SNDT Women's University, Mumbai

Bachelor Of Science (Mathematics)

B.Sc. In Mathematics

As Per NEP – 2020

Semester – III & IV

Syllabus

(WEF. 2025-2026)

SNDT Women's University,Mumbai

Mathematics Undergraduate Programme

S.Y.B.Sc. (Mathematics)

2025-26

Terminologies

Abbreviation	Full-form	Remarks	Related to Major and Minor Courses	
Major (Core)	Main Discipline			
Major (Elective)	Elective Options		related to the Major Discipline	
Minor Stream	Other Disciplines (Inter/ Multidisciplinary) not related to the Major	either from the same Faculty or any other faculty		
OEC	Open Elective Courses/ Generic		Not Related to the Major and Minor	
VSEC	Vocational and Skill Enhancement Courses			
VSC	Vocational Skill Courses		~~Not~~ Related to the Major and Minor	Advanced laboratory practical of Major
SEC	Skill Enhancement Courses		Not Related to the Major and Minor	

AEC	**Ability Enhancement Courses**	**Communication skills, critical reading, academic writing, etc.**	**Not Related to the Major and Minor**	
VEC	**Value Education Courses**	**Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness**	**Not Related to the Major and Minor**	
IKS	**Indian Knowledge System**	**I. Generic IKS Course: basic knowledge of the IKS** **II. Subject Specific IKS Courses: advanced information** **pertaining to the subject: part of the major credit.**	**Subject Specific IKS related to Major**	
OJT	**On-Job Training (Internship/Apprenticeship)**	**corresponding to the Major Subject**	**Related to the Major**	
FP	**Field projects**	**corresponding to the Major Subject**	**Related to the Major**	

CC	**Co-curricular Courses**	**Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts**	**Not Related to the Major and Minor**	
CE	**Community Engagement and service**		**Not Related to the Major and Minor**	
RP	**Research Project**	**corresponding to the Major Subject**	**Related to the Major**	

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester III						
30132311	**Calculus of several variables**	**Major (Core)**	**4**	**100**	**50**	**50**
30132312	**Ordinary Differential Equations**	**Major (Core)**	**4**	**100**	**50**	**50**
30132313	**Practical based on 3.1 and 3.2**	**Major (Core)**	**4**	**100**	**50**	**50**
30332311	**Graph Theory**	**Minor Stream**	**2**	**50**	**0**	**50**
30432311	**(A) Mathematical Techniques for Competitive Examination-I**	**OEC**	**2**	**50**	**0**	**50**
30432312	**(B)** स्पर्धा परीक्षेसाठी गणित तंत्र भाग १	**OEC**	**2**	**50**	**0**	**50**
30432313	**(C) Reasoning For Competitive Examination Part 1**	**OEC**	**2**	**50**	**0**	**50**
30432314	**(D) Financial Mathematics**	**OEC**	**2**	**50**	**0**	**50**
	Modern Indian Language Marathi/ Hindi/English	**AEC**	**2**	**50**	**50**	**0**
31332301	**Field Project**	**FP**	**2**	**50**	**50**	**0**
	NSS/NCC/PE	**CC**	**2**	**50**	**50**	**0**
			22	**550**	**300**	**250**
Semester IV						
40132311	**Linear Algebra**	**Major (Core)**	**4**	**100**	**50**	**50**
40132312	**Numerical Analysis**	**Major (Core)**	**4**	**100**	**50**	**50**
40132313	**Practical based on 4.1 and 4.2**	**Major (Core)**	**4**	**100**	**50**	**50**
40432311	**(A) Mathematical Techniques for competitive examination-II**	**OEC**	**2**	**50**	**0**	**50**
40432312	**(B)**ओ इ सी : स्पर्धा परीक्षेसाठी गणित तंत्र भाग 2	**OEC**	**2**	**50**	**0**	**50**

40432313	**(C) Reasoning for Competitive Examination Part II**	**OEC**	**2**	**50**	**0**	**50**
40432314	**(D) Basic Statistics**	**OEC**	**2**	**50**	**0**	**50**
40732311	**Python Programing**	**SEC**	**2**	**50**	**0**	**50**
	Modern Indian Language Marathi /Hindi/English	**AEC**	**2**	**50**	**0**	**50**
41732301	**CEP**	**CEP**	**2**	**50**	**50**	**0**
	NSS/NCC/PE	**CC**	**2**	**50**	**50**	**0**
			22	**550**	**250**	**300**

Four Year Degree Program in Mathematics under the Faculty of Science and Technology
B.A. / B.Sc. (Honours / Honours with Research)

S.Y. B.Sc. Mathematics

Preamble, PSOs, COs and Assignment/activities towards CCE

Structure with Course Titles

(Options related to our area of study to be provided with "OR" for baskets of different types)

Exit with UG Diploma with 10 extra credits (44 + 10 credits)

3.1 Major (Core)

Course Title	**Calculus of Several Variables**
Course Credits	4
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
odule 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. **A**pply 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 Outcomes	After learning the module, learners will be able to
	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.

3.2 Major (Core):- Ordinary Differential Equation

Course Title	**Ordinary Differential Equation**
Course Credits	4
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	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 Bernouli differential equation
Content Outline	(1.1) Definition, order and degree of differential equations,separable differential equations, homogeneous and non-homogeneous differential equations. (1.2) Exact differential equations and its solution. (1.3) Integrating factors and rules for finding integrating factors of $M(x, y)\, dx + N(x, y)\, dy = 0$ (without proof) (1.4) Linear differential equations and Bernoulli differential equations. (1.5) 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	After learning the module, learners will be able to
	Evaluate the wronskian and determine the linear independence of differential equation.
	Apply the methods of undetermined coefficients and variation of parameter for nonhomogeneous differential equation.

Content Outline	(2.1)The general second order linear differential equation. Existence and Uniqueness Theorem (statement only). (2.2)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. (2.3)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. (2.4)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	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	3.1 Introduction 3.2 First order linear system: Definition, Solution to the system of linear equation. 3.3 Linear system of differential equation: Existence and Uniqueness Theorem (only statement), relevant theorems. 3.4 Homogenous linear system of differential equation: Wronskian, linearly independent solutions, general solutions 3.5 Homogenous linear system with constant coefficients. 3.6 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	After learning the module, learners will be able to
	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	4.1 Introduction: Definition and basic properties of Laplace Transform. Transform of some basic functions: e^x, sinx, cosx, step functions, etc. 4.2 Inverse Laplace Transform 4.3 Solution of linear ordinary differential equation using Laplace Transform 4.4 Initial and boundary value problems using Laplace Transform 4.5 Solving second order ordinary differential equation using Laplace Transform 4.6 Applications: Mechanical system, electrical circuit, control theory,

	population dynamics, etc.

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..

3.3 Practical based on Ordinary Differential Equation and Multivariable Calculus

Title	**Practical on Calculus of Several Variables**
Course Credits	**4**
Course Outcomes	After completing this course, learner will be able to
	CO1. Analyze and visualize functions of several variables, including domain, range, and limits.
	CO2. Apply partial derivatives and optimization techniques to solve real-world mathematical problems.
	CO3. Evaluate double and triple integrals, and interpret them in terms of area and volume.
	CO4. Solve line and surface integrals with applications in physics and engineering.
	CO5. Apply integral theorems such as Green's, Stokes', and Divergence Theorem in vector field analysis.
	CO6. Demonstrate understanding of vector calculus including divergence, curl, and conservative fields, and apply this to geometric and physical interpretations.
Learning Outcomes	After learning this module, learner will be able to
	LO1. Utilize calculus tools to analyse multi-variable systems in both Cartesian and alternative coordinate systems.
	LO2. Apply theoretical knowledge of multivariable calculus through hands-on problem-solving and practical computation.
Content Outline	**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: $\lim_{(x,y)\to(0,0)} \frac{yx^2}{y^2+x^2}$ [3] Show that the function $f(x,y) = x^4 + 3xy^3$ satisfies Euler's theorem for homogeneous functions. [4] Compute $\frac{dz}{dx}$ 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 $\frac{dz}{dt}$ if $z = xy$ where $x = t$ and $y = t^2$ [4] Find the gradient vector of $f(x,y) = x^2 + y^2$ at a point (1, 0) and (0, 1). [5] Find the directional derivative of $(x,y) = x^2 + y^2$ at (1, 0) in the direction of the vector v = (0, 1). **Practical 3: Double and Triple Integrals** [1] Evaluate I = $\int_0^1 \int_0^{x^2} (x+y)dydx$ [2] Compute the volume of the solid bounded by $36 - x^2 - y^2$ and the xy – plane.

[3] Convert the integral I = $\int_0^2 \int_0^{\sqrt{4-x^2}} f(x,y)dydx$ into polar coordinate.

[4] Find the volume of a sphere of radius 4 using triple integrals in spherical coordinates.

[5] Compute I = $\int_0^{\pi} \int_0^{\pi} rsin(\theta)\, d\theta dr$ in spherical coordinates.

Practical 4: Line and Surface Integrals

[1] Evaluate the line integral $\int (x^2 - y)dx + (y^2 - x)dy$ over the curve C: y = x^2 from (0, 0) to (2, 4).

[2] Compute the work done by the force field $F = (x, -y)$ along the circle $x^2 + y^2 = 4$

[3] Evaluate $\int F.dr$ for $F = (x, y)$ along the line segment from (0,0) to (1,1)

[4] Find the flux of $F = (x^2, y^2, z^2)$ across the surface $x + y + z = 2$

[5] Evaluate $\int F.dS$ where S is the hemisphere $x^2 + y^2 + z^2 = 9$, $z \geq 0$ and $F = (x, -y, z)$.

Practical 5: Integral Theorems

[1] Verify Green's theorem for $\oint (y^2 dx + x^2 dy)$ where C is the boundary of the region $x^2 + y^2 \leq 1$.

[2] Use Stokes' theorem to evaluate $\oint F.dr$ for $F = (-y, x, 0)$ where C is the boundary of the disk $x^2 + y^2 \leq 1$.

[3] Use the divergence theorem to compute the flux of $F = (x, y, z)$ across the surface of the sphere $x^2 + y^2 + z^2 = 1$.

[4] Verify Stokes' theorem for $F = (z, 0, -x)$ on the hemisphere $x^2 + y^2 + z^2 = 1, z \geq 0$.

[5] Compute the circulation of $F = (y, -x)$ around the unit circle using Green's theorem.

Practical 6: Vector Calculus

[1] Compute the divergence of $F = (x - y, xy, z)$

[2] Find the curl of $F = (x^2, x, zx)$

[3] Determine whether the vector field $F = (x^2 - y^2, 2xy)$ is conservative or not.

[4] Compute the directional derivative of $f(x, y, z) = xyz$ at (1, 0, 1) in the direction of $v = (2, -1, 1)$.

[5] Find the equation of the tangent plane to the surface $z = x^2 - y^2$ at (1, 0)

Practical on Ordinary Differential Equation

Learning Outcomes

After learning the module, learners will be able to

1. Find the orthogonal trajectories using first order differential equations.

2. Developed the modeling skill and solving methods.

Content Outline

Practical 7.

1. Examples based on order and degree of differential equation.
2. Examples based on variable seperable methods
3. Examples based on homogeneous differential equation.
4. Examples based on non-homogeneous differential equations.
5. Determine whether the given differential equation is Exact ?
6. Solving first order exact equations.

Practical 8.

1. Solving first order nonexact equations.
2. Solving Linear differential equations of first order and first degree
3. Examples based on Bernoulli differential equations.
4. Examples based on Modeling with first order equations. (examples on Financial Mathematics, Chemistry, Environmental Science, Population growth and decay, e.t.c)
5. Examples based on orthogonal trajectories .

Content Outline

Practical 9

1. Examples based on linearly independent solutions of the general second order linear differential equation. Existence and Uniqueness Theorem (statement only).
2. Examples based on used of known solution to find other solution for second order linear differential equation.
3. Simple examples on wronskian.
4. Examples like find auxillary equation for given homogenous second order linear differential equation with constant coefficient

Practical 10

1. Examples based on homogenous second order linear differential equation with constant coefficient.
2. Examples based on nonhomogenous second order linear differential equation.

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 .

	3. Examples based on variation of parameters method. 4. Examples based on method of undetermined coefficients. 5. Examples on construction of system of first order linear differential equation. **Practical 11** 1 Examples to construct the system of linear differential equation. associated with given differential equation. Examples to find the wronskian of two solutions of system of homogenous differential equation Examples on solutions to the homogenous system. Examples on general solution to the homogenous system with constant coefficients Examples on general solutions to the non- homogenous linear system. **Practical 12** 1. Examples to obtain the Laplace transform of given functions 2. Examples to obtain Inverse Laplace Transform of given functions 3 Examples based on solution of linear ordinary differential equation using Laplace Transform 4 Examples based on Initial and boundary value problems using Laplace Transform 5 Examples to solve second order ordinary differential equation using Laplace Transform 6 Examples based on Applications

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

Students are suggested to solve at least four problems from each practical. Note the solution of each problem. Make detailed record of each practical in the form of Journal. Submit the journal to the 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, 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.

3.4 Minor Stream :- Graph Theory

Course Title	**Graph Theory**
Course Credits	2
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	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 • (i) Vertex in graph: Adjacent vertices, degree of a vertex, isoloated vertex, pendant vertex in a undirected graph. (ii) 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. o Adjacency matrix of a simple graph. o Incidence matrix of an undirected graph. o Isomorphism of simple graphs. • Connectivity: o Circuit and paths. o Connected graphs, connected components in an undirected graph, A strongly connected directed graph, A weakly connected directed graph. A cut vertex. o Connecting paths between vertices. o Paths and isomorphisms. o Euler paths and circuits, Hamilton paths and circuits, Dirac's Theorem, Ore's

	Theorem o Shortest path problem, The shortest path algorithm - Dijkstra's Algorithm.
Module 2(Credit 1) –Tree	
Learning Outcomes	After learning the module, learners will be able to
	1. Find th**e** minimum spanning trees using Prim's Algorithm, Kruskal's Algorithm.
	2. Understand the different properties of trees using theorems and algorithms.
Content Outline	(a) (i) Trees: Definition and Examples. (ii) Forests, Rooted trees, subtrees, binary trees. (iii) Trees as models. (iv) Properties of Trees. (b) Application of Trees: (i) Binary Search Trees, Locating and adding items to a Binary Search Tree. (ii) Decision Trees (simple examples). (c) Game Trees, Minimax strategy, Tree Traversal, Traversal algorithm including preorder traversal, inorder traversal, postorder traversal using recursion. (d) (i) Spanning Tree, Depth-First Search and Breadth-First Search. (ii) Minimum Spanning Trees, Prim's Algorithm, Kruskal's Algorithm

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

1. Explain the different types of graphs in details (directed graph, undirected graph, weighted graph, bipartite graph, complete graph, regular graphs e.t.c.). List the examples on each mentioned graph. Make the detailed notes and submit it to course instructor.
2. Consider the weighted graph where vertex are represented with icelands and edges with bridges.Weight assign to bridge is distance between Iceland

Icelands: 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 the detail 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, Dovers 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*.

3.5 (A) OEC: Mathematical techniques for competitive examination Paper 1

Course Title	**Mathematical Techniques for competitive examination Paper 1**
Course Credits	**2**
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.
Module1(Credit1) – 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.
Module2(Credit1) – 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 Streams • 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

३.५.**(B)** ओ इ सी : स्पर्धा परीक्षेसाठी गणित तंत्र भाग १

Course Title	ओ इ सी : स्पर्धा परीक्षेसाठी गणित तंत्र भाग १
Course Credits	**2**
Course Outcomes	सदर विषय अभ्यासल्यानंतर विध्यार्थी 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.
Module1(Credit1) – वेळ या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	सदर पाठ अभ्यासल्यानंतर विध्यार्थी 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.

learning Outcomes	सदर पाठ अभ्यासल्यानंतर विध्यार्थी 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) • वयवारी
Module2(Credit1) – पाणी (द्रव) या संकल्पनेवर आधारित प्रश्न	

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1.विध्यार्थ्यानी एम पी एस सी च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
2.विध्यार्थ्यानी पोलीस भरती व तलाठी भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
3. विध्यार्थ्यानी बँक भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
4.विध्यार्थ्यानी 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 .**

3.5 (C) OEC: Reasoning For Competitive Examination Part 1

Course Title	**Reasoning For Competitive Examination Part 1**
Course Credits	**2**
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.
Module1(Credit1) – Nonverbal Reasoning Tests:1	
Learning	After learning this module, the learner will be able to

Outcomes	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	1. Completion of series (Sequence/order) 2. Classification 3. Analogical Nonverbal Reasoning 4. Pattern comparison between two sets of figures 5. Arranging figures in sequence 6. Detection of figures out of series 7. Mirror reflection of a pattern 8. Detection of the hidden figure in a given pattern 9. Figure rotation 10. Pattern completion test 11. Pattern comparison 12. Grouping of identical figures 13. Application of given rules to a set of figures
Module2(Credit1) – Nonverbal Reasoning Tests:2	

Learning Outcomes	After learning this module, learner will be able to
	4. **Demonstrate** proficiency to solve mathematical problems accurately. 5. **Distinguish** the situations for and obtain the solutions.
	6. **Develop** the ability to analyze complex word problems, apply appropriate mathematical techniques to obtain the solutions of the problems.
Content Outline	1. Pattern rearrangement 2. Paper cutting 3. Making blocks by paper folding 4. Completing a given block from broken pieces 5. Making a key figure from given components 6. Folded views of paper 7. Deciphering opposite view of a design 8. Making a perfect square of a given design from cutup pieces 9. Cubes and Dices 10. Multidimensional figures/ blocks 11. Magic Square 12. 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 questions 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.

3.5 (D) OEC. :- Financial Mathematics

Course Title	**Financial Mathematics**
Course Credits	**2**
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 concepts of finance towards budgeting
	2. Apply shortcut formulae to obtain the solution to the problems of finding interests, tax, GST etc.
Content Outline	<u>Module 1: Basics of Banking</u> [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 <u>Module 2: Interest Calculations</u> [8 Hours] Simple and Compound Interest: Differences and Applications, Annual and Half Yearly Calculation PAN and TAN: Meaning, Difference and use <u>Module 3: Goods and Service Tax</u> [8 Hours] GST: CGST, SGST, IGST meaning and uses Calculation of GST in billing, Practical billing examples <u>Module 4: Taxation and Budget</u> [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):

5. Students have to solve questions based on the topic interest, GST
6. Solve questions based on topic TAX.
7. Obtain the solutions of the problems based on finding suitable tax slabs for simple word problems.
8. 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 Field Projects:

Field Project Topics (Teacher Can Choose topic from following or give any project involving mathematics)
1. Home Science & Mathematics
Nutritional Analysis of Local Diets: Use statistical methods to analyze the nutritional intake of different age groups.
Household Budget Optimization: Survey families and apply mathematical models to optimize daily expenses.
Food Waste Management: Conduct a survey on food waste in households and propose solutions using data analysis.
2. B.A. (Social Sciences, Humanities)
Voting Trends and Political Preferences: Analyze election data and survey trends in voting behavior.
Impact of Social Media on Youth: Conduct a survey and apply statistical tools to measure the correlation between social media usage and academic performance.
Cultural Influence on Spending Habits: Analyze how cultural background influences consumer spending through surveys
3. B.Com. (Commerce & Business Analytics)
Customer Satisfaction Analysis in Local Businesses: Conduct a survey and analyze using statistical tools like regression.
Stock Market Awareness Among Students: Study investment habits and analyze risk perception using probability models.
E-commerce vs. Local Markets: A Statistical Comparison: Analyze consumer preferences and spending behavior.
4. Computer Science & Mathematics
Cybersecurity Awareness Among Students: Conduct a survey and use probability models to analyze vulnerability risks.
AI Chatbots vs. Human Interaction: A Comparative Study: Collect data on user experience and apply mathematical models for analysis.
Data Patterns in Online Learning Engagement: Use machine learning and statistics to analyze student participation.

SEM IV

4.1 Major (Core)

Course Title	**Linear Algebra**

Course Credits	4
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.
	Co5: **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	After learning the module, learners will be able to
	3. **Distinguish various types of matrices**
	4. **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	After learning the module, learners will be able to
	1. Define vector space.
	2. Apply Union and intersection of the subspaces. **3. Obtain orthogonal projections and orthogonal compliments of the vector subspace.** **4. Evaluate** the linear dependence and independence of vectors within a given vector space. **5. 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, Examples, 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 R. Lay, and Judi J. McDonald

[2] "Elementary Linear Algebra" by Howard Anton and Chris Rorres

[3] "Linear Algebra" by Kenneth Hoffman and Ray Kunze

4.2.Major (Core)

Course Title	**Numerical Analysis**
Course Credits	4
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
	5. Demonstrate proficiency in using Scilab for basic mathematical computations and programming concepts.
	6. Apply Scilab's built-in functions and control structures to solve mathematical and computational problems efficiently.
Content Outline	1. **Introduction to Scilab** Overview of Scilab: Features and Applications, Installation and Setup of Scilab, Scilab Interface: Workspace, Console, and Editor 2. **Simple Mathematical Calculations using Scilab** Arithmetic Operations and Operator Precedence, Working with Scalars, Vectors, and Matrices, Use of Built-in Mathematical Constants 3. **Basic Programming in Scilab** Variables and Data Types, Input and Output Commands, Conditional Statements (if-else, switch), Looping Constructs (for, while) 4. **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	After learning the module, learners will be able to
	3. **Analyze the sources and impact of round-off and truncation errors in numerical computations and their effects on algorithm accuracy.**

	4. **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
	3. Apply interpolation techniques, including Lagrange and Newton methods, to estimate values and analyze the accuracy of numerical approximations.
	4. 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
	3. Apply numerical methods such as Euler's, Runge-Kutta, and multi-step methods for solving differential equations and analyzing their accuracy.
	4. 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)

1. **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.)
2. **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.

4.3 **Practicals Based on 4.1 and 4.2**

Course Title	4.4 **Practicals Based on 4.1 and 4.2** **Practical on Linear Algebra**
Course Credits	**4**
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).

Practical's 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.

4.4 (A) OEC: Mathematical techniques for competitive examination Paper 2

Course Title	**Mathematical Techniques for competitive examination Paper 2**
Course Credits	**2**
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.
Module1(Credit1) – 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.
Module2(Credit1) – Equations	

Learning Outcomes	After learning this module, learner will be able to
	7. **Demonstrate** proficiency to solve mathematical problems accurately. 8. **Distinguish** the situations for various problems and obtain the solutions.
	9. **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

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

4.4 (B) ओ इ सी : स्पर्धा परीक्षेसाठी गणित तंत्र भाग **2**

Course Title	ओ इ सी : स्पर्धा परीक्षेसाठी गणित तंत्र भाग **2**
Course Credits	**2**
Course Outcomes	सदर विषय अभ्यासल्यानंतर विध्यार्थी 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.
Module1(Credit1) – वेळ या संकल्पनेवर आधारित प्रश्न	
Learning Outcomes	सदर पाठ अभ्यासल्यानंतर विध्यार्थी 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.
Module2(Credit1) – पाणी (द्रव) या संकल्पनेवर आधारित प्रश्न	

Learning	सदर पाठ अभ्यासल्यानंतर विध्यार्थी पुढील बाबीसाठी सक्षम असेल

Outcomes	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	• घातांक • वर्ग व वर्गमूळ • घन व घनमूळ • अंकगणिती व भूमिती श्रेढी • आंतरराष्ट्रीय प्रमाण वेळ • गुणोत्तर व प्रमाण • उदाहरणे जलद सोडवण्यासाठी सूत्रे व त्यांचा वापर

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. विध्यार्थ्यानी एम पी एस सी च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
2. विध्यार्थ्यानी पोलीस भरती व तलाठी भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
3. विध्यार्थ्यानी बँक भरती च्या मागील वर्षीच्या प्रश्नपत्रिकेमध्ये विचारलेले प्रश्न सोडवणे
4. विध्यार्थ्यानी 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**

4.4 (C) OCE Reasoning for Competitive Examination Part II

Course Title	**Reasoning for Competitive Examination Part II**
Course Credits	**2**
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.

Module1(Credit1) – 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	5. Series Completion • Letter Series Number Series • Letter number mixed series 6. Verbal Classification b. Letter Classification c. Number Classification d. Word/ item classification 3. Verbal Analogy 4. Letters and Numbers analogy 5. Coding and Decoding 6. Sense of directions 7. Word building 8. Formatting meaningful word from jumbled letters 9. Word completion 10. Finding similar or dissimilar words 11. Jumbled words
Module2(Credit1) – 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	1. Basic concepts in Logic 2. Types of logical relationships 3. Logical inference 4. Immediate inference 5. Assumption/ Conclusion 6. Analysis of Statements 7. Reasoning Logical Diagrams

	8. Family/ Blood relations 9. Age doubts 6. 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.

For unit 1:Section 4 and 5.

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

4.4 (D) OEC :- Basic Statistics

Course Title	**Basic Statistics**
Course Credits	2
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 diagraph.
Content Outline	(1.1) Introduction to Statistics: Population, Data, Frequency distribution, (1.2) Diagram and Graph (1.3) 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
	1. Calculate the standard deviation of data and interpret the results.
	2. Apply correlation for data analysis.
Content Outline	(2.1) Introduction to dispersion (2.2) Types of dispersion: range, quartile deviation, mean Deviation, standard deviation (2.3) Introduction to correlation: Definition, Scatter diagram, types of correlation (4.1) Karl Pearson Coefficient of Correlation, Spearman's Rank Correlation Coefficient

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

1 Construct three real world examples. Each example should contains 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)

1. 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, 13 th edit., Boston, 2020
2 D.J.Hand, Statistics a very short introduction, Oxford University Press, Oxford, 2014.
3 V.R.P. Murthy, Elementary Statistics, Himalaya Public. House, Mumbai, 2018.
4 S.C.Gupta, V.K.Kapoor, Introduction to statistics, Sultan Chand and Sons, New Delhi, 2018.

4.5. SEC (Core) Introduction to Python Programming

Course Title	**Introduction to Python Programming**
Course Credits	2
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	1. **Fundamentals of Computers and Programming** Overview of Computers: Introduction, Hardware, and Software, Data Representation and Storage in Computers, Understanding Program Execution and Flow, Introduction to Python Programming 2. **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 3. **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	**1. Decision Making and Boolean Logic in Python** Conditional Statements: if, if-else, and if-elif-else Structures, String Comparisons and Logical Operators, Boolean Variables and Their Applications, Implementing Nested Decision Structures **2. 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 **3. 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 **4. 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 **5. 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: Buttons, Dialog Boxes, and Input Fields, Using Radio Buttons and Check Buttons for User Selection

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, Inc.", 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, Inc.", 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; First edition, ISBN-10: 9789382609810, ISBN-13: 978-9382609810
9. Thareja, Reema. Python Programming: Using Problem Solving Approach. Oxford university press, 2018.
10. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Second edition ISBN10:938605230X, ISBN-13: 978-9386052308 ASIN: B07BFSR3LL

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. o 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. o 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.
- 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. o 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.

8. 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 CEP

Community Engagement Services (Teacher can conduct any suitable activity)

1. **Data Analysis of Local Public Issues**

Conduct surveys on issues like waste management, water usage, or transportation.

Use statistics and data visualization to present insights to local authorities.

2. **Mathematics Behind Budgeting for Households and Small Businesses**

Teach and develop simple budgeting models for families or local vendors using arithmetic and percentages.

Create financial literacy modules with community outreach.

3. **Math in Everyday Life Workshops**

Organize sessions for school children or adults on practical math (e.g., measurements, unit conversions, simple interest).

Prepare interactive teaching aids.

4. **Mapping and Analyzing Local Infrastructure Using Geometry**

Create scaled maps of neighborhoods.

Analyze road connectivity, public facilities, or emergency response optimization using geometric tools.

5. **Optimization of Local Resources**

Use linear programming to optimize use of resources like water supply, electricity, or food distribution in the community.

6. **Cost Analysis and Pricing Strategies for Local Farmers or Vendors**

Help local producers understand break-even analysis and profit maximization using algebra and functions.

7. **Statistical Study of Education or Health in the Community**

Collect and analyze data on literacy rates, dropout rates, or health indicators.

Suggest improvements based on statistical interpretation.

8. **Mathematical Modelling for Environmental Awareness**

Model pollution levels, population growth, or waste production.

Propose strategies for sustainability through mathematical predictions.

9. **Cryptography and Basic Cybersecurity Awareness**

Teach basic coding systems and the importance of data security using number theory and modular arithmetic.

Conduct community workshops on password safety and online privacy.

10. **Weather and Climate Data Analysis**

Collect local weather data, analyze patterns, and correlate with agricultural activities.

Present findings to farmers and local planning bodies.

11. Math Tutoring & Mentorship Program

- **Objective:** Provide free math tutoring to school students or underprivileged communities.
- **Activities:**
    - Partner with local schools or NGOs.
    - Conduct weekly math tutoring sessions.
    - Develop fun learning materials (videos, worksheets, games).
    - Measure impact through student improvement assessments.

12. Data-Driven Community Analysis

- **Objective:** Use statistical and mathematical modeling to analyze and solve local community issues.
- **Activities:**
    - Identify a problem (e.g., traffic patterns, pollution levels, economic disparity).
    - Collect and analyze real-world data.
    - Present findings to local authorities or stakeholders.

13. Financial Literacy Workshops

- **Objective:** Teach basic financial mathematics (budgeting, interest rates, savings) to local communities.
- **Activities:**
    - Develop an engaging curriculum.
    - Conduct workshops in schools or community centers.
    - Provide interactive tools (spreadsheets, online calculators).

14. Math & Art in Public Spaces

- **Objective:** Explore mathematical patterns in art and create community murals/installations.
- **Activities:**

- Design a project based on fractals, tessellations, or symmetry.
- Engage the community in creating the artwork.
- Explain the mathematical concepts behind the artwork.

15. Gamified Math Learning for Kids

- **Objective:** Develop educational math games for children in underprivileged areas.
- **Activities:**
  - Design engaging math-based games (board games, online games, apps).
  - Test games in schools/community centers.
  - Collect feedback and refine the games.

16. Environmental Math Modeling

- **Objective:** Use math to analyze environmental issues (waste management, water usage, pollution).
- **Activities:**
  - Collaborate with environmental groups.
  - Use statistics, calculus, or differential equations to model trends.
  - Present findings and propose solutions.

17. Math for Small Businesses

- **Objective:** Help local entrepreneurs with financial planning, cost analysis, and pricing strategies.
- **Activities:**
  - Partner with small businesses.
  - Teach basic business math (profit margins, break-even analysis).
  - Develop easy-to-use financial tools for them.

Continuous Assessment Structure (Total: 50 Marks)

Continuous Assessment (CA) – 30 Marks

1. Weekly/biweekly progress reports, participation, and initiative (10)
2. Mid-semester presentation (10)
3. Assignment submission per topic (10)

Final Project Report & Presentation – 10 Marks

Structured documentation (5)

Clarity of mathematical analysis (5)

Community relevance and impact (5)or

Community Feedback & Reflection – 5 Marks or

Feedback from community members/partners (5) or

Student reflection journal/experience sharing (5)