AC: DATE

Item No. _____

Chikitsak Samuha's

Sir Sitaram and Lady Shantabai Patkar College of Arts and Science and V.P. Varde College of Commerce and Economics,
S. V. Road, Goregaon (West), Mumbai – 400104
AUTONOMOUS, Affiliated to University of Mumbai

Reaccredited with 'A+ Grade' by NAAC (3rd Cycle), with an institutional score of 3.53, ISO 9001-2015, Best College 2016-17, DBT STAR COLLEGE SCHEME and RUSA 2.0 Awardee, India's Education Excellence Award 2018: Berkshire Media LLC, USA, Ranked 45th in the EW India Private Autonomous College Rankings 2020-21

SYLLABUS FOR

PROGRAMME – BSC (PUSMA)

YEAR – FIRST YEAR

SEMESTERS – III AND IV

Choice based Credit and Grading System (CBCGS)

Syllabus to be implemented with effect from the academic year 2024– 2025

PROGRAMME SPECIFIC CODE: PUSMA

Programme Specific Outcomes

PSO	A Student completing Bachelor's Degree in Science Programme with Mathematics subject will be able to:
PSO 1	Equipped with mathematical modelling ability, problem solving skills, creative talent which is necessary for various kind of employment
PSO 2	Apply their skills and knowledge to translate information into mathematical form, select and use appropriate mathematical formulae or techniques to process the information and draw the relevant conclusion
PSO 3	Acquire their analytical thinking, logical deductions and rigor in reasoning
PSO 4	To undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics

PEDAGOGY

1. Caring classroom communities that are focused on mathematical goals help develop students' mathematical identities and proficiencies.
2. Providing students with opportunities to work both independently and collaboratively to make sense of ideas.
3. Selecting an example which influences how students come to view, develop, use and make sense of mathematics.
4. Supporting students in creating connections between different ways of solving problems, between mathematical representations and topics and between mathematics and everyday experience.
5. Making use of wide range of assessments to make students' thinking visible and to support students' learning.

INDEX

Semester III			**Semester IV**		
CourseNo.	**Course Title**	**Credits**	**Course No.**	**Course Title**	**Credits**
Major 1	Real Analysis – I	3.5	Major 1	Real Analysis – II	3.5
Major 2	Linear Algebra – I	3.5	Major 2	Linear Algebra – II	3.5
Minor	Ordinary Differential Equations	04	Minor	Numerical Solutions to First Order ODE	04
VSEC	Algorithms	04	VSEC	Introduction to Graph Theory	04
FP/CEP		02	IKS	Ancient Indian Mathematics	02
OE	Mathematical and Statistical Techniques - III	02	OE	Mathematical and Statistical Techniques – IV	02

Semester III

Major I

Course Title	Real Analysis – I
Course Code	
Total Number of Lectures	02 Lectures + Practicals
Credits	3.5
Introduction	This course focuses on ● sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and know how to use them by solving and interpreting ● To enhance students' overall development and to equip them with problem solving skills and creative talent necessary for various kinds of employment
Course Outcomes	● After successful completion of this course students will be able to think deductively, analyse mathematical situations and extend ideas to a new context.
Units	Given Below

Major paper

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Topology of Real Numbers** • Review of the notion of supremum, infimum and lub axiom with their consequences, Nested Interval Theorem • Neighbourhood of a point in R, Hausdorff property • Open and Closed sets in R • Limit point of a subset of R, Examples, Characterisation of a closed set as sets containing all its limit points, Elementary results , Bolazano Weierstrass theorem i.e, a bounded infinite subset of R has atleast one limit point • Heine-Borel Theorem i.e, A subset of R is compact if and only if it is closed and bounded	15
II	**Infinite Series of real numbers** ● Review of notion of Sequences and subsequences of real numbers ● If $lim\ x_{2n} = l = lim\ x_{2n+1}$ then $lim\ x_n = l$ ● Definition of $lim\ sup\ x_n$ and $lim\ inf\ x_n$ and if $lim\ sup\ x_n = l = lim\ inf\ x_n$ then $lim\ x_n = l$ ● Series $\sum_{n=1}^{\infty} a_n$ of real numbers, Simple examples of series, Sequence of partial sums of a series, Convergent Series, Divergent Series, Necessary condition: If $\sum_{n=1}^{\infty} a_n$ converges then (a_n) converges to 0 but converse is not true, Algebra of Convergent Series ● Cauchy criterion for the convergence of series, Divergence of Harmonic Series, Comparison test (without proof), limit comparison test (without proof) and examples, Alternating Series, Leibnitz theorem (alternating series test) and examples ● Absolute convergence, Conditional convergence, Absolute convergence implies convergence but not conversely ● Ratio test (without proof), Root test (without proof) and examples	15

Reading List

1. Introduction to Real Analysis: Bartle and Sherbert
2. A basic course in Real Analysis: Ajit Kumar and S.Kumaresan
3. Principles of Mathematical Analysis: W.Rudin
4. Methods of Real Analysis: R.R.Goldberg
5. A course in Calculus and Real Analysis: Ghorpade and Limaye

Sr. No.	Title of the Practical
1.	Open and Closed sets in R
2.	Limit point of a subset of R
3.	Examples of series of real numbers using sequence of partial sums
4	Convergence of series using Comparison test, limit form of comparison test, Ratio test and Root test

Major II

Course Title	Linear Algebra – I
Course Code	
Total Number of Lectures	02 lectures +Practicals
Credits	3.5
	• To learn computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces • To learn and understand visualization, spatial reasoning, as well as geometric properties and strategies to model, solve problems, and view solutions, especially in $\mathbb{R}^2$; $\mathbb{R}^3$, as well as conceptually extend these results to higher dimensions. (Geometric Skills).
Course Outcomes	Upon successful completion of this course students will be able to: • Apply mathematical methods involving arithmetic, algebra, geometry, and graphs to solve problems. • Solving System of linear equation • Introduction to vector spaces
Units	Given Below

Unit Number	CONTENT	NUMBER OF LECTURES
I	**System of Linear Equation** ● Parametric equation of lines and planes, system of homogeneous and non- homogeneous linear equations, the solution of system of m homogeneous linear equations in n unknowns by elimination and their geometrical interpretation for$(n, m) = (1, 2), (1, 3), (2, 2), (2, 3), (3, 3)$; definition of $n-$tuples of real numbers, sum of two $n-$tuples and scalar multiple of an n−tuple. Matrices with real entries; addition, scalar multiplication and multiplication of matrices; transpose of a matrix, types of matrices: zero matrix, identity matrix, scalar matrices, diagonal matrices, upper triangular matrices, lower triangular matrices, symmetric matrices, skew-symmetric matrices, Invertible matrices; identities such as$(AB)^t = B^t A^t, (AB)^{-1} = B^{-1}A^{-1}$. ● System of linear equations in matrix form, elementary row operations, row-echelon matrix, Gaussian elimination method, to deduce that the system of $m$homogeneous linear equations in n unknowns has a non-trivial solution if $m < n$.	15
II	**Vector spaces** ● Definition of a real vector space, examples such as $\mathbb{R}^n$; $\mathbb{R}[X]$; $M_{n\times m}(\mathbb{R})$; spaceof all real valued functions on a non-empty set. ● Subspace: definition, examples: lines, planes passing through origin as sub-spaces of $\mathbb{R}^2$; $\mathbb{R}^3$ respectively; upper triangular matrices, diagonal matrices, symmetric matrices, skew-symmetric matrices as subspaces of $M_n(\mathbb{R})(n = 2; 3)$; $P_n(X) = \{a_0 + a_1X + \cdots + a_nX_n/a_i \in \mathbb{R}, \forall\ 0 \leq i \leq n\}$ as a subspace of $\mathbb{R}[X]$; the space of all solutions of the system of m homogeneous linear equations in$n$ unknowns as a subspace of $\mathbb{R}^n$ ● Properties of a subspace such as necessary and sufficient condition for a nonempty subset to be a subspace of a vector space, arbitrary intersection of sub-spaces of a vector space is a subspace, union of two subspaces is a subspace if and only if one is a subset of	15

	the other. ● Finite linear combinations of vectors in a vector space; the linear span $L(S)$of a non-empty subset S of a vector space, S is a generating set for $L(S)$; $L(S)$is a vector subspace of; linearly independent/linearly dependent subsets of avector space, a subset $\{v_1, v_2, \dots, v_k\}$of a vector space is linearly dependent ifand only if $\exists\, i \in \{1,2,3, \dots, k\}$such that v_i is a linear combination of the other vectors $v_j's$.	

Reading List

1. Serge Lang, Introduction to Linear Algebra, Second Edition, Springer.
2. S. Kumaresan, Linear Algebra, A Geometric Approach, Prentice Hall of India Pvt. Ltd, 2000.
3. M. Artin: Algebra, Prentice Hall of India Private Limited, 1991.
4. K. Hoffman and R. Kunze: Linear Algebra, Tata McGraw-Hill, New Delhi, 1971.
5. Gilbert Strang: Linear Algebra and its applications, International Student Edition.
6. L. Smith: Linear Algebra, Springer Verlag.
7. Ramachandra Rao and P. Bhima Sankaran: Linear Algebra, Tata McGraw-Hill, New Delhi.
8. T. Banchoff and J. Warmers: Linear Algebra through Geometry, Springer Verlag, New York, 1984.
9. Klaus Janich: Linear Algebra.
10. Otto Bretcher: Linear Algebra with Applications, Pearson Education.
11. Gareth Williams: Linear Algebra with Applications.

Practical

Practical code: and No. of Credits):

Sr. No.	Title of the Practical
1.	Solving homogeneous system of m equations in n unknowns by elimination for $(m; n) = (1; 2); (1; 3); (2; 2); 2; 3); (3; 3)$; row echelon form.
2.	Solving system $Ax = b$ by Gauss elimination, Solutions of system of linear Equations.
3.	Verifying whether given $(V, +, .)$ is a vector space with respect to addition $+$ and scalar multiplication
4	Linear span of a non-empty subset of a vector space, determining whether a given subset of a vector space is a subspace.
5	Showing the set of convergent real sequences is a subspace of the space of real sequences etc.

Minor

Course Title	Ordinary Differential Equations
Course Code	
Total Number of Lectures	
Credits	04 = (02 Theory + 02 Practical)
Introduction	● This course will prepare learner to get solutions of so many kinds of problems in all subjects of Science ● This course will also prepare learner for further studies of differential equations and related fields
Course Outcomes	On successful completion of this course, ● Student should have a knowledge of basic application problems described by second order linear differential equations with constant coefficients ● Student will be able to find the general solution of a non homogeneous differential equation
Units	Given Below

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Second order Linear Differential equations** ● Revision: First order differential equations ● Homogeneous and non-homogeneous second order linear differentiable equations: The space of solutions of the homogeneous equation as a vector space. Wronskian and linear independence of the solutions. The general solution of homogeneous differential equations. The general solution of a non-homogeneous second order equation. ● 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	15

II	**Linear System of First Order Differential Equations** Existence and uniqueness theorem to be stated clearly when needed in the sequel. Study of homogeneous linear system of ODEs in two variables: Let$a_1(t)$, $a_2(t)$, $b_!(t)$,$b_2(t)$ be continuous real valued functions defined on [a, b]. Fix $t_0 \in$ [a, b]. Then there exists a unique solution $\{x = x(t) y = y(t)$ valid throughout [a,b] of the following system: $\{\frac{dx}{dt} = a_1(t)x + b_!(t)y \quad \frac{dy}{dt} = a_2(t)x + b_2(t)y$ Satisfying initial conditions $x(t_0) = x_0$ and $y(t_0) = y_0$ ● The Wronskian *W* (*t*) of two solutions of a homogeneous linear system of ODEs in two variables, result: W (t) is identically zero or nowhere zero on [a, b]. ● Two linearly independent solutions and the general solution of a homogeneous linear system of ODEs in two variables ● Explicit Solutions of homogenous linear systems with constant coefficients in two variables. examples	15

Reading List (Books)

1) G. F. Simmons, Differential equations with applications and historical notes, McGraw Hill.
2) E. A. Coddington, An introduction to ordinary differential equations, Dover Books
3) E. Balaguruswamy, Numerical methods, Tata-McGraw Hill.

Sr. No.	Title of the Practical
1.	Solving second order linear ODE
2.	Finding general solution of homogenous equations
3.	Finding general solution of non-homogenous equations
3.	Solving equations using method of undetermined coefficients and method of variation parameters
4	Solving a system of first order linear ODEs

Course Description-VSEC

Course Title	Algorithm
Course Code	
Total Number of Lectures	
Credits	02 Theory + 02 Practical=04
Introduction	Aim of this course: • To develop Algorithm thinking towards problem solving • To study Problem solving strategies like divide and concur, recursive thinking etc.
Course Outcomes	• In this course students are enabled to write their own algorithms and to develop Algorithm thinking towards problem solving
Units	given below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Introduction to Algorithm - I** • Definition of an algorithm, characteristics of an algorithm, Selection and iterative constructs in pseudo code, simple examples such as: • Exchanging values of variables • Sum of n given numbers • first n terms of the Fibonacci sequence • finds factorial of a non-negative integer • Algorithms on Base conversion	15
II	**Introduction to Algorithm - II** • Algorithms on integers: • Modular exponent • Euclidean algorithm to find the g.c.d of two non-zero integers • Sorting algorithms including the following: Sorting of a finite sequence of integers in ascending order: Selection sort, Insertion sort and Bubble sort • Searching Algorithms-Linear Search and Binary Search	15

Reading List (Books)

1. R.G. Dromey, How to Solve it by computers, Prentice-Hall India

2. T. H. Cormen, Charles E. Leisenon and Ronald L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998 Edition.

3. K. H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Edition.

4. F. Harary, Graph Theory, Narosa Publication.

5. D. B. West, Introduction to graph Theory, Pearson.

Practical code: and No. of Credits

1	Describe an algorithm to count total number of positive and negative values from the set {23, −632, 325, 63, −63, 0, −55, −652.23, 65.21, 98.235, −1}
2	Describe an algorithm to accept the values of A and B and swap them
3	Describe an algorithm to accept the highest number from the user.
4	List all the steps used to search for 9 in the sequence 1, 3, 4, 5, 6, 8, 9, 11 using a) a linear search. b) a binary search.
5	Describe an algorithm that inserts an integer x in the appropriate position into the list a1, a2, · · · , an of integers that are in increasing order.
6	Describe an algorithm based on the Selection sort for sorting the list 3, 2, 5, 4, 1, 9, 6, 8, 7, 2.
7	Describe an algorithm that prints first n terms of the Fibonacci sequence
8	Describe an algorithm that finds factorial of a non-negative integer.
9	Describe Euclidean algorithm to find GCD of given two integers

Course Description: OE

Course Title	Mathematical and Statistical Techniques - III
Course Code	
Total Number of Lectures	
Credits	02
Introduction	• This course focuses on developing the mathematical and statistical problem solving ability. • This course can help in in the field of commerce and industry to solve the real life problems.
Course Outcomes	On successful completion of this course: • Students should have learnt the different techniques of data collection and its presentation • Students should have understood the concept of Shares and Mutual Funds
Units	given below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Shares and Mutual Funds** • **Shares**: Concept of share, face value, market value, dividend, equity shares, preferential shares, bonus shares. Simple examples. • **Mutual Funds**: Simple problems on calculation of Net income after considering entry load, dividend, change in Net Asset Value (N.A.V.) and exit load. Averaging of price under the Systematic Investment Plan (S.I.P.)	15

II	**Measures of Dispersions** • Concept and idea of dispersion. Various measures Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance, Combined Variance.	15

Reading List (Books)

1. Business Mathematics: D.C. Sancheti and V.K.Kapoor,SultanChand and Sons
2. Business Mathematics: A. P. Verma, Asian Books Pvt. Limited
3. Fundamentals of Statistics: D. N. Elhance. Kitab Mahal, Wholesale Division, 1964
4. Statistical Methods : S.G. Gupta, Sultan Chand & Sons, 1976
5. Statistics for Management: Lovin R. Rubin D.S., Prentice Hall of India
6. Modern Business Statistics: B. Pearles & C. Sullivan, Prentice Hall of India.
7. Business Mathematics & Statistics - B Aggarwal, Ane Book Pvt. Limited

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Semester IV

Course Description- Major I

Course Title	Real Analysis – II
Course Code	
Total Number of Lectures	02 Lectures + Practicals
Credits	3.5
Introduction	● To give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and know how to use them by solving and interpreting ● To reflect the broad nature of the subject and develop mathematical tools for continuing further study in various fields of science ● To enhance students' overall development and to equip them with problem solving skills and creative talent

	necessary for various kinds of employment
Course Outcomes	Upon successful completion of this course the student will be able to • calculate higher order derivatives • calculate maxima, minima
Units	Given Below

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Differentiability** • Differentiation of real valued function of one variable: Definition of differentiation at a point of an open interval, Examples of differentiable and non-differentiable function, function which is differentiable n times but not $n+1$ times, differentiable functions are continuous but not conversely, Algebra of differentiable functions, Chain rule for derivative of composite of functions • Higher order derivatives, Leibnitz rule, Derivative of inverse functions (only examples), Implicit differentiation (only examples)	15
II	**Applications of differentiability** • Definition of local maximum and local minimum of real valued function of one variable, necessary condition, stationary points, second derivative test, Graphing of functions using first and second derivative, Concave upwards, Concave downwards, points of inflection • Rolle's theorem, Lagrange's and Cauchy's Mean Value theorem, Increasing and decreasing function • L'Hospital's Rule (without proof), Taylor's theorem with Lagrange's form of remainder, Taylor's polynomial	15

Reading List

1. Methods of Real Analysis: R. R. Goldberg
2. A course in Calculus and Real Analysis: Ghorpade and Limaye
3. Calculus, Third Edition: James Stewart
4. A basic course in Real Analysis: Ajit Kumar and S. Kumaresan
5. An introduction to Calculus and Analysis, Volume I: Courant and Fritz John
6. Calculus, 12th Edition: G. B. Thomas
7. Calculus, Volume I: Apostol
8. Mathematical Analysis: K.G. Binmore

Practical

Practical code: and No. of Credits:

Sr. No.	Title of the Practical
01	Differentiability of a function, chain rule
02	Leibnitz theorem, Derivative of inverse functions, Implicit differentiation
03	Graphing of functions, Lagrange's and Cauchy's Mean Value theorem
04	L'Hospital's rule, Applications of Taylor's theorem and Taylor's polynomial

Course Description: Major II

Course Title	Linear Algebra – II
Course Code	
Total Number of Lectures	02 lectures +Practicals
Credits	3.5
Introduction	• To learn computational techniques and algebraic skills essential for the study of algebra, vector spaces, • To learn linear transformation
Course Outcomes	Upon successful completion of this course students will be able to: • Apply mathematical methods involving arithmetic, algebra, geometry, and graphs to solve problems. • Represent mathematical information and communicate mathematical reasoning symbolically and verbally. • identify patterns to formulate and validate reasoning
Units	Given Below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Basis of a Vector Space** • Basis of a vector space, dimension of a vector space, maximal linearly independent subset of a vector space is a basis of a vector space, minimal generating set of a vector space is a basis of a vector space, any two basis of a vector space have the same number of elements, any set of n linearly independent vectors in an $n-$dimensional vector space is a basis, any collection of $n+1$ linearly independent vectors in an $n-$dimensional vector space is linearly dependent. • If $W1$; $W2$ are two subspaces of a vector space V then $W_1 + W_2$ is a subspace of the vector space V of dimension $dim(W_1) + dim(W_2) - dim(W1 \cap W2)$); extending any basis of a subspace W of a vector space V to a basis of the vector space V.	15
II	**Linear Transformations** • Linear transformation, kernel, matrix associated with a linear transformation, properties such as; kernel of a linear transformation is a subspace of the domain space, image T for a linear transformation , is a subspace of the co-domain space, , Rank nullity theorem with proof andexamples. • The matrix units, row operations, elementary matrices, elementary matrices are invertible and an invertible matrix is a product of elementary matrices. • Row space, column space of an m n matrix, row rank and column rank of a matrix, Equivalence of the row and the column rank, Invariance of rank upon elementary row or column operations. • Equivalence of rank of an mxn matrix A and rank of the linear transformation LA : Rn→ Rm (LA(X) = AX). The dimension of solution space of the system of linear equations AX = 0 equals nrank(A). • The solutions of non-homogeneous systems of linear equations represented by AX = B; Existence of a solution when rank(A)= rank(A; B), The general solution of the system is the sum of a particular solution of the system and the solution of the associated homogeneous system.	15

Reading List (Books)

1. M. Artin: Algebra, Prentice Hall of India Private Limited.
2. K. Hoffman and R. Kunze: Linear Algebra, Tata McGraw-Hill, New Delhi.
3. Gilbert Strang: Linear Algebra and its applications, International Student Edition.
4. L. Smith: Linear Algebra, Springer Verlag.
5. Ramachandra Rao and P. Bhima Sankaran: Linear Algebra, Tata McGraw- Hill, New Delhi.
6. T. Bancho_ and J. Wermer: Linear Algebra through Geometry, SpringerVerlag Newyork, 1984.
7. Klaus Janich: Linear Algebra.
8. Otto Bretcher: Linear Algebra with Applications, Pearson Education

Practical

Practical code_____and No. of Credits _____

Sr. No.	Title of the Practical
01	Verifying whether given $(V, +, .)$ is a vector space with respect to addition $+$ and scalar multiplication
02	Linear span of a non-empty subset of a vector space, determining whether a given subset of a vector space is a subspace. Showing the set of convergent real sequences is a subspace of the space of real sequences etc
03	Finding basis of a vector space such as $P_3(X)$; $M_3(\mathbb{R})$ etc. Verifying whether a set is a basis of a vector space. Extending basis of a subspace to a basis of a finite dimensional vector space.
04	Verifying whether a map $T : X \to Y$ is a linear transformation, finding kernel of a linear transformation and matrix associated with a linear transformation,
05	Verifying the Rank- Nullity theorem

Course Description: Minor

Course Title	Numerical Solutions to First Order Ordinary Equation
Course Code	
Total Number of Lectures	
Credits	04 = (02 Theory + 02 Practical)
Introduction	• This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering • This course aims to lay foundation of computational mathematics for higher studies

Course Outcomes fir	• This course will help students to choose, develop and apply the appropriate numerical techniques for the data provided.
Units	Given Below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Numerical Solution for Ordinary Differential Equations - I** • Initial Value Problem: Background • Solution of Initial value problem of first order ordinary differential equation: • One step methods: Taylor's series method, Picard's method, Euler's method, Heun's method, Polygon method	15
II	**Numerical Solution for Ordinary Differential Equations-II** • Runge-Kutta method of fourth order • Accuracy of one-step methods. • Multistep methods (Predictor - Corrector methods). Milne-Simpson method Adams- Bashforth-Moulton method • Accuracy of multistep methods.	15

Reading List (Books)

1) G. F. Simmons: Differential equations with applications and historical notes, McGraw Hill.
2) E. A. Coddington: An introduction to ordinary differential equations, Dover Books
3) E. Balaguruswamy: Numerical methods, Tata-McGraw Hill.
4) James F. Epperson: An Introduction to Numerical Methods and Analysis, Wiley Publications

Practical

Practical code_____and No. of Credits _____

Sr. No.	Title of the Practical
01	Solution of Initial value problem of first order ordinary differential equation by Taylor's series method, and Picard's method
02	Solution of Initial value problem of first order ordinary differential equation by Euler's method, Heun's method
03	Solution of Initial value problem of first order ordinary differential equation by Polygon method
04	Solution of Initial value problem of first order ordinary differential equation by Runge-Kutta Method
05	Solution of Initial value problem of first order ordinary differential equation by Milne-Simpson's Method and Adam's Bashforh Moulton Method
06	Accuracy of one step method

VSEC

Course Description

Course Title	Graph theory
Course Code	
Total Number of Lectures	
Credits	
Introduction	• This course focuses on theory regarding the existence if graph theory, and understand vertex connectivity and edge connectivity in graphs
Course Outcomes	• Students will understand and apply the core theorems and algorithms, generating examples as needed. • Students will understand the fundamental definition and concept of graph theory
Units	Given Below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Introduction to graphs:** ● Types of graphs: Simple graph, directed graph, (One example / graph model of each type to be discussed). ● (a) Graph Terminology: Adjacent vertices, degree of a vertex, isolated vertex, pendant vertex in a undirected graph. (b) The handshaking Theorem for an undirected graph (statement only), Theorem: An undirected graph has an even number of odd vertices (statement only). ● Some special simple graphs (by simple examples): Complete graph, cycle, wheel in a graph, Bipartite graph, regular graph. ● Representing graphs and graph isomorphism: (a) Adjacency matrix of a simple graph. (b) Incidence matrix of an undirected graph. ● Connectivity: (a) Paths, circuits, simple paths, simple circuits in a graph (simple examples). (b) Connecting paths between vertices (simple examples).	15
II	**Algorithms: Shortest path problem** ● Euler paths and circuits, Hamilton paths and circuits, Diracs Theorem (statement only), Ores Theorem (statement only) ● Planar graphs, planar representation of graphs, Eulers formula. Kuratowskis Theorem (statement only) ● Algorithms: Shortest path problem: Construction of Eulerian path by Fleury's Algorithm, The shortest path algorithm - Dijkstras Algorithm	15

Reading List (Books)

1. R. Wilson, Introduction to Graph theory, Fourth Edition, Prentice Hall.
2. T. H. Cormen, Charles E. Leisenon and Ronald L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998 Edition.
3. K. H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Edition.
4. B. Kolman, Robert Busby, Sharon Ross: Discrete Mathematical Structures, Prentice-Hall India

Practical

Practical code_____and No. of Credits _____

Sr. No.	Title of the Practical
01	Drawing a graph, counting the degree of vertices and number of edges
02	Representing a given graph by an adjacency matrix and drawing a graph having given matrix as adjacency matrix.
03	Determining whether the given graph is connected or not. Finding connected components of a graph. Finding strongly connected components of a graph. Finding cut vertices.
04	Algorithms
05	Euler paths and circuits, Hamilton paths and circuits,
06	Planar graphs, planar representation of graphs, Eulers formula. Kuratowskis Theorem
07	Algorithms: Shortest path problem

Course Description – OE

Course Title	Mathematical and Statistical Techniques - IV
Course Code	
Total Number of Lectures	
Credits	02
Introduction	● This course focuses on developing the statistical problem solving ability. ● This course can help in the field of science and industry to solve real life problems.
Course Outcomes	On successful completion of this course, ● Students should have learnt the different techniques of data collection and its presentation
Units	Given Below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**Interest and Annuity** • **Interest:** Simple Interest, Compound Interest (Nominal and Effective Rate of Interest). Calculations involving upto 4 timeperiods. • **Annuity:** Annuity Immediate and its Present value, Future value. Equated Monthly Instalments (EMI) using reducing balance method and amortization of loans. Stated Annual Rate and Affective Annual Rate Perpetuity and its present value. Simple problems involving upto 4 time periods.	15
II	**Bivariate Linear Correlation** • **Correlation Analysis:** Meaning, Types of Correlation, Determination of Correlation: Scatter diagram, Karl Pearson's method of Correlation Coefficient (excluding Bivariate Frequency Distribution Table) and Spearman's Rank Correlation Coefficient.	15

Reading List (Books)

1. Business Mathematics : D. C. Sancheti and V. K. Kapoor, Sultan Chand and Sons
2. Business Mathematics: A. P. Verma, Asian Books Pvt. Limited
3. Fundamentals of Statistics D. N. Elhance. KitabMahal, Wholesale Division, 1964
4. Statistical Methods S.G. Gupta, Sultan Chand & Sons, 1976
5. Statistics for Management Lovin R. Rubin D.S., Prentice Hall o f India
6. Statistics Theory, Method & Applications - D.S.Sancheti& V. K. Kapoor. Sultan Chand & Sons, 2010
7. Modern Business Statistics (Revised} B. Pearles& C. Sullivan , Prentice Hall of India.
8. Business Mathematics & Statistics - B Aggarwal, Ane Book Pvt. Limited

Course Description-IKS

Course Title	IKS
Course Code	
Total Number of Lectures	
Credits	02
Introduction	• This course will facilitate the students with the concept of Indian knowledge and will make them understand the importance of roots of Indian Knowoldge System
Course Outcomes	• Students will explore the diverse facets of sulba-sutra and mathematical principals and their relevance in today's world
Units	given below

UNITS

Unit Number	CONTENT	NUMBER OF LECTURES
I	**The Introduction to Ancient Mathematics** Introduction to Brief introduction of inception of Mathematics & Astronomy from vedic periods. Details of different authors who has given mathematical & astronomical sutra (e.g.Arytabhatta, Bhaskara, Brahmagupta, Varamahira, Budhyana, Yajanvlkya, Panini, Pingala Bharat muni, Sripati, Mahaviracharya, Madhava, Nilakantha Somyaji, Jyeshthadeva, Bhaskara-II,	15

	Shridhara) Periodical enlisting of Mathematical & Astrological achievement in India. Evolution of Indian Numerals (Brahmi (1^{st} century), Gupta (4^{th} century) & Devanagri Script (11^{th} century) Veda & Sulvasutras (Pythagoras theorem, Square root & Squaring Circle) (Baudhayana Sulbhasutra, Apastamba Sulbhasutra, Katyayana Sulbhasutra, Manava Sulbhasutra, Maitrayana Sulbhasutra, Varaha sulbhasutra, Vadhula sulbhasutra Pingala's chandasutras, Sunya, Yaat-tavat, Aryabhata (Aryabhatiya, Asanna, ardha-jya, kuttaka,), Bhaskara (trigonometory,shridhara, mahavira), Bhaskara Acharya (Sidhantashiromani), Varamahira panchasiddhantika	
II	**Ancient Mathematics–II** Brahamgupta (vargaprakrati, bhramasphuta siddhanta, bhavana), ayatavrtta, ganitasarasamgraha, lilavathi, ganesadaivajna, randavantika, suryasidhhanta, grahalaghava, sadratnamala, mandavrtta, sighrartta, Bijaganita, Bakshali manuscript Pingala's chandasutras, sunya, yaat-tavat, Aryabhata (Aryabhatiya, Asanna, ardha-jya, kuttaka,), bhaskara (trigonometory,shridhara, mahavira), Bhaskara Acharya (Sidhantashiromani), Varamahira panchasiddhantika Golavada, Madhyamanayanaprakara, Mahajyanayanaprakara (Method of Computing Great Sines), Lagnaprakarana, Venvaroha, Sphutacandrapti, Aganita-grahacara , Chandravakyani (Table of Moon-mnemonics)	15

Reading List

1. A.Kolachana, StudiesinIndianMathematicsandAstronomy,HindustanBookagency
2. S.B. Rao, Indian Mathematics and Astronomy: Some Landmarks(Revised Third Edition), Bhartiya Vidhya Bhavan, 2012,
3. G.G.Josheph,IndianMathematics:EngagingwiththeWorldfromAncienttoModernTimes,speaking Tiger, 2016
4. B.S.Yadav, Ancient Indian Leapsinto Mathematics, brikausherpublication, 2010

Evaluation Pattern for Semester III & IV

- **Semester-end Examination (60 Marks)**

Four Questions to be set for 15 marks each
OR
Five questions to set for 12 marks each

- **Continuous Internal Evaluation (40 Marks)**

Sr. No.	Particulars	Marks
1	One class test to be conducted in each semester	10 marks
2	Overall conduct as a responsible student, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 marks
3	Research Project/ Book Review/ Research Paper Review/ Survey/ Field Work Project/etc.	25 marks

- **For Departments of Science Faculty:**

  Practical Examination will be of 50 marks per paper.

- **Semester-end Examination (30 Marks)**

  Two Questions to be set for 15 marks each

- **Continuous Internal Evaluation (20 Marks)**

Members of Syllabus committee	Designation
Mrs. Anagha Renapurkar	Chairman
Mr. AmitGawde.	Member
Mrs. Manisha Gangurde	Member
Mr. GauravJadhav	Member
Dr. Rekha Santhanam, IIT Bombay	Subject Expert, outside parent university

Dr. Akshay Rane, ICT, Matunga, Mumbai	Subject Expert, outside parent university
Dr. Ganesh Joshi, Maharshi Dayanand College, Parel	Expert, Vice Chancellor Nominee
Mr. Jasraj Date, Deloitte	Expert, Industry
Mr. Sanket Kini , Genepact	Member, Past Student

This Syllabus is prepared by:

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