplication theorem.
Module3(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,
Module4(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	• 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 distributions and random variables. They will present the visuals, 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.

.2.6 C. Open Elective Courses/ Generic (OEC)

Course Title	Advanced Mathematics For Competitive Examination
Course Credits	4
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.
	2. Critically analyze and synthesize the intricacies of mathematical principles including Average, Percentage, Profit and Loss, Commission and Discount.
Content Outline	• Average, • Percentage • Profit and Loss • Commission and Discount
Module2(Credit1) - Interest, Ratio and Proportion	
Learning Outcomes	After learning this module, learner will be able to

	1. Demonstrate a proficient understanding of fundamental mathematical concepts such as Simple interest, Compound Interest, Ratio and Proportion.
	2. Critically analyze and synthesize the intricacies of mathematical principles including Simple interest, Compound Interest, Ratio and Proportion
Content Outline	• Simple Interest • compound interest • Ratio and proportion

Module3(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.
	2. Critically analyze and synthesize the intricacies of mathematical principles including Mixture and Alligation, Partnership, Problems based on ages.
Content Outline	• Mixture and Alligation • Partnership • Problems based on ages
Module4(Credit1) - Work, Time and Wages	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate a proficient understanding of fundamental mathematical concepts such as Work and Time, Work and wages problems.
	2. Critically analyze and synthesize the intricacies of mathematical principles including Work and Time, Work and wages problems.
Content Outline	• 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) - 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 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 orarray 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, 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*.

Course Syllabus

Semester – III

.3.1 Major (Core)

Course Titles	Calculus of Several Variables
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to:
	CO 1: Understand the fundamental concepts of functions of several variables, limits, and continuity.
	CO 2: Compute partial derivatives and apply them to optimization problems.
	CO 3: Evaluate double and triple integrals and use them to solve real-world problems.
	CO 4: Apply vector calculus concepts like gradient, divergence, and curl in mathematical and physical contexts.
	CO 5: Analyze and apply Green's theorem, Stokes' theorem, and the divergence theorem in physical and engineering problems
Module 1 (Credit 1) – Functions of Several Variables	
Learning Outcomes	After learning the module, learners will be able to:
	1. Analyze the behaviour of functions of several variables in terms of limits, continuity, and differentiability.
	2. Evaluate the applications of partial derivatives in solving optimization problems
Content Outline	• Functions of two or more variables, Domain, and Range, Limit and continuity of multivariable functions, Partial derivatives, higher-order derivatives, and differentials, Euler's theorem on homogeneous functions, Chain rule and implicit differentiation.
Module 2 (Credit 1) – Multiple Integrals and Applications	
Learning Outcomes	After learning the module, learners will be able to:
	1. Analyze the techniques for evaluating double and triple integrals in various coordinate systems
	2. Apply Cartesian Polar coordinates.
Content Outline	• Double Integrals: Definition, evaluation in Cartesian and polar coordinates. • Triple Integrals: Definition, evaluation in Cartesian, cylindrical, and spherical coordinates. • Applications: Area, volume, and center of mass calculations
Module 3 (Credit 1) – Integral Theorems and Applications	
Learning	After learning the module, learners will be able to:

Outcomes	1. Apply integral theorems to solve problems in physics and engineering.
	2. Formulate solutions to problems involving line integrals, surface integrals and volume integrals in fluid flow, physics and Engineering.
Content Outline	Green's Theorem in the plane and applications, Stokes' theorem and its significance, Gauss' Divergence Theorem and Applications to Fluid flow, Applications of integral theorems in Physics and Engineering
Module 4 (Credit 1) – Introduction to Vector Calculus	
Learning Outcomes	After learning the module, learners will be able to:
	1. Formulate solutions to problems involving line integrals and work done by force fields
	2. Interpret the physical significance of gradient, divergence, and curl.
Content Outline	Vector functions: Limits, continuity, differentiation, and integration, Gradient, divergence, and curl with their physical interpretation, Directional derivatives and tangent planes, Line integrals, work done by a force field.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

References:

1. M.D. Weir, J. Hass, F.R. Giordano, *Thomas' Calculus*, Pearson Education.
2. H. Anton, I. Bivens, S. Davis, *Calculus: Multivariable*, Wiley.
3. J.E. Marsden, A.J. Tromba, *Vector Calculus*, W. H. Freeman.
4. M.J. Strauss, G.L. Bradley, K.J. Smith, *Calculus*, Pearson.

Semester – III**.3.2 Major (Core)**

Course Titles	Ordinary Differential Equation
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Recognize homogenous and nonhomogeneous first and second order differential equation.
	2. Construct the mathematical model using modeling.
	3. Analyze the properties of solutions to the linear system.
	4. Apply the methods for solving different first and second order differential equation.
Module 1 (Credit 1) - First Order Differential Equations	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Identify the families of orthogonal trajectories
	2. Developed advanced problem-solving skills in differential equation, showcasing proficiency in finding the solution of exact, linear and Bernoulli differential equation
Content Outline	• Definition, order and degree of differential equations, separable differential equations, homogeneous and non-homogeneous differential equations. • Exact differential equations and its solution. • Integrating factors and rules for finding integrating factors of $M(x, y) dx + N(x, y) dy = 0$ (without proof) • Linear differential equations and Bernoulli differential equations. • Modeling with first order equations. Examples from Financial Mathematics, Chemistry, Environmental Science, Population growth and decay, orthogonal trajectories e.t.c.
Module 2 (Credit 1) – Second Order Linear Differential Equations	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Evaluate the wronskian and determine the linear independence of differential equation.
	2. Apply the methods of undetermined coefficients and variation of parameter for nonhomogeneous differential equation.
Content Outline	• The general second order linear differential equation. • Homogeneous and non-homogeneous second order linear differential equations: Wronskian and linear independence of the solutions. The general solution of homogeneous differential

	equation. The general solution of a non-homogeneous second order equation, Complementary functions and particular integrals. • The homogeneous equation with constant coefficients, auxiliary equation, the general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation. • Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameters, solution by inspection.
Module 3 (Credit 1) – Linear System of Ordinary Differential Equations	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Examine the linear independence of solutions to homogenous linear system of differential equation.
	2. Solve homogenous and non-homogenous linear system of differential equation
Content Outline	• Introduction • First order linear system: Definition, Solution to the system of linear equation. • Linear system of differential equation: Existence and Uniqueness Theorem (only statement), relevant theorems. • Homogenous linear system of differential equation: Wronskian, linearly independent solutions, general solutions • Homogenous linear system with constant coefficients. • General solution of non-homogenous linear system: Basic theorems and examples, Method of variation of parameters.
Module 4 (Credit 1) – Laplace Transform and Ordinary Differential Equations	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Solve initial and boundary value problem using Laplace transform Apply the Laplace Transform to real word problem like mechanical system, electrical circuit, population dynamics.
Content Outline	• Introduction: Definition and basic properties of Laplace Transform. Transform of some basic functions: e^x, $\sin x$, $\cos x$, step functions, etc. • Inverse Laplace Transform • Solution of linear ordinary differential equation using Laplace Transform • Initial and boundary value problems using Laplace Transform

	• Solving second order ordinary differential equation using Laplace Transform • Applications: Mechanical system, electrical circuit, control theory, population dynamics, etc.
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Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students are instructed to construct any three mathematical models. Solve the model by using methods of solving differential equations. Submit the report to the course instructor. (CO2)(CO3)
2. Students are suggested to create their own five examples using everyday life examples. Students can use first or second order differential equations. Find the solutions to the equations. Submit the report to the course instructor. (CO4)

References:

1. G.F. SIMMONS, Differential Equations with Applications and Historical Notes, McGraw Hill
2. E.A. Coddington, An introduction to ordinary differential equation, Dovers Books.
3. Z. Dennis, A first course in differential equation with modeling applications, 12th edition, Brooks/Cole, London, 2023.
4. N.W. McLachlan, Laplace Transform and their applications to differential equation, Dovers Publications, Mineola, 2014.

Semester – III

.3.3 Major (Core)

Course Titles	Practical based on 3.1 and 3.2 Practical based on Ordinary Differential Equation and Multivariable Calculus Practical on Calculus of Several Variables
Course Credits	4 Credit's
Course Outcomes	After completing this course, learner will be able to
	C01. Analyze and visualize functions of several variables, including domain, range, and limits.
	C02. Apply partial derivatives and optimization techniques to solve real-world mathematical problems.
	C03. Evaluate double and triple integrals, and interpret them in terms of area and volume.
	C04. Solve line and surface integrals with applications in physics and engineering.
	C05. Apply integral theorems such as Green's, Stokes', and Divergence Theorem in vector field analysis.
Learning Outcomes	C06. Demonstrate understanding of vector calculus including divergence, curl, and conservative fields, and apply this to geometric and physical interpretations.
	After learning this module, learner will be able to
	L01. Utilize calculus tools to analyse multi-variable systems in both Cartesian and alternative coordinate systems.
Content Outline	L02. Apply theoretical knowledge of multivariable calculus through hands-on problem-solving and practical computation.
	Practical 1: Functions of Several Variables [1] Find the domain and range of the function $f(x, y) = \sqrt{36 - x^2 - y^2}$ [2] Find the limit: $\lim_{(x,y) \rightarrow (0,0)} (xy)/(x^2 + y^2)$ [3] Show that the function $f(x, y) = x^4 + 3xy^3$ satisfies Euler's theorem for homogeneous functions. [4] Compute dz/dx for the function $x^3 + y^3 + z^3 = 1$ using implicit differentiation. [5] Find the second-order partial derivatives of $f(x, y) = xe^y + \sin(x + y)$ Practical 2: Partial Derivatives and Optimization [1] Compute f_{xy} for the function $f(x, y) = e^x + \cos(x - y)$ [2] Verify whether the function $f(x, y) = x^2 - 3xy + 4y^2$ has any

	local maxima, minima, or saddle points. [3] Use the chain rule to find dz/dt if $z = xy$ where $x = t$ and $y = t^2$ [4] Find the gradient vector of $f(x, y) = x^2 + y^2$ at points $(1, 0)$ and $(0, 1)$. [5] Find the directional derivative of $f(x, y) = x^2 + y^2$ at $(1, 0)$ in the direction of vector $v = (0, 1)$. Practical 3: Double and Triple Integrals [1] Evaluate $I = \int_0^1 \int_0^x (x + y) dy dx$ [2] Compute the volume of the solid bounded by $36 - x^2 - y^2$ and the xy-plane. [3] Convert the integral $I = \int_0^2 \int_0^{\sqrt{4-x^2}} f(x, y) dy dx$ into polar coordinate. [4] Find the volume of a sphere of radius 4 using triple integrals in spherical coordinates. [5] Compute $I = \int_0^\pi \int_0^\pi r \sin(\theta) d\theta dr$ Practical 4: Line and Surface Integrals [1] Evaluate the line integral $\int (x^2 - y)dx + (y^2 - x)dy$ from $(0,0)$ to $(2,4)$ on $y = x^2$ [2] Compute work done by force field $F = (x, -y)$ along circle $x^2 + y^2 = 4$ [3] Evaluate $\int F \cdot dr$ for $F = (x, -y)$ from $(0,0)$ to $(1,1)$ [4] Find flux of $F = (x^2, y^2, z^2)$ across surface $x + y + z = 2$ [5] Evaluate $\int F \cdot dS$ on hemisphere $x^2 + y^2 + z^2 = 9, z \geq 0, F = (x, -y, z)$ Practical 5: Integral Theorems [1] Verify Green's theorem for $\oint (y^2 dx + x^2 dy)$ over $x^2 + y^2 \leq 1$ [2] Use Stokes theorem for $F = (-y, x, 0)$ on unit disk [3] Use divergence theorem for $F = (x, y, z)$ on sphere $x^2 + y^2 + z^2 = 1$ [4] Verify Stokes theorem for $F = (z, 0, -x)$ on hemisphere [5] Compute circulation of $F = (y, -x)$ around unit circle Practical 6: Vector Calculus [1] Compute divergence of $F = (x^2 - y, xy, z)$ [2] Find curl of $F = (x^2, x, zx)$ [3] Check whether $F = (x^2 - y^2, 2xy)$ is conservative [4] Directional derivative of $F(x,y,z)=xy-yz$ at $(1,0,1)$ along $v=(2,-1,1)$ [5] Equation of tangent plane to $z = x^2 - y^2$ at $(1,0)$
	1 Get necessary exposure in different aspects of mathematical and natural sciences.
	2 Analyze the methods for solving different first and second order differential equation.
Practical on Ordinary Differential Equation	
Learning	Learning Outcomes After learning the module, learner will be able to

Outcomes	Find orthogonal trajectories using first order differential equations.
	Develop modeling skill and solve the models.
Content Outline	Practical 7 1. Order and degree of differential equation examples 2. Variable separable method examples 3. Homogeneous differential equation examples 4. Non-homogeneous differential equation examples 5. Check whether differential equation is exact 6. Solve exact equations Practical 8 1. Non-exact equations 2. Linear differential equations of first order 3. Bernoulli differential equations 4. Modeling problems (finance, chemistry, population, etc.) 5. Orthogonal trajectories Practical 9 1. Linearly independent solutions (second order DE) 2. Use known solution to find another solution 3. Wronskian examples 4. Auxiliary equation problems Practical 10 1. Homogeneous second order DE (constant coefficients) 2. Non-homogeneous second order DE 3. Variation of parameters 4. Undetermined coefficients 5. First order system construction Practical 11 1. System construction from DE 2. Wronskian of system solutions 3. Homogeneous system solutions 4. Constant coefficient systems 5. Non-homogeneous systems Practical 12 1. Laplace transform of functions

	2. Inverse Laplace transform 3. DE solution using Laplace 4. Initial/boundary value problems 5. Second order DE using Laplace 6. Applications
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Assignment/Activities towards CCE

- Solve at least four problems from each practical. Maintain journal of solutions and submit to course instructor.

References:

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill
2. E.A. Coddington, An Introduction to Ordinary Differential Equation, Dover Books
3. Z. Dennis, A First Course in Differential Equation with Modeling Applications, Brooks/Cole, 2023
4. N.W. McLachlan, Laplace Transform and Their Applications to Differential Equation, Dover Publications

Semester – III

.3.4 Minor Stream

Course Titles	Graph Theory
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Analyze operation on tree like insertion, deletion and tree traversal techniques
	2. Construct the graphs using incidence and adjacency matrices.
	3. Obtain the shortest path in tree.
	4. Apply algorithm techniques in different types of graphs.
Module 1 (Credit 1) – Graphs	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Use Dirac's Theorem, Ore's Theorem, Dijkstra's Algorithm for different graphs.
	2. Identify isomorphic graphs.
Content Outline	• Introduction to graphs: Types of graphs: Simple graph, Multigraph, directed graph, undirected graph, null graph ◦ Vertex in graph: Adjacent vertices, degree of a vertex, isolated vertex, pendant vertex in an undirected graph. ◦ The handshaking Theorem. An undirected graph has an even number of odd vertices. • Some special types of graphs: Complete graph, cycle, wheel in a graph, Bipartite graph, regular graph. • Isomorphism. • Adjacency matrix of a simple graph. • Incidence matrix of an undirected graph. • Isomorphism of simple graphs. • Connectivity: • Circuit and paths. • Connected graphs, • Connecting paths between vertices. • Paths and isomorphisms. • Euler paths and circuits, Hamilton paths and circuits, Dirac's Theorem, Ore's Theorem • Shortest path problem, the shortest path algorithm - Dijkstra's Algorithm.

Module 2 (Credit 1) – Tree	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Find the minimum spanning trees using Prim's Algorithm, Kruskal's Algorithm.
	2. Understand the different properties of trees using theorems and algorithms.
Content Outline	• Trees: ○ Definition and Examples. ○ Forests, Rooted trees, subtrees, binary trees. ○ Trees as models. ○ Properties of Trees. • Application of Trees: ○ Binary Search Trees, Locating and adding items to a Binary Search Tree. ○ Decision Trees (simple examples). • Game Trees, Minimax strategy, Tree Traversal, Traversal algorithm including preorder traversal, inorder traversal, postorder traversal using recursion. • Spanning Tree, Depth-First Search and Breadth-First Search. • Minimum Spanning Trees, Prim's Algorithm, Kruskal's Algorithm

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Explain the different types of graphs in detail (directed graph, undirected graph, weighted graph, bipartite graph, complete graph, regular graphs etc.). List examples of each mentioned graph. Make detailed notes and submit to course instructor.
2. Consider the weighted graph where vertices are represented with islands and edges with bridges. Weight assigned to bridge is distance between islands.
Islands: I, J, K, L, K
Edges: (I,J,5), (I,K,6), (J,K,2), (J,L,3), (C,K,1), (L,K,8), (I,L,4)
Use Dijkstra's algorithm and find the shortest path from I to K.
Also obtain the depth-first search from vertex I and breadth-first search from I.
Submit detailed note to the course instructor.

References:

1. R. Diestel (2017) Graph Theory, Springer.
2. G. Chartrand, P. Zhang (2012). A First Course in Graph Theory, Dover Publication.
3. M. Tuzhilin, D. Zhang (2012), Introduction to Graph Theory and Basic Algorithms, Springer.

4. G. Chartrand, L. Lesniak, P. Zhang (2016), Graphs and Digraphs, CRC Press.
5. Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Edition.

Semester – III**.3.5 A. Open Elective Courses/ Generic (OEC)**

Course Titles	Mathematical Techniques for Competitive Examination Paper - 1
Course Credits	2 Credit's
Course Outcomes	After completing this course, learner will be able to
	1. Understand and apply foundational concepts of the speed distance and time and Calendar
	2. Analyze, evaluate, and apply advanced techniques in work, distance and time and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving basic numerical problems.
	4. Analyze complex mathematical problem-solving strategies and obtain the solutions to the problems easily.
Module 1 (Credit 1) – Problems based on Time	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate a comprehensive understanding of Work and Time, Speed, time and distance, Clock and Calendar.
	2. Apply shortcut formulae to obtain the solution to the problems, and Fundamental employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	• Work and Time. • Speed, time and distance. • Clock and Calendar. • Fast track formulae to solve the questions
Module 2 (Credit 1) – Problems based on water (Liquid)	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate proficiency to solve mathematical problems accurately.
	2. Distinguish the situations for and obtain the solutions.
	3. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems.
Content Outline	• Pipes and Cisterns • Boats and Stream • Word problems based on probability

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to solve questions based on the topic Speed, Distance and Time from various competitive examination question papers.
2. Solve questions based on topic Clock and Calendar from various competitive examination question papers.
3. Obtain the solutions of the problems based on Pipes and Cisterns.
4. Obtain the solutions of the problems based on Boats and Streams.

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.
5. Dinkar Patil, Spardha Pariksha Ankaganit, Yashodin Publication, N 53 S.F. 4 /5/ 3 Uttamnagar Po. Trimurti Chowk CIDCO Nashik 422008

Semester – III**.3.5 B. Open Elective Courses/ Generic**

Course Titles	स्पर्धा परीक्षेसाठी गणित तंत्र - भाग १
Course Credits	2 Credit's
Course Outcomes	सदर विषय अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	1. Understand and apply foundational concepts of the speed distance and time and Calendar
	2. Analyze, evaluate, and apply advanced techniques in work, distance and time and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving basic numerical problems.
	4. Analyze complex mathematical problem-solving strategies and obtain the solutions to the problems easily.
Module 1 (Credit 1) – वेळ या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	सदर पाठ अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	1. Demonstrate a comprehensive understanding of pipes, cisterns, boats and stream, Clock and Calendar.
	2. Apply shortcut formulae to obtain the solution to the problems, and fundamental employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	● काम व काळ ● वेग, वेळ व अंतर ● घड्याळ व दिनदर्शिका ● उदाहरणे जलद सोडवण्यासाठी सूत्रे व त्यांचा वापर
Module 2 (Credit 1) – पाणी (द्रव) या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	सदर पाठ अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	1. Demonstrate proficiency to solve mathematical problems accurately.
	2. Distinguish the situations for and obtain the solutions.
	3. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of

	the problems.
Content Outline	● पाण्याची टाकी व नळ ● बोट, नाव व प्रवाह ● चलन (सम चलन व व्यस्त चलन) ● शेतकरी

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. विद्यार्थ्यांनी एमपीएससी च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
2. विद्यार्थ्यांनी पोलीस भरती व तलाठी भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
3. विद्यार्थ्यांनी बँक भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
4. विद्यार्थ्यांनी मागील वर्षीच्या स्पर्धा परीक्षेच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे

संदर्भ पुस्तके:

1. दिनकर पाटील, स्पर्धा परीक्षा अंकगणित, यशोदिन पब्लिकेशन्स, नाशिक
2. सिद्धेश्वर हाडबेज, अंकगणित व बुद्धिमत्ता, भारती प्रकाशन पुणे
3. पंढरीनाथ राणे, Sampurna Ganit, चैताली प्रकाशन

Semester – III**.3.5 C. Open Elective Courses/ Generic (OEC)**

Course Titles	Reasoning For Competitive Examination Part 1
Course Credits	2 Credit's
Course Outcomes	After completing this course, the learner will be able to
	1. Understand and apply foundational concepts of reasoning to solve the problems in various competitive examinations
	2. Analyze, evaluate, and apply advanced techniques in reasoning and fast-track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving problems in various competitive examinations like Banking, Railway recruitment, LIC, Police examinations.
	4. Analyze complex mathematical problem-solving strategies and obtain the solutions to the problems easily.
Module 1 (Credit 1) – Nonverbal Reasoning Tests: 1	
Learning Outcomes	After learning this module, the learner will be able to
	1. Demonstrate a comprehensive understanding of pipes, cisterns, boats and streams, clocks and calendars.
	2. Apply shortcut formulae to obtain the solution to the problems and fundamentally employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	• Completion of series (Sequence/order) • Classification • Analogical Nonverbal Reasoning • Pattern comparison between two sets of figures • Arranging figures in sequence • Detection of figures out of series • Mirror reflection of a pattern • Detection of the hidden figure in a given pattern • Figure rotation • Pattern completion test • Pattern comparison • Grouping of identical figures • Application of given rules to a set of figures
Module 2 (Credit 1) – Nonverbal Reasoning Tests: 2	

Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate proficiency to solve mathematical problems accurately.
	2. Distinguish the situations for and obtain the solutions.
	3. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems.
Content Outline	• Pattern rearrangement • Paper cutting • Making blocks by paper folding • Completing a given block from broken pieces • Making a key figure from given components • Folded views of paper • Deciphering opposite view of a design • Making a perfect square of a given design from cutup pieces • Cubes and Dices • Multidimensional figures/ blocks • Magic Square • Clock movements

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to solve questions appeared in last two years bank recruitment competitive examination question papers.
2. Solve questions appeared in various police Bharti competitive examination question papers of last year.
3. Obtain the solutions of the problems asked in various question papers of M.P.S.C. Examinations.
4. Obtain the solutions of the problems on reasoning of various railway recruitment examinations.

Reference Books:

1. Edgar Thorpe; Test of Reasoning for Competitive Examinations, Third Edition, Tata McGraw Hill, Section 2 and 3.
2. Dr. R.S. Aggarwal; A Modern Approach to Verbal and Nonverbal Reasoning, S. Chand.
3. Jaykishan and Premkishan; How to Crack Test of Reasoning in all Competitive Examinations, Arihant.

Semester – III

.3.5 D. Open Elective Courses/ Generic (OEC)

Course Titles	Financial Mathematics
Course Credits	2 Credit's
Course Outcomes	After completing this course, learner will be able to
	1. Understand the functioning of the banking system and related terminologies.
	2. Compute simple and compound interest and understand their applications.
	3. Apply knowledge of GST and taxation in financial calculations.
	4. Evaluate financial statements and investment options.
	5. Make informed decisions on personal finance and budgeting.
	6. Implement the various concept of taxation for real life applications.
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate a basic concept of finance towards budgeting
	2. Apply shortcut formulae to obtain the solution to the problems of finding interests, tax, GST etc.
Content Outline	Module 1: Basics of Banking [8 Hours] Types of Bank account: Saving, Current, FD, RD and their differences Cheque, ATM, Debit and Credit Card: Meaning and their uses Concepts: KYC, IFSC, MICR meaning and their uses Module 2: Interest Calculations [8 Hours] Simple and Compound Interest: Differences and Applications, Annual and Half Yearly Calculation PAN and TAN: Meaning, Difference and use Module 3: Goods and Service Tax [8 Hours] GST: CGST, SGST, IGST meaning and uses Calculation of GST in billing, Practical billing examples Module 4: Taxation and Budget [6 Hours] Income Tax: Basics and Slabs ITR: Basic concepts in Form 16 and ITR form Practical of finding income tax according to various tax slabs

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to solve questions based on the topic interest, GST

2. Solve questions based on topic TAX.
3. Obtain the solutions of the problems based on finding suitable tax slabs for simple word problems.
4. Obtain the solutions of the problems based on finding suitable tax slabs under GST for simple word problems.

Recommended Books / Materials:

1. "Mathematics for Economics and Finance" by Martin Anthony and Norman Biggs
2. "Practical Financial Mathematics" by C. B. Gupta
3. Online GST Portal and Income Tax India Portal
4. RBI Financial Literacy Materials

.3.7 Major (Core)

Course Title	Metric Spaces
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	CO1: Understand fundamental concepts of metric spaces such as open sets, sequences, and completeness.
	CO2: Understand and analyze continuity and topological properties of functions and spaces.
Module 1 (Credit 1) - Basic Notions and Convergence	
Learning Outcomes	After learning the module, learners will be able to
	1. Explain and apply concepts of open balls, open sets, convergence, limit points, and bounded sets.
	2. Analyze properties of Cauchy sequences, completeness, dense sets, and boundaries of sets.
Content Outline	Definition and examples, Open Balls and Open Sets, Convergent Sequences, Limit and Cluster points, Cauchy Sequences and Completeness, Bounded Sets, Dense Sets, Boundary of a set
Module 2 (Credit 1) – Continuity, Compactness and Connectedness	
Learning Outcomes	After learning the module, learners will be able to
	1. Explain continuity, limits, uniform continuity, and equivalent definitions in metric spaces.
	2. Analyze topological concepts such as open and closed maps, compactness, and connectedness.
Content Outline	Continuous Functions, Equivalent Definitions of Continuity, Topological Property, Uniform Continuity, Limit of a Function, Open and closed maps, Compact Spaces and their Properties, Connected Spaces

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

- Explore concepts of metric spaces by analyzing open sets, convergence, Cauchy sequences, completeness, and properties of sets.
- Study continuity and topological properties by solving problems on limits, uniform continuity, compactness, and connectedness.

References

1. Topology of Metric Spaces, S. Kumaresan, Narosa Publishing House (2nd edition), 2011.
2. Metric Spaces, Q.H. Ansari: Narosa Publishing House, New Delhi, Chapters 1 –

- 5.
3. Metric Spaces, Satish Shirali, H. Vasudeva, Springer.
3. First Course in Metric Spaces, B. K. Tyagi, Cambridge University Press
4. M. O. Searcoid: Metric spaces, Springer, 2007.
5. Metric Spaces, E.T. Copson, University Press, Cambridge, 2nd edition, Mumbai, 1978.

Course Syllabus

Semester – IV

.4.1 Major (Core)

Course Titles	Linear Algebra
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	Co 1: Define and identify subspaces in different vector spaces
	Co 2: Perform operations on subspaces such as sum, intersection, and direct sum.
	Co 3: Compute the basis and dimension of subspaces resulting from these operations
	Co 4: Apply the rank-nullity theorem and orthogonal projections in solving problems.
	Co 5: Utilize linear transformations and eigenvalues/eigenvectors in applications.
	Co 6: Demonstrate proficiency in working with quotient spaces and orthogonal complements
Module 1 (Credit 1) – Matrices	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Distinguish various types of matrices
	2. Apply properties of determinants efficiently.
Content Outline	• Various types of matrices, Arithmetic operations on matrices, orthogonal matrices, Determinant, Properties of determinants, Adjoint of a matrix, Inverse of a matrix, Inverse of the product of matrices, Inverse of an orthogonal matrix.
Module 2 (Credit 1) – Vector Spaces and Subspaces	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Define vector space.
	2. Apply Union and intersection of the subspaces. Obtain orthogonal projections and orthogonal compliments of the vector subspace.
	3. Evaluate the linear dependence and independence of vectors within a given vector space.
	4. Construct bases and determine the dimension of vector spaces and subspaces.
Content Outline	• Vector spaces: definition, properties, and examples Subspaces, Null Space, Column Space, and Row Space using matrices Union

	and Intersection of subspaces Orthogonality and Orthogonal projections Sum, Direct Sum, Orthogonal complement of subspaces. Linear Dependence and Independence of vectors Examples Basis, Dimension Coordinate vector relative to a basis Gram-Schmidt process.
Module 3 (Credit 1) – Eigenvalues and Eigenvectors	
Learning Outcomes	After learning the module, learners will be able to
	1. Formulate solutions to systems of linear equations using eigenvalues and eigenvectors.
	2. Determine Characteristic Value and Characteristic Vectors of a matrix.
Content Outline	Definition and computation of eigenvalues and eigenvectors, Characteristic equation, Cayley-Hamilton theorem (Statement Only), Characteristic value and Characteristic vector of a matrix.
Module 4 (Credit 1) – Linear Transformation	
Learning Outcomes	After learning the module, learners will be able to
	1. Appraise the matrix representation of linear transformations
	2. Evaluate the problems on Linear Transform.
	3. Analyze the rank-nullity theorem to solve problems related to linear transformations
Content Outline	Linear Transformations: Definition and examples of linear transformations, Matrix representation of linear transformations, Kernel and range of linear transformations, Rank-Nullity theorem.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

References:

1. "Linear Algebra and Its Applications" by David C. Lay, Steven C. Lay, and Judi J. McDonald
2. "Elementary Linear Algebra" by Howard Anton and Chris Rorres
3. "Linear Algebra" by Kenneth Hoffman and Ray Kunze

Semester – IV

.4.2 Major (Core)

Course Titles	Numerical Analysis
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	CO 1 Develop basic Scilab programs using variables, input/output commands, conditional statements, and loops
	CO 2 Learn about various interpolating and extrapolating methods.
	CO 3 Solve initial and boundary value problems in differential equations using numerical methods.
	CO 4 Apply various numerical methods in real life problems.
Module 1 (Credit 1) – Introduction to Scilab	
Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate proficiency in using Scilab for basic mathematical computations and programming concepts.
	2. Apply Scilab's built-in functions and control structures to solve mathematical and computational problems efficiently.
Content Outline	• Introduction to Scilab Overview of Scilab: Features and Applications, Installation and Setup of Scilab, Scilab Interface: Workspace, Console, and Editor • Simple Mathematical Calculations using Scilab Arithmetic Operations and Operator Precedence, Working with Scalars, Vectors, and Matrices, Use of Built-in Mathematical Constants • Basic Programming in Scilab Variables and Data Types, Input and Output Commands, Conditional Statements (if-else, switch), Looping Constructs (for, while) • Use of Mathematical Functions in Scilab Built-in Mathematical Functions (Trigonometric, Logarithmic, Exponential), User-Defined Functions, Handling Complex Numbers and Special Functions
Module 2 (Credit 1) – Numerical Methods for Solving Algebraic and Transcendental Equations	
Learning Outcomes	Learning Outcomes After learning the module, learners will be able to
	1. Analyze the sources and impact of round-off and truncation errors in numerical computations and their effects on algorithm accuracy.

	2. Apply numerical methods such as Bisection, False Position, Fixed Point Iteration, Newton's, and Secant methods to solve equations and assess their convergence.
Content Outline	Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations.
Module 3 (Credit 1) – Interpolation, Numerical Differentiation and Integration	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply interpolation techniques, including Lagrange and Newton methods, to estimate values and analyze the accuracy of numerical approximations.
	2. Implement numerical differentiation and integration methods, such as finite difference approximations, Trapezoidal, and Simpson's rules, while evaluating error behavior and convergence.
Content Outline	Lagrange and Newton interpolations, Piecewise linear interpolation, Finite difference operators, Gregory–Newton forward and backward difference interpolations, First order and higher order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rules and error analysis, Bulirsch–Stoer extrapolation methods, Richardson extrapolation.
Module 4 (Credit 1) – Initial and Boundary Value Problems of Differential Equations	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply numerical methods such as Euler's, Runge-Kutta, and multi-step methods for solving differential equations and analyzing their accuracy.
	2. Implement finite difference and shooting methods in real-life applications, including simulations and predictive models like weather forecasting and search engine algorithms.
Content Outline	Euler's method, Runge–Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE):

- Numerical Computation in Scilab (CO1, CO2)
(e.g. Write a Scilab program to implement Lagrange interpolation and estimate the value of a function at a given point.)
- Solving Differential Equations using Numerical Methods (CO3, CO4)
(e.g Implement Euler's method in Scilab to solve a first-order differential equation)

and analyze its accuracy with real-world data (e.g., population growth or heat conduction).)

References:

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
3. F. B. Hildebrand (2013). Introduction to Numerical Analysis (2nd edition). Dover Publications.
4. M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
5. Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

Semester – IV**.4.3 Major (Core)**

Course Titles	Practical's Based on 4.1 and 4.2 Practical on Linear Algebra
Course Credits	4 Credit's
Course Outcomes	After completing this course, learner will be able to
	CO1. Understand matrix operations and their algebraic properties.
	CO2. Analyze vector spaces and identify key substructures like subspaces
	CO3. Evaluate linear dependence, basis, and dimension in vector spaces
	CO4. Compute and interpret eigenvalues and eigenvectors
	CO5. Apply linear transformations and represent them via matrices
	CO6. Use vector space theory in practical and applied mathematical contexts
Learning Outcomes	After learning this module, learner will be able to
	LO1. Students will develop the ability to apply abstract linear algebra concepts to solve practical problems.
	LO2. Students will enhance their logical reasoning and computational skills in analyzing linear systems and transformations.
Content Outline	Practical 1: Matrices and Determinants [1] Perform arithmetic operations (addition, multiplication) on given matrices. [2] Verify that a given matrix is orthogonal. [3] Compute the determinant and verify its properties. [4] Find the inverse of a matrix using Adjoint. [5] Show that the inverse of a product of two matrices is the product of their inverses in reverse order. Practical 2: Vector Spaces and Subspaces [1] Verify whether a set forms a vector space under given operations. [2] Determine if a subset is a subspace of a given vector space. [3] Find the null space and column space of a given matrix. [4] Find the intersection and sum of two subspaces. [5] Verify whether a set of vectors is orthogonal and find the orthogonal complement. Practical 3: Basis and Dimension [1] Check if a set of vectors is linearly independent. [2] Find a basis and dimension of a subspace. [3] Represent a vector relative to a given basis. [4] Use the Gram-Schmidt process to obtain an orthonormal

	basis. [5] Find the dimension of the row space and column space of a matrix. Practical 4: Eigenvalues and Eigenvectors [1] Compute the eigenvalues and eigenvectors of a 2×2 or 3×3 matrix. [2] Verify the Cayley-Hamilton theorem for a matrix (statement only). [3] Diagonalize a matrix using its eigenvalues and eigenvectors. [4] Show that eigenvectors corresponding to distinct eigenvalues are linearly independent. [5] Solve a system of linear equations using the eigenvalue method. Practical 5: Linear Transformations [1] Determine whether a given transformation is linear. [2] Find the matrix representation of a linear transformation. [3] Compute the kernel and range of a linear transformation. [4] Apply the rank-nullity theorem to a linear transformation. [5] Check if a given transformation is one-to-one and/or onto. Practical 6: Applications [1] Verify if a vector lies in the column space of a matrix. [2] Decompose a vector into components along a basis. [3] Find the orthogonal projection of one vector onto another. [4] Use linear transformations in geometric contexts (e.g., rotation, reflection). [5] Solve a real-world application involving eigenvectors (e.g., population model).
Practicals for Numerical Analysis using Scilab	Practical No. 07 : Introduction to Scilab • Solve simple mathematical examples using Scilab Practical No. 08 : Round-off Error and Truncation Errors • Examples on Round-off Error and Truncation Errors Practical No. 09 : Root Finding Methods-I • Bisection Method • False Position Method • Fixed Point Iteration Method Practical No. 10 : Root Finding Methods-II • Newton's Method • Secant Method Practical No. 11: Interpolation, Numerical Differentiation and Integration • Lagrange and Newton Interpolations • Piecewise Linear and Cubic Spline Interpolation • Finite Difference Operators • Gregory-Newton Interpolation Practical No. 12: Numerical Differentiation and Integration

	• Numerical Differentiation • Numerical Integration:-Trapezoidal Rule • Numerical Integration:-Simpson's Rule • Numerical Integration:-Error Analysis and Extrapolation Methods Practical No. 13: Initial and Boundary Value Problems of Differential Equations • Euler's Method • Runge-Kutta Methods Practical No. 14 : Finite Difference and Shooting Methods • Solve boundary value problems using the finite difference method. • Implement the shooting method.
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Semester – IV

.4.4 A. Open Elective Courses/ Generic (OEC)

Course Titles	Mathematical Techniques for competitive examination Paper - 2
Course Credits	2 Credit's
Course Outcomes	After completing this course, learner will be able to
	1. Understand and apply foundational concepts of the trains, Races, games of skill, Proportion, linear equations, system of linear equations and quadratic equations.
	2. Analyze, evaluate, and apply advanced techniques in equations, Proportion and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving basic numerical problems.
	4. Analyze complex mathematical problem-solving strategies and obtain the solutions to the problems easily.
Module 1 (Credit 1) – Problems based on Train, Races and Games	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate a comprehensive understanding of rains problems, Games of Skill and Proportion.
	2. Apply shortcut formulae to obtain the solution to the problems, and fundamental employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	• Problems based on Trains. • Races and Games of Skill. • Direct Proportion and indirect Proportion. • Fast track formulae to solve the questions.
Module 2 (Credit 1) – Equations	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate proficiency to solve mathematical problems accurately.
	2. Distinguish the situations for various problems and obtain the solutions.
	3. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems.
Content Outline	• Linear Equations in one, two and three variables • System of linear equations

	• Quadratic Equations • Word problems based on equations
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to solve questions based on the topic problems based on trains from various competitive examination question papers.
2. Solve questions based on topic proportion from various competitive examination question papers.
3. Obtain the solutions of the problems based on Linear equations and System of equations.
4. Obtain the solutions of the problems based on quadratic equations.

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.
5. Dinkar Patil, Spardha Pariksha Ankaganit, Yashodin Publication, N 53, S.F. 4 /5/ 3 Uttamnagar Po. Trimurti Chowk CIDCO Nashik 422008

Semester – IV**.4.4 B. Open Elective Courses/ Generic**

Course Titles	स्पर्धा परीक्षेसाठी गणित तंत्र भाग – २
Course Credits	2 Credit's
Course Outcomes	सदर विषय अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	1. Understand and apply foundational concepts of the speed distance and time and Calendar
	2. Analyze, evaluate, and apply advanced techniques in work, distance and time and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving basic numerical problems.
	4. Analyze complex mathematical problem-solving strategies and obtain the solutions to the problems easily.
Module 1 (Credit 1) – वेळ या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	सदर पाठ अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	1. Demonstrate a comprehensive understanding of करणी, विभाज्यतेच्या कसोट्या, कमिशन व सूट, रोमन अंक
	2. Apply shortcut formulae to obtain the solution to the problems, and fundamental employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	● करणी ● विभाज्यतेच्या कसोट्या ● कमिशन व सूट ● रोमन अंक ● उदाहरणे जलद सोडवण्यासाठी सूत्रे व त्यांचा वापर
Module 2 (Credit 1) – पाणी (द्रव) या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	1. सदर पाठ अभ्यासल्यानंतर विद्यार्थी पुढील बाबीसाठी सक्षम असेल
	2. Demonstrate proficiency to solve mathematical problems accurately

	3. Distinguish the situations for and obtain the solutions
	4. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems
Content Outline	● घातांक ● वर्ग व वर्गमूळ ● घन व घनमूळ

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. विद्यार्थ्यांनी एमपीएससी च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
2. विद्यार्थ्यांनी पोलीस भरती व तलाठी भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
3. विद्यार्थ्यांनी बँक भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
4. विद्यार्थ्यांनी मागील वर्षीच्या स्पर्धा परीक्षेच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे

संदर्भ पुस्तके:

1. दिनकर पाटील, स्पर्धा परीक्षा अंकगणित, यशोदिन पब्लिकेशन्स, नाशिक
2. सिद्धेश्वर हाडबेज, अंकगणित व बुद्धिमत्ता, भारती प्रकाशन पुणे
3. पंढरीनाथ राणे, Sampurna Ganit, चैताली प्रकाशन

Semester – III**.4.4 C. Open Elective Courses/ Generic (OEC)**

Course Titles	Reasoning for Competitive Examination Part II
Course Credits	2 Credit's
Course Outcomes	After completing this course, learner will be able to
	1. Understand and apply foundational concepts of reasoning to solve the problems in various competitive examinations
	2. Analyze, evaluate, and apply advanced techniques in reasoning and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. Apply formulae and simplification techniques in solving problems
	4. Solve complex mathematical problem-solving strategies and obtain the solutions to the problems appeared in various competitive examinations easily.
Module 1 (Credit 1) – Verbal Reasoning Tests	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate a comprehensive understanding of pipes, cisterns, boats and stream, Clock and Calendar.
	2. Apply shortcut formulae to obtain the solution to the problems, and fundamental employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	• Series Completion ○ Letter Series ○ Number Series ○ Letter number mixed series • Verbal Classification ○ Letter Classification ○ Number Classification ○ Word/item classification • Verbal Analogy • Letters and Numbers analogy • Coding and Decoding • Sense of directions • Word building • Formatting meaningful word from jumbled letters • Word completion

	• Finding similar or dissimilar words • Jumbled words
Module 2 (Credit 1) – Logical Reasoning	
Learning Outcomes	After learning this module, learner will be able to
	1. Demonstrate proficiency to solve mathematical problems accurately.
	2. Distinguish the situations for and obtain the solutions.
	3. Develop the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems.
Content Outline	• Basic concepts in Logic • Types of logical relationships • Logical inference • Immediate inference • Assumption / Conclusion • Analysis of Statements • Reasoning Logical Diagrams • Family / Blood relations • Age doubts • Arrangement Problems

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Students have to form meaningful words from given jumbled letters
2. To complete the given words
3. To find similar and dissimilar words
4. Find family / Blood relations
5. Solve Arrangement Problems

Reference Books:

1. Edgar Thorpe; Test of Reasoning for competitive examinations, Third Edition, Tata McGraw Hill.
(1) For unit 1: Section 4 and 5.
(2) For unit 2: Section 6 and 7.
2. Surendranath Banarjee; A handbook of verbal reasoning, New Age International Publisher.
3. Dr. R.S. Aggarwal; A Modern Approach to Verbal and Nonverbal Reasoning, S. Chand.
4. Dr. M. B. Lal and Ashok Gupta; CSAT Logical Reasoning and Analytical Reasoning, Upkar Prakashan

Semester – IV**.4.4 D. Open Elective Courses/ Generic (OEC)**

Course Titles	Basic Statistics
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Understand the scope of statistics.
	2. Understand basic terminology in Statistics.
	3. Differentiate the primary and secondary data.
	4. Understand the applicability of measure of central tendency and dispersion.
Module 1 (Credit 1) – Measure of Central Tendency	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify the characteristics of the population.
	2. Interpret the result through the construction of graph and diagram.
	3. Learning Outcomes After learning the module, learners will be able to
Content Outline	• Introduction to Statistics: Population, Data, Frequency distribution • Diagram and Graph • Measure of Central Tendency: Arithmetic mean, weighted mean, mode, median, quartiles, deciles
Module 2 (Credit 1) – Measure of Dispersion and Correlation	
Learning Outcomes	After learning the module, learners will be able to
	Calculate the standard deviation of data and interpret the results.
	Apply correlation for data analysis.
Content Outline	• Introduction to dispersion • Types of dispersion: range, quartile deviation, mean deviation, standard deviation • Introduction to correlation: Definition, Scatter diagram, types of correlation • Karl Pearson Coefficient of Correlation, Spearman's Rank Correlation Coefficient

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Construct three real world examples. Each example should contain at least ten observations. Students are suggested to calculate any three types of measure of

central tendency and dispersion. Mention your conclusion about measure of central tendency and dispersion used for data set. Submit the detail report to course instructor. (CO1)(CO4)

8. Make a survey of your college students and collect the data of study hours and marks obtained in last semester. Randomly collect the sample of at least 10 students from the population. Draw scatter diagram for bivariate data. Also find Karl Pearson coefficient of correlation for this data. Write your comments from the calculation. Submit the detail report to course instructor. (CO2)(CO3)

References:

1. M.F. Triola, Elementary Statistics, Pearson Education, 13th edition, Boston, 2020
2. D.J. Hand, Statistics a Very Short Introduction, Oxford University Press, Oxford, 2014
3. V.R.P. Murthy, Elementary Statistics, Himalaya Publishing House, Mumbai, 2018
4. S.C. Gupta, V.K. Kapoor, Introduction to Statistics, Sultan Chand and Sons, New Delhi, 2018

Semester – IV

.4.5 Skill Enhancement Courses (SEC)

Course Titles	Introduction to Python Programming
Course Credits	2 Credits
Course Outcomes	After going through the course, learners will be able to
	CO1: Explain basic principles of computers.
	CO2: Make a use of basics operations, control structures, data types
	CO3: Apply basics commands of python in computations
Module 1 (Credit 1) – Python Programming Fundamentals	
Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate foundational knowledge of computer systems and programming by designing and implementing basic Python programs.
	2. Apply problem-solving techniques using functions, input/output operations, and data processing to develop well-structured and efficient programs.
Content Outline	• Fundamentals of Computers and Programming: Overview of computers including introduction, hardware and software, data representation and storage in computers, understanding program execution and flow, introduction to Python programming. • Input, Processing, and Output in Python: Program design and development process, handling user input and processing data, displaying output using the print statement, using comments, variables, and data types, performing arithmetic operations and formatting output. • Functions in Python: Introduction to functions and their importance, defining and calling functions in Python, structuring programs with functions, understanding local and global variables, passing arguments and using global constants in functions.
Module 2 (Credit 1) – Decision Structures and Boolean Logic	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply decision structures and Boolean logic to control program flow using conditional statements and logical operators in Python.
	2. Develop efficient programs utilizing loops, value-returning functions, and modules to automate repetitive tasks and enhance code reusability.
Content Outline	• Decision Making and Boolean Logic in Python: Conditional statements including if, if-else, and if-elif-else structures, string

	comparisons and logical operators, Boolean variables and their applications, implementing nested decision structures. • Looping and Iteration in Python: Introduction to loop structures, condition-controlled loops (while loop), count-controlled loops (for loop), using sentinels and input validation in loops, calculating running totals and implementing nested loops. • Functions and Modules in Python: Understanding value-returning functions, generating random numbers in Python, writing and using custom functions, utilizing the math module for mathematical computations, organizing code using modules. • Recursion in Python: Introduction to recursion and its working principle, problem-solving approach using recursion, examples of recursive algorithms (factorial, Fibonacci, binary search), understanding base case and recursive case. • Graphical User Interface (GUI) Programming in Python: Basics of GUI development and event-driven programming, introduction to the Tkinter module, creating and displaying text using label widgets, organizing layouts with frames, implementing interactive elements such as buttons, dialog boxes, and input fields, using radio buttons and check buttons for user selection.
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Design a flowchart and write pseudocode for a basic problem-solving task to understand fundamental programming logic. (CO1, CO2)
(e.g. Create a flowchart and write pseudocode for a basic program that calculates the sum of two numbers and checks if the result is even or odd.)
2. Develop a Python program that takes user input, processes the data using control structures, and displays meaningful output. (CO2, CO3)
(e.g. Write a Python program that converts temperatures between Celsius and Fahrenheit, allowing user input and displaying the result with appropriate formatting.)

References:

1. Gaddis, Tony. Starting Out with Programming Logic and Design, 2/e. Pearson Education India, 2008.
2. VanderPlas, Jake. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media, 2016.
3. Rogel-Salazar, Jesus. Data Science and Analytics with Python. Chapman and Hall/CRC, 2018.
4. Madhavan, Samir. Mastering Python for Data Science. Packt Publishing Ltd, 2015.
5. Dromey, R. Geoff. How to Solve it by Computer. Prentice-Hall, Inc., 1982.
6. Barry, Paul. Head First Python: A Brain-Friendly Guide. O'Reilly Media, 2016.
7. Brown, Martin C. Python: The Complete Reference. McGraw-Hill Professional, 2001.
8. Jeeva Jose, P. Sojan Lal. Introduction to Computing & Problem Solving with Python. Khanna Computer Book Store.
9. Thareja, Reema. Python Programming: Using Problem Solving Approach. Oxford

University Press, 2018.

10. R. Nageswara Rao. Core Python Programming. Dreamtech Press.

List of Suggestive Practical's for Skill Enhancement Course Semester-III

1. Introduction to Computers and Programming

- Write a Python program to display basic information about hardware and software.
- Create a program that explains how computers store different types of data.
- Develop a simple Python program that demonstrates the basic workflow of a program.
- Design a Python program to take user input, process it, and display the output using print statements.
- Implement comments in Python programs to describe various parts of the code.
- Write a program to use variables for storing data and perform basic calculations.

2. Simple Functions

- Define and call a simple function in Python that performs a specific task.
- Design a program that incorporates multiple functions with local variables.
- Create a Python program that uses global variables and constants within functions.
- Write programs to handle different data types in Python (integers, floats, strings, etc.).
- Develop a program to format and display data output using formatted strings and the format method.
- Implement basic operations on strings and numeric data types in Python.

3. Control Structures: Decision Making

- Use if statements to make decisions based on conditions in a Python program.
- Expand decision-making capabilities using if-else statements for more complex conditions.
- Compare strings and implement nested decision structures (if-elif-else) in Python.
- Implement a while loop in Python to execute a block of code based on a condition.
- Use a for loop to iterate over a sequence of elements and perform specific operations.
- Develop programs with nested loops to solve problems requiring repetitive execution.

4. Functions and Modular Programming

- Write Python functions that return values based on calculations or user inputs.
- Utilize Python's random module to generate random numbers in various programs.
- Create custom modules containing functions to organize and reuse code effectively.
- Develop Python programs that read input from files and process the data.
- Write data to files using Python programs and handle file operations like opening, reading, and closing files.
- Implement error handling techniques for file operations to manage exceptions effectively.

5. Introduction to Lists and Dictionaries

- Create lists and dictionaries in Python to store and manipulate collections of data.
- Perform operations on lists such as appending, slicing, and iterating over elements.
- Use dictionaries to store key-value pairs and implement operations like accessing values and updating entries.
- Define sets and tuples in Python and perform operations like intersection, union, and difference on sets.
- Use tuples for immutable sequences and implement tuple packing and unpacking operations.
- Compare the performance and characteristics of lists, sets, and tuples in different scenarios.

6. Decision Structures and Boolean Logic

- Develop Python programs using if statements to make decisions based on various conditions.
- Implement if-else statements for handling multiple decision outcomes in Python programs.
- Compare strings and use logical operators (and, or, not) to create complex conditions.
- Develop nested loops in Python programs to solve problems requiring multiple levels of iteration.
- Implement error handling techniques in Python programs using try-except blocks.
- Handle specific exceptions and customize error messages for better program reliability.
- Use finally blocks to execute cleanup code regardless of whether an exception occurred.

7. Functions and Modules

- Define value-returning functions in Python to encapsulate specific operations and return computed results.
- Explore built-in modules like math for mathematical operations and functions in Python programs.

8. Organize functions into modules and import them to reuse code across different Python programs.

- Implement arrays and matrices in Python using numpy or built-in data structures.
- Perform operations such as addition, multiplication, and transposition on matrices using Python.
- Compare the efficiency and application scenarios of arrays and matrices in numerical computing tasks.
- Object-Oriented Programming Basics
- Define classes and objects in Python to represent real-world entities and encapsulate data and behavior.

- Implement inheritance and polymorphism concepts to create class hierarchies and override methods.
- Utilize class constructors, instance variables, and class methods to manipulate object data and perform operations.

.4.7 A. Minor Stream

Course Title	Introduction to Mathematics for Image Processing
Course Credits	2 2 Credits for Theory
Course Outcomes	After going through the course, learners will be able to 1. Recognize mathematical representation of digital images 2. Demonstrating linear algebra and transforms in image processing. 3. Demonstrate image enhancement and filtering techniques 4. Analyze the mathematical concepts to real-world image applications
Module 1 (Credit 1) - Mathematical Foundation of Digital Images	
Learning Outcomes	After learning the module, learners will be able to 1. Construct Images as a matrix 2. Developed Energy of an image
Content Outline	• Definition of digital image • Pixel, resolution, grayscale and color images • Image as a matrix (2D signals) • Sampling and quantization • Image storage and formats • Image as a matrix and vector space • Basics of linear algebra (matrices, eigenvalues – intuition only) • Linear transformations (rotation, scaling only) • Inner product and Orthogonality • Energy of an image (Introduction only)
Module 2 (Credit 1) – Fourier Transformation and Image Processing	
Learning Outcomes	After learning the module, learners will be able to 1. Achieve mastery 2D Fourier Transform 2. s for Image Processing 3. Apply the properties of Fourier Transformation in image processing

Content Outline	• 2D Fourier Transform (concept and intuition) • Frequency domain representation of images • Low-pass and high-pass filtering • Applications in noise removal • Convolution in image processing • Kernel operations • Applications: medical imaging, satellite imaging, pattern recognition
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Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

1. Students are instructed to find Images as a matrix and Linear transformations applications. **(CO1 and CO2)**
2. Students are suggested to use 2D Fourier Transform. **(CO3)**
3. Students are suggested to find Applications in Image Processing. **(CO4)**

➤ Reference Books:

1. Fundamentals of Digital Image Processing – Anil K. Jain
2. Fundamentals of Image Processing – Ian T. Young , Jan J. Gerbrands and Lucas J. van Vliet, Delft University of Technology
3. Digital Image Processing – Rafael C. Gonzalez Fundamentals of Signals and Systems – Michael J. Roberts
4. Image Processing, Analysis, and Machine Vision – Milan Sonka, Vaclav Hlavac, and Roger Boyle

.4.7 B. Minor Stream

Course Title	Partial Differential Equations-II
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	CO1: know the role of Green's function in the solution of Partial Differential Equations.
	CO2: Understand and solve heat and wave equations using analytical methods.
Module 1 (Credit 1) - Green's Functions and Integral Representations	
Learning Outcomes	After learning the module, learners will be able to
	1. Explain singularity functions, fundamental solutions, and Green's identities.
	2. Construct and apply Green's functions and Neumann functions to solve Dirichlet and boundary value problems.
Content Outline	Singularity functions and the fundamental solution, Green functions, Greens identities, Green's function for m-dimensions sphere of radius R, Green's functions Dirichlet problem in the plane, Neumann's function in the plane.
Module 2 (Credit 1) – The Diffusion Equation & Parabolic Differential Equations	
Learning Outcomes	After learning the module, learners will be able to
	1. Explain existence and uniqueness of solutions and apply maximum–minimum principles for heat equations.
	2. Solve one-dimensional heat and wave equations using separation of variables and boundary value problems.
Content Outline	Existence and Uniqueness theorem for initial value problem in an infinite domain, semi-infinite domain, one-dimensional Heat equation, maximum and minimum principle for the heat equation and for some parabolic equations, one dimensional wave equation, boundary value problem for the one dimensional heat and wave equations, method of separation of variables.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

- Apply Green's functions and identities to solve boundary value problems including Dirichlet and Neumann problems.
- Solve heat and wave equations using appropriate methods and analyze properties such as existence, uniqueness, and maximum–minimum principles.

References:

1. Prasad, Phoolan, And Renuka Ravindran. *Partial Differential Equations*. New Age International, 1985.
2. Pinchover And Rubinstein, Y. "An Introduction To Partial Differential Equations." (2021).
3. Amaranath, T. An Elementary Course In Partial Differential Equations. Jones & Bartlett Learning, 2009.
4. Bers, Lipman, Fritz John, And Martin Schechter, Eds. Partial Differential Equations. American Mathematical Soc., 1964.
5. G.B. Folland, Introduction To Partial Differential Equations, Prentice Hall.

.4.7 C. Minor Stream

Course Title	Probability and Statistics -II
Course Credits	2 2 Credits for Theory
Course Outcomes	After going through the course, learners will be able to
	1Recognize and classify the discrete probability distributions
	2. Demonstrating the Binomial, Hypergeometric, Geometric and Poisson distribution
	3.Demonstrate Continuous Probability distributions
	4.Analyze and apply the continuous probability distributions on various problems.
Module 1(Credit 1) - Some Discrete Probability Distributions	
Learning Outcomes	After learning the module, learners will be able to
	1.Construct Discrete probability distributions.
	2.Developed advanced problem-solving skills in discrete probability distributions.
Content Outline	• Binomial and Multinomial distributions • Hypergeometric distribution • Negative binomial distribution • Geometric distribution • Poisson distribution and Poisson process.
Module 2(Credit 1) – Some Continuous Probability Distributions	
Learning Outcomes	After learning the module, learners will be able to
	1. Achieve mastery in continuous probability distributions like uniform distributions, Normal distributions, Gamma, exponential and Chi Square distributions.
	2. Apply the properties of Continuous probability distribution,

Content Outline	• Continuous Uniform distribution • Normal distribution • area under the normal curve • applications of the Normal distribution • normal approximation to the binomial distribution • Gamma distribution • Exponential distribution • Chi-squared distribution
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Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

1. Students are instructed to solve problems on Binomial distributions. Hyper geometric distributions, geometric and Poisson distributions (**CO1 and CO2**)
2. Students are suggested to use normal distribution. (**CO3**)
3. Students are suggested apply gamma, Exponential and Chi Square distributions (CO 4)

References

1. R. Walpole, R.H. Myers, S.L. Myers, and K. Ye ; Probability and Statistics for Engineers and Scientists (Seventh Edition, Pearson India).
2. Sheldon M. Ross; Introduction to Probability and Statistics for Engineers and Scientists, (Fourth Edition).
3. M. Samules, J. Witmer and A. Schaffner; Statistics for the Life Sciences (Fifth Edition, Pearson India)
4. Richard Gupta, C B Gupta.; Probability and Statistics for Engineers.
5. Sheldon M. Ross; A first course in Probability (Nineth Edition).
6. J. N. Kapoor, H. C. Saxena; Mathematical Statistics, S. Chand.