SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE, CGPA 3.51/4.00

BEST COLLEGE AWARD - UNIVERSITY OF MUMBAI

SIES College of Arts, Science and Commerce
(Autonomous)
Affiliated to Mumbai University

Syllabus under Autonomy - July 2018

Program: F.Y.B.Sc.
Course: MATHEMATICS

Credit Based Semester and Grading System (CBSGS)
with effect from the academic year 2018-19

Aim:

To attract mathematically able students and to provide for them an academically coherent undergraduate program, with courses that range from the fundamental to the advanced.

Broad Objectives:

The course; divided into two semesters, two papers in each semester, has the following goals for its learners:

1. To develop critical thinking, reasoning and logical skills
2. To improve analytical skills and its application to problem solving.
3. To take the learners from simple to difficult and from concrete to abstract
4. Have a deeper understanding of abstract mathematical theory and concepts
5. To improve capacity to communicate mathematical/logical ideas in writing

Course objectives: Paper1

On completion of this course of paper1 successfully, student should be able to

1. Understand order relation in IR and compute supremum and infimum of a subset of IR
2. State domain and range of standard functions and plot their graphs
3. Check convergence of a sequence and series of real numbers using tests and definition

Course objectives: Paper2

On completion of this course of paper 2 successfully, student should be able to

1. Compute gcd using Euclidean Algorithm and also compute last digit of powers of integers using congruences.
2. Write Mathematical proofs effectively.
3. Check for bijectivity of a function, write partitions w.r.t. equivalence relations.
4. Find roots of polynomials and gcd of polynomials.

SEMESTER I				
CALCULUS I THEORY				
Course Code	UNIT	TOPICS	Credits	L or P/week
SIUSMAT11	I	Real Number System, real valued functions of one variable and graphs	3	3L
	II	Sequences		
	III	Series		
ALGEBRA I				
Course Code	UNIT	TOPICS	Credits	L or P/week
SIUSMAT12	I	Integers and divisibility	3	3L
	II	Functions and Equivalence relations		
	III	Polynomials		
PRACTICALS				
Course Code	TOPICS		Credits	L or P/week
SIUSMATP1	Practicals based on courses SIUSMAT11 & SIUSMAT12		3	1P(=2L)

Teaching Pattern

1. Three lectures per week per course.
2. One Practical per week per batch per course.
3. Minimum 4 practicals to be conducted per batch per course in each semester.

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and examples.

SEMESTER I: PAPER I: CALCULUS I		
Pre-requisites:	Introduction to sets $\mathbb{N}, \mathbb{Q}, \mathbb{Z}, \mathbb{R}$	
Unit I	Real Number System, real valued functions of one variable and graphs	15 Lectures
	• Real Numbers:Real number system and order properties of $\mathbb{R}$, Law of Trichotomy , Absolute value properties, AM-GM inequality, Cauchy-Schwarz inequality • Intervals and neighbourhoods, Hausdorff property • Bounded sets, Supremum and infimum, Maximum and minimum, Basic results: Continuum property (l.u.b.Axiom-statement) and consequences,Archimedean property and its applications. • Functions and Graphs: Domain, Range, Types of function: Injective, Surjective, Bijective,Inverse, Composite.Graph of a function.Examples	

	:constant function, identity function, absolute value, step function, floor and ceiling functions, trigonometric functions, linear and quadratic functions and their graphs. Graphs of functions such as$x^3, \frac{1}{x}, \frac{1}{x^2}$, $\sin\left(\frac{1}{x}\right)$, log(x) , a^x and e^x.Monotonic and strictly monotonic functions-definition and examples.	
Unit II	Sequences	15 Lectures
	• Definition of a sequence and examples, Definition of convergent and divergent sequences.Limit of sequence, uniqueness of limit if it exists. Simple examples such as seq(1/n) , where convergence is checked using ϵ- n_0 definition. • Sandwich theorem, Algebra of convergent sequences , Examples. • Subsequences: Definition, Subsequence of a convergent sequence isconvergent and converges to the same limit. • Cauchy sequence: Definition, every convergent sequence is a Cauchy sequence and conversely. Examples of Cauchy sequences. • Monotonic and Bounded sequences: Definition of bounded sequence.Every convergent sequence is bounded .Monotone sequences and Monotone convergence theorem. Examples .	
Unit III	Series	15 Lectures
	• Definition of Series as a Sequence of partial sums, Summation of a series, simple examples like Geometric series • Convergent and divergent series, Necessary condition for convergence of series, Converse not true. Algebra of convergent series. • Cauchy criterion for convergence of a series. • Alternating series, Leibnitz Test, Examples. • Absolute convergence implies convergence but not conversely. Conditional convergence. • Convergence of a p- series • Tests for convergence (Statements only): ○ Comparison test, limit form of comparison test, examples, ○ Ratio test, examples, ○ Root test, examples	
SIUSMATP1	Practicals	
1	Application based examples of Archimedean property, intervals, neighbourhood. Consequences of continuum property, infimum and supremum of sets.	
2	Calculating limits of sequences using definition. Cauchy sequence, monotone sequence.	
3	Sum of the series, conditional convergence, Leibnitz test. Tests of convergence, Examples.	
4	Miscellaneous Theoretical questions based on full paper.	

References for Paper I

1. Ajitkumar, S. Kumaresan.(2014). *A Basic Course in Real Analysis*, CRC press
2. R. R. Goldberg.(1964). *Methods of Real Analysis*, Oxford and IBH
3. James Stewart, Third Edition.(1994). *Calculus*, Brooks/Cole Publishing Company
4. T. M. Apostol.(1991).*Calculus Vol I*, Wiley & Sons (Asia) Pte. Ltd.
5. GhorpadeLimaye. (2000).*A Course in Calculus and Real Analysis*, Springer International Ltd
6. Binmore. (1982). *Mathematical Analysis*, Cambridge University Press
7. G. B. Thomas.(2009).*Calculus*, Addison Wesley

References for Paper II

1. Larry J. Gerstein.(2012). *Introduction to Mathematical Structures and Proofs,* Springer-Verlag, New York
2. J. P. Tremblay & R. Manohar.(1974).*Discrete Mathematical Structures with Applications to Computer Science,* McGraw Hill
3. David M. Burton.(2015). *Elementary Number Theory,* McGraw Hill Education (India) Private Ltd.
4. Norman L. Biggs.(1989).*Discrete Mathematics*, Clarendon Press, Oxford
5. I. Niven and S. Zuckerman.(1972).*Introduction to the theory of numbers,* Wiley Eastern
6. G. Birkoff and S. Maclane. (1965).*A Survey of Modern Algebra,*Mac Millan, New York
7. N. S. Gopalkrishnan.(2013).*University Algebra*, Ne Age International Ltd
8. I .N. Herstein, , John Wiley.(2006).*Topics in Algebra*
9. P. B. Bhattacharya S. K. Jain and S. R. Nagpaul.(1994). *Basic Abstract Algebra*, New Age International
10. Kenneth Rosen.(1999). *Discrete Mathematics and its applications*, Mc-Graw Hill International Edition, Mathematics Series.
11. Ajit Kumar & S Kumaresan.(2018).*Foundation Course in Mathematics,* Narosa

SEMESTER II

Course objectives: Paper1

On completion of this course of paper1 successfully, student should be able to

1. Test existence of limit and continuity and differentiability of a function at a point and on a set, identify types of discontinuity

2. Understand the relation between Continuity and Differentiability

3. Compute higher order derivatives

4. Understand the application of Mean Value theorems

5. Compute Local and Global Extremas of functions

Course objectives: Paper2

On completion of this course of paper 2 successfully, student should be able to

1. Solve system of linear equations using matrices.

2. Identify Vector spaces and their subspaces.

3. Write a Basis of given vector space and identify linear transformations.

SEMESTER II				
CALCULUS II **THEORY**				
Course Code	UNIT	TOPICS	Credits	L or P/week
SIUSMAT21	I	Limits and Continuous functions	3	3L
	II	Differentiation		
	III	Applications of derivatives		
ALGEBRA II				
Course Code	UNIT	TOPICS	Credits	L or P/week
SIUSMAT21	I	System of Linear Equations and Matrices	3	3L
	II	Vector spaces		
	III	Basis and Linear Transformation		
PRACTICALS				
Course Code	TOPICS		Credits	L or P/week
SIUSMATP2	Practicals based on courses SIUSMAT21 & SIUSMAT22		3	1P(=2L)

Teaching Pattern

1. Three lectures per week per course.
2. One Practical per week per batch per course.
3. Minimum 4 practicals to be conducted per batch per course in each semester.

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and examples.

SEMESTER I: PAPER II: ALGEBRA I		
Pre-requisites:	Set Theory: Set, subset, union and intersection of two sets, empty set, universal set, complement of a set, De Morgan's laws, Cartesian product of two sets, Relations, Permutations and combinations.	
Unit I	Integers and divisibility	15 Lectures
	• Concepts of Statements, Propositions and Theorems, Logical Connectives and Truth Tables, Methods of proofs with basic examples. • Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second), Binomial theorem for non-negative integer exponents, Pascal's rule. • Divisibility in integers, division algorithm, Primes, Euclid's lemma, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of integers and that the g.c.d. can be expressed as	

	$ma + nb, m, n \in \mathbb{Z}$, Euclidean algorithm, statement of Fundamental theorem of arithmetic, The set of primes is infinite. • Congruences, definition and elementary properties, Euler's ϕ-function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem, Applications.	
Unit II	Functions and Equivalence relations	15 Lectures
	• Definition of a function, domain, co-domain and range of a function, composite functions, examples, Direct image $f(A)$ and inverse image $f^{-1}(B)$ for a function f; Injective, surjective, bijective functions; Composite of injective, surjective, bijective functions when defined; invertible functions, bijective functions are invertible and conversely; examples of functions including constant, identity, projection, inclusion; • Binary operation as a function, properties, examples. • Equivalence relation, Equivalence classes, properties such as two equivalences classes are either identical or disjoint, Definition of partition, every partition gives an equivalence relation and vice versa. Congruence is an equivalence relation on $\mathbb{Z}$, Residue classes and partition of $\mathbb{Z}$.	
Unit III	Polynomials	15 Lectures
	• Definition of a polynomial, polynomials over the field F where F = $\mathbb{Q}$, $\mathbb{R}$ or $\mathbb{C}$, Algebra of polynomials, degree of polynomial, basic properties, • Division algorithm in F[X] (without proof), and g.c.d. of two polynomials and its basic properties (without proof), Euclidean algorithm (without proof), applications, Roots of a polynomial, relation between roots and coefficients, multiplicity of a root, Remainder theorem, Factor theorem, A polynomial of degree n has at most n roots , Complex roots of a polynomial in R[X] occur in conjugate pairs, Statement of Fundamental Theorem of Algebra, A polynomial of degree n in C[X] has exactly n complex roots counted with multiplicity, A non constant polynomial in R[X] can be expressed as a product of linear and quadratic factors in R[X], necessary condition for a rational number p/q to be a root of a polynomial with integer coefficients, simple consequences such as $\sqrt{p}$ is an irrational number where p is a prime number	
SIUSMATP1	Practicals	
1	Mathematical induction, Division Algorithm and Euclidean algorithm in $\mathbb{Z}$, primes and the Fundamental Theorem of Arithmetic.Congruences and Euler's ϕ-function, Fermat's little theorem, Euler's theorem and Wilson's theorem.	
2	Functions (direct image and inverse image), Injective, surjective, bijective functions, finding inverses of bijective functions. Equivalence relations and Partitions.	
3	Division Algorithm and GCD of polynomials.Factor Theorem, relation between roots and coefficients of polynomials, factorization.	

4	Miscellaneous Theoretical questions based on full paper.

SEMESTER II: PAPER I: CALCULUS II		
Pre-requisites:	Concepts of limits and continuity from classes XI and XII	
Unit I	Limits and Continuity of functions	15 Lectures
	• ε - δ definition of limit of a function, Evaluation of limit of simple functions using the definition, Uniqueness of limit if it exists, Algebra of limits (with proof), Limit of composite function • Sandwich theorem, Left hand, Right hand limits, non-existence of limits • Infinite limits and Limits at infinity. • Indeterminate forms, L'hospital rule without proof, examples of indeterminate forms • Continuity of a real valued function at a point in terms of Limits, Continuity of a real valued function on a set in terms of Limits, examples, Continuity of a real valued function at end points of domain • Sequential continuity • Algebra of continuous functions • Discontinuous functions, examples of removable and essential discontinuity, Continuous extension of a function • Statements of properties of continuous functions on closed intervals such as Intermediate Value Property, Attainment of bounds, Location of roots and examples.	
Unit II	Differentiation	15 Lectures
	• Definition of Derivatives of a real valued function of one variableat a point and on an open set • Left / Right Derivatives Examples of differentiable and non differentiable functions • Geometric/ Physical Interpretation of derivative • Differentiable functions are continuous but not conversely • Algebra of differentiable functions, • Derivative of inverse functions, Implicit differentiation (onlyexamples). • Higher order derivatives Derivative of a composite function - Chain rule Higher order derivatives of some standard functions, Leibnitz rule.	
Unit III	Applications of derivatives	15 Lectures
	• The Mean Value Theorems: Rolle's theorem Lagrange's mean value theorem. examples and applications Cauchy's mean value theorems, examples and applications Taylor's theorem with Lagrange's form of remainder	

	Taylor's polynomial and applications. • Applications of first and second derivatives: Monotone increasing and decreasing function, examples, Concave, Convex functions, Points of Inflection Asymptotes, Definition of local maximum and local minimum, First derivative test for extrema, Necessary condition for extrema, Stationary points Second derivative test for extrema, examples Global maxima and minima • Graphing of functions using first and second derivatives
SIUSMATP2	Practicals
1	Limits of functions and continuity. Properties of continuous functions.
2	Differentiability. Higher order derivatives, Leibnitz theorem.
3	Extreme values, increasing and decreasing functions. Mean value theorems and its applications.
4	Miscellaneous Theoretical questions based on full paper.

SEMESTER II: ALGEBRA II		
Pre-requisites:	Review of vectors in $\mathbb{R}^2, \mathbb{R}^3$ as points, Addition and scalar multiplication of vectors, Dot product, Scalar triple product, Length (norm) of a vector.	
Unit I	System of Linear equations and Matrices	15 Lectures
	• Parametric equation of lines and planes, homogeneous and non-homogeneous system of linear equations, the solution of homogeneous system of m 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 $(AB)^t = B^tA^t$, $(AB)^{-1} = B^{-1}A^{-1}$. • System of linear equations in matrix form, elementary row operations, row echelon matrix, Gaussian elimination method, to deduce that the homogeneous system of m linear equations in n unknowns has a non-trivial solution if $m < n$.	
Unit II	Vector spaces	15 Lectures
	• Definition of a real vector space, examples such as $\mathbb{R}^n, \mathbb{R}[x], M_{m\times n}(\mathbb{R})$, space of all real valued functions on a non empty set. • Subspace: definition, examples: lines, planes passing through origin as subspaces of $\mathbb{R}^2, \mathbb{R}^3$, upper triangular matrices, diagonal matrices, symmetric matrices, skew-symmetric matrices as subspaces of $M_n(\mathbb{R})$ $(n = 2,3)$; $P_n(x) = \{a_0 + a_1x + \cdots + a_nx^n \mid a_i \in \mathbb{R}\ \forall\ 0 \le i \le n\}$ as a subspace $\mathbb{R}[x]$, the space of all solutions of ahomogeneoussystem of m linear equations in n unknowns as a subspace of $\mathbb{R}^n$. Properties of a	

	subspace such as necessary and sufficient condition fora non empty subset to be a subspace of a vector space, arbitrary intersection of subspaces of a vector space is a subspace, union of two subspaces is a subspace if and only if one is a subset of 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$V$ • Linearly independent/linearly dependent subsets of a vector space, a subset $\{v_1, v_2, \cdots, v_k\}$ of a vector space is linearly dependent if and only if $\exists\ i \in \{1, 2, \cdots, k\}$ such that v_i is a linear combination of the othervectors v_j s.	
Unit III	Basis and Linear Transformations	15 Lectures
	• 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 subset 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 W_1, W_2 are two subspaces of a vector space V then $W_1 + W_2$is a subspace of the vector space V of dimension $\dim W_1 + \dim W_2 - \dim(W_1 \cap W_2)$, extending any basis of a subspace W of a vector space V to a basis of the vector space V. • Linear transformations; kernel and image, matrix associated with a linear transformation, properties such as: for a linear transformation T, kernel(T) is a subspace of the domain space of T and the image image(T) is a subspace of the co-domain space of T. If V, W are real vector spaces with $\{v_1, v_2, \cdots, v_n\}$ a basis of V and $w_1, w_2, \cdots, w_n$ any vectors in W then there exists a unique linear transformation $T : V \rightarrow W$ such that $\mathrm{T}(v_j) = w_j \ \ \forall\ 1 \leq j \leq n$, Rank nullity theorem (statement only) and examples.	
SIUSMATP2	Practicals	
1	Finding parametric equations and row echelon form. Solving system Ax=b by Gauss elimination	
2	Proving the given sets to be subspaces, Linear span of a non-empty subset of a vector space, linear independence/dependence	
3	Finding basis of a vector spaces. 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. Verifying whether a map $T : X \rightarrow Y$ is a linear transformation, finding kernel of a linear transformation and matrix associated with a linear transformation, verifying the Rank Nullity theorem.	
4	Miscellaneous Theoretical questions based on full paper.	

References for Paper I

1. Ajitkumar, S. Kumaresan.(2014).*A Basic Course in Real Analysis,* CRC press
2. R. R. Goldberg. (1964).*Methods of Real Analysis*, Oxford and IBH
3. James Stewart.(1994).*Calculus*, Third Edition, Brooks/cole Publishing Company
4. T. M. Apostol.(1991). *Calculus Vol I*, Wiley & Sons (Asia) Pte. Ltd.
5. Ghorpade&Limaye .(2000). *A Course in Calculus and Real Analysis*, Springer International Ltd
6. Binmore.(1982).*Mathematical Analysis*, Cambridge University Press
7. G. B. Thomas.(2009). *Calculus,* 12th Edition

References for Paper II

1. Serge Lang. (1986). *Introduction to Linear Algebra*, Second Edition, Springer.
2. S. Kumaresan.(2000).*Linear Algebra, A Geometric Approach*, Prentice Hall of India Pvt. Ltd
3. M. Artin.(1991).*Algebra*, Prentice Hall of India Private Limited
4. K. Hoffman and R. Kunze.(1971). *Linear Algebra*, Tata McGraw-Hill, New Delhi.
5. Gilbert Strang.(1900).*Linear Algebra and its applications*, International Student Edition.

SCHEME OF EVALUATION

1. Semester End Theory Examination:

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part; and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:

(a) Internal assessment 40% :

Sr No	Evaluation type	Marks
1	One class test	20
2	Viva	10
3	Assignment/Project/Presentation	10
	Total	40

(b) External Theory examination 60 % :

Duration – 2 hours.
Question Paper Pattern:- Four questions each of 15 marks.
One question on each unit (Questions 1, 2, 3).
Question 4 will be based on entire syllabus.
All questions shall be compulsory with not more than 50% internal choice within the questions. Question may be subdivided into sub-questions a, b, c.

2. Semester End Practical Examination:

At the end of semesters I & II, practical examination of 2 hours duration and 100 marks shall be conducted for the courses SIUSMATP1 and SIUSMATP2.

Sr. No.	Evaluation type	Marks
1	Part A: Questions from SIUSMAT11	40
2	Part B: Questions from SIUSMAT12	40
3	Journal	10
4	Class Work	10

Guidelines about conduct of Practicals

The practical session should consist of discussion between the teacher and the students in which students should participate actively. Each practical of every course of sem I & II shall contain ten problems out of which minimum five have to be written in the journal. A student must have a certified journal to appear for the practical examination.

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Syllabus under Autonomy - July 2018

Program: S.Y. B.Sc.

Course: Mathematics

Credit Based Semester and Grading System (CBSGS)
with effect from the academic year 2018-19

Program: S.Y. B.Sc.
Course: Mathematics

Broad Objectives

To provide a degree programme in mathematics which is intellectually challenging and rigorous and whose graduates are well placed to pursue post graduate studies or to enter employment.
On successful completion of this course, all students should

1. have learnt to apply critical and analytical reasoning and to present logical and concise arguments.
2. have developed problem solving skills
3. have covered the core topics of advanced mathematics which our Department considers appropriate to their degree programme.
4. be able to comprehend high levels of abstraction in study of pure mathematics.

Learning Outcomes

SEMESTER III

SIUSMAT31 (CALCULUS OF SEVERAL VARIABLES)

In the previous semesters, students have studied the calculus of one variable functions. In This course, they learn to extend these concept to the general Euclidean space R^n . This course should enable them to

- Discuss Convergence of sequences in R^n
- Understand the concept of neighbourhoods of points in R^n and sketch the same for subsets of R^2 and R^3 Understand the concept of Open and Closed sets in R^n and be able to classify subsets of R^2 and R^3
- Understand the concept of Scalar and Vector valued functions defined on R^n, Basic concepts like limit of a Scalar and a Vector valued function at a point, continuity of a function at a point in R^n, and be able to discuss the same for functions on R^2 and R^3
- Understand the concept of Existence of partial derivatives and directional derivatives of a scalar field at a point, Gradient, The direction of Maximum and Minimum rate of change of a scalar field, and be able to solve problem on R^2 and R^3
- Understand the concept of derivative of a scalar field in terms of a linear transformation, relation between differentiability and continuity, relation between differentiability and existence and continuity of partial derivatives, be able to discuss differentiability of real valued functions of 2 and 3 variables.
- The optimization techniques, finding maxima and minima of functions of 2 variable. Constrained Maxima Minima.
- Introduction to Vector valued functions and their derivative as a linear transformation, and also as a matrix. Relation between Jacobian and Derivative. Examples based on R^2 and R^3.

SIUSMAT32 (ALGEBRA III)

Successful completion of this course will enable students to

- understand linear isomorphisms and apply Rank- Nullity theorem
- find rank of matrix using elementary matrices and their relation with matrix units
- understand relation between rank of a matrix and solution space of non-homogeneous system
- understand relation between determinant of a matrix and permutations, also existence and uniqueness of the determinant
- develop the application of Cramer's rule and finding inverse of a matrix using adjoint of the matrix
- find orthogonal basis of an inner product space using Gram-Schmidt orthogonalization process

SIUSMAT33 (DISCRETE MATHEMATICS)

Unlike Calculus problems, combinatorial problems are typically not solvable with a core set of theorems and formulae. Most of them are solved through a careful logical analysis of possibilities and thus the main goal of this course is the development of these combinatorial reasoning skills. On successful completion of this course the student develops the experience and confidence to try multiple approaches to problem solving.

SEMESTER III				
CALCULUS OF SEVERAL VARIABLES				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT31	I	Functions of several variables	2	3
	II	Differentiation		
	III	Applications		
ALGEBRA III				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT32	I	Linear Transformations and Matrices	2	3
	II	Determinants		
	III	Inner Product Spaces		
DISCRETE MATHEMATICS				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT33	I	Permutations and Recurrence relation	2	3
	II	Preliminary Counting		
	III	Advanced Counting		
PRACTICALS				
SIUSMATP3	Practicals based on Courses **SIUSMAT31, SIUSMAT32, SIUSMAT33**		3	5

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and examples.

SIUSMAT31: CALCULUS OF SEVERAL VARIABLES

Unit I : Functions of several variables (15 Lectures)

1. The Euclidean inner product on R^n and Euclidean norm function on R^n, distance between two points, open ball in R^n, definition of an open subset of R^n, neighbourhood of a point in R^n, sequences in R^n, convergence of sequences – these concepts should be specifically discussed for $n = 2$ and $n = 3$.
2. Functions from $R^n \to R$ (scalar fields) and from $R^n \to R^m$ (vector fields), limits, continuity of functions, basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity and components of a vector field.
3. Directional derivatives and partial derivatives of scalar fields.
4. Sketching of Quadric surfaces, level curves, level surfaces.

Unit II : Differentiation (15 Lectures)

1. Gradient of a scalar field, geometric properties of gradient, level sets and tangent planes.
2. Chain rule for scalar fields.
3. Higher order partial derivatives, mixed partial derivatives, sufficient condition for equality of mixed partial derivative.
4. Differentiability of a scalar field(in terms of linear transformation), the total derivative, uniqueness of total derivative of a differentiable function at a point, simple examples, differentiability at a point of a function f implies continuity and existence of directional derivatives of f at the point, the existence of continuous partial derivatives in a neighbourhood of a point implies differentiability at the point.
5. Mean value theorem for derivatives of scalar fields.

Unit III : Applications (15 lectures)

1. Second order Taylor's formula for scalar fields.
2. Maxima, minima and saddle points.
3. Second derivative test for extrema of functions of two variables.
4. Method of Lagrange Multipliers.
5. Differentiability of vector fields, definition of differentiability of a vector field at a point, Jacobian matrix, differentiability of a vector field at a point implies continuity. The chain rule for derivative of a vector field (statements only).

Reference Books:

1. Apostol T. , (1969) , Second Edition, *Calculus, Vol. 2,* John Wiley, New York.
2. Stewart J. ,(2009), *Calculus with early transcendental Functions*, Cengage Learning.
3. Thomas G. B. and Finney R. L.,(1998), *Calculus and Analytic Geometry*, Ninth Ed. (ISE Reprint), Addison Wesley, Reading Mass.

Additional Reference Books

1. Ghorpade S. R. and Limaye B., (2009), *A course in Multivariable Calculus and Analysis*, Springer International Edition.
2. Howard Anton, (1999), *Calculus-A* new *Horizon*, Sixth Edition, John Wiley and Sons Inc.
3. Marsden J.E. and Tromba A.J.,(1996) (Fourth Edition), *Vector Calculus*, W.H. Freeman and Co., New York.
4. Protter M.H. and Morrey C.B. Jr., (1995), *Intermediate Calculus*, Second Ed., Springer-Verlag, New York.

Online reference: http://mtts.org.in/useful-links/

SIUSMAT32 ALGEBRA III

Note: Revision of relevant concepts is necessary.

Unit 1: Linear Transformations and Matrices (15 lectures)

1. Review of linear transformations: Kernel and image of a linear transformation, Rank-Nullity theorem (with proof), Linear isomorphisms, inverse of a linear isomorphism, Any n–dimensional real vector space is isomorphic to R^n.
2. The matrix units, row operations, elementary matrices, elementary matrices are invertible and an invertible matrix is a product of elementary matrices.
3. Row space, column space of an $m\times n$ 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.
4. Equivalence of rank of an $m\times n$ matrix A and rank of the linear transformation $L_A : R^n \longrightarrow R^m$, $L_A(X) = AX$. The dimension of solution space of the system of linear equations $AX = 0$ equals $n-\text{rank}(A)$.
5. 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.

Unit II : Determinants (15 Lectures)

1. Definition of determinant as an n–linear skew-symmetric function from $R^n \times R^n \times \ldots\ldots \times R^n \longrightarrow R$ such that determinant of $(E1, E2, \ldots, En)$ is 1, where Ej denotes the j^{th} column of the $n \times n$ identity matrix In. Determinant of a matrix as determinant of its column vectors (or row vectors).
2. Existence and uniqueness of determinant function via permutations, Computation of determinant of 2×2, 3×3 matrices, diagonal matrices, Basic results on determinants such as $\det(A^t) = \det(A)$, $\det(AB) = \det(A)\det(B)$, Laplace expansion of a determinant, Vandermon determinant, determinant of upper triangular and lower triangular matrices.
3. Linear dependence and independence of vectors in R^n using determinants, The existence and uniqueness of the system $AX = B$, where A is an $n\times n$ matrix with $\det(A) \neq 0$, Cofactors and minors, Adjoint of an $n\times n$ matrix A, Basic results such as $A.\text{adj}(A) = \det(A)In$.
   An $n\times n$ real matrix A is invertible if and only if $det(A) \neq 0$, $A^{-1} = \frac{1}{\det det A} adjA$ for an invertible matrix A, Cramer's rule.
4. Determinant as area and volume.

Unit III : Inner Product Spaces (15 Lectures)

1. Dot product in R^n , Definition of general inner product on a vector space over R . Examples of inner product including the inner product $<f,g> = \int_{-\pi}^{\pi} f(t)\,g(t)\,dt$ on C$[-\pi, \pi]$, the space of continuous real valued functions on $[-\pi, \pi]$.
2. Norm of a vector in an inner product space. Cauchy-Schwartz inequality, Triangle in-equality, Orthogonality of vectors, Pythagoras theorem and geometric applications in R^2 , Projections on a line, The projection being the closest approximation, Orthogonal complements of a subspace, Orthogonal complements in R^2 and R^3 . Orthogonal sets and orthonormal sets in an inner product space, Orthogonal and orthonormal bases . Gram-Schmidt orthogonalization process, Simple examples in R^3 , R^4 .

Recommended Books:

1. Lang S., (1997), *Introduction to Linear Algebra*, Springer Verlag.
2. S. Kumaresan,(2001), *Linear Algebra : A geometric approach*, Prentice Hall of India Private Limited.

Additional Reference Books:

1. M. Artin,(1991), *Algebra*, Prentice Hall of India Private Limited.
2. K. Hoffman and R. Kunze , (1978), *Linear Algebra*, Tata McGraw-Hill, New Delhi.
3. T. Banchoff and J . Wermer, (1984), *Linear Algebra through Geometry,* Springer VerlagNew york.

Online reference: http://mtts.org.in/useful-links/

SIUSMAT33: DISCRETE MATHEMATICS

Unit I: Permutations and Recurrence relation (15 lectures)

1. Permutation of objects, S_n, composition of permutations and related results, even and odd permutations, rank and signature of a permutation, cardinality of Sn, An.
2. Recurrence Relations, definition of homogeneous, non-homogeneous, linear & non-linear recurrence relation, obtaining recurrence relation in counting problems, solving(homogeneous as well as non-homogeneous) recurrence relations by using iterative methods, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result.

Unit II: Preliminary Counting (15 Lectures)

1. Finite and infinite sets, countable and uncountable sets, examples such as $N, Z, N \times N,\ Q, (0, 1), R$
2. Addition and multiplication Principle, counting sets of pairs, two way counting.
3. Stirling numbers of second kind. Simple recursion formulae satisfied by $S(n, k)$ for $k = 1, \ldots, n$
4. Pigeonhole principle and its strong form, its applications to geometry, monotonic sequences, etc.

Unit III: Advanced Counting (15 Lectures)

1. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following with emphasis on combinatorial proofs:

- $\sum_{k=0}^{r} \binom{m}{k}\binom{n}{r-k} = \binom{m+n}{r}$
- $\sum_{i=r}^{n} \binom{i}{r} = \binom{n+1}{r+1}$
- $\sum_{i=0}^{k} \binom{k}{i}^2 = \binom{2k}{k}$
- $\sum_{i=0}^{n} \binom{n}{i} = 2^n$

2. Permutation and combination of sets and multisets, circular permutations, emphasis on solving problems.
3. Non-negative and positive integral solutions of equation $x1+x2+\cdots+xk=n$
4. Principle of inclusion and exclusion, its applications, derangements, explicit formula for dn, deriving formula for Euler's function $\phi(n)$.

Recommended Books:

1. Norman Biggs: (2002) *Discrete Mathematics*, Oxford University Press.
2. Richard Brualdi (2008) *Introductory Combinatorics*, John Wiley and sons.
3. V. Krishnamurthy(2008) *Combinatorics-Theory and Applications*, Affiliated East West Press.
4. Kenneth Rosen (2017) *Discrete Mathematics and its Applications*, Tata McGraw Hills.
5. Schaum's outline series: *Discrete mathematics*,
6. Allen Tucker (2007) *Applied Combinatorics*:, John Wiley and Sons.

SIUSMATP33: Practicals in SIUSMAT31, SIUSMAT32, SIUSMAT33

Practicals in SIUSMAT31

1. Neighbourhoods, Open and Closed sets, Sequences in R^2 and R^3.
2. Limits and continuity of scalar fields and vector fields, using definition and otherwise, iterated limits.
3. Computing directional derivatives, partial derivatives and mean value theorem of scalar fields.
4. Total derivative, gradient, level sets and tangent planes.
5. Chain rule, higher order derivatives and mixed partial derivatives of scalar fields.
6. Taylor's formula, differentiation of a vector field at a point, finding Hessian/ Jacobean matrix, Mean Value Inequality.
7. Finding maxima, minima and saddle points, second derivative test for extrema of functions of two variables and method of Lagrange multipliers.
8. Miscellaneous Theoretical Questions based on full paper.

Practicals in SIUSMAT32

1. Rank-Nullity Theorem.
2. System of linear equations.
3. Determinants, calculating determinants of 2×2 matrices, $n \times n$ diagonal, upper triangular matrices using definition and Laplace expansion.
4. Finding inverses of $n \times n$ matrices using adjoint.
5. Inner product spaces, examples. Orthogonal complements in R^2 and R^3.
6. Gram-Schmidt method.
7. Miscellaneous Theoretical Questions based on full paper

Practicals in SIUSMAT33

1. Derangement and rank,signature of permutation.
2. Recurrence relation. Formation of Recurrence relations(word problems) and solving Recurrence relations.
3. Problems based on counting principles,Two way counting.
4. Stirling numbers of second kind,Pigeonhole principle.
5. Multinomial theorem, identities, permutation and combination of multi-set.
6. Inclusion-Exclusion principle.Euler phi function.
7. Miscellaneous theory questions from all units.

Learning Outcomes

SEMESTER IV

SIUSMAT41 (INTEGRAL CALCULUS OF 1 VARIABLE)

In this course, students are introduced to the concept of Riemann Integration of a real valued function of one variable. They are aware of the technique of integration and that it is related to the process of differentiation. This course should enable them to

- Understand Integration as a process to compute area under a curve.
- Compute lower and upper sums of bounded functions on closed bounded intervals.
- Discuss integrability of a bounded function, a continuous function, and a function with finitely many discontinuities.
- Understand the relation between integrability and sum of functions, product of functions, domain additivity.
- Study Derivation of change of variables formula and integration by part.
- Understand the interdependence of integration and differentiation through Fundamental theorem of Integral Calculus.
- Study and discuss the convergence of Improper integrals, Beta and Gamma functions.
- Use integration as a tool to compute areas of bounded regions and surface area and volumes of surfaces of revolution.

SIUSMAT42 (ALGEBRA IV)

In this course students will be learning Abstract Algebra- Groups. On successful completion of this course they will

- be able to think and understand various Groups, their Subgroups, Cyclic groups.
- learn to find order of an element in the Group.
- be able to understand cosets, Lagrange's theorem, Euler’s Theorem and Group Homomorphisms.

SIUSMAT43 (ORDINARY DIFFERENTIAL EQUATIONS)

Successful completion of this course will enable students to

- solve first order differential equations
- solve first and second order linear differential equations
- study and understand the solution space of differential equations
- solve application problems modelled by linear differential equations
- determine if a set of functions is linearly dependent or independent by using the Wronskian
- develop the Prey-Predator equations
- understand the use of differential equations in various disciplines of science

SEMESTER IV				
INTEGRAL CALCULUS OF 1 VARIABLE				
Course Code	UNIT	TOPICS		
SIUSMAT41	I	Riemann Integration		
	II	Indefinite and improper integrals		
	III	Applications		
ALGEBRA IV				
Course Code	UNIT	TOPICS		
SIUSMAT42	I	Groups and Subgroups		
	II	Cyclic Groups and Cyclic Subgroups		
	III	Lagrange's Theorem and Group homomorphism		
ORDINARY DIFFERENTIAL EQUATIONS				
Course Code	UNIT	TOPICS		
SIUSMAT43	I	First order First degree Differential equations		
	II	Second order Linear Differential equations		
	III	Linear System of ODEs		
PRACTICALS				
SIUSMATP4	Practicals based on Courses **SIUSMAT41, SIUSMAT42, SIUSMAT43**			

SIUSMAT41: INTEGRAL CALCULUS OF 1 VARIABLE

Pre-requisites: Definition of uniform continuity of real valued functions, continuity of functions on closed and bounded intervals implying uniform continuity.

Unit I: Riemann Integration (15 Lectures)

Approximation of area, Upper/Lower/General Riemann sums and properties, Upper/Lower integrals, Definition of Riemann integral on a closed and bounded interval, Criterion of Riemann integrability,

If $a<c<b$ then $f \in R[a,b]$, if and only if $f \in R[a,c]$ and $f \in R[c,b]$ and $\int_a^b f = \int_a^c f + \int_c^b f$.

Properties:

$f, g \in R[a,b] \Rightarrow f+g \in R[a,b]$ and $\int_a^b f+g = \int_a^b f + \int_a^b g$

1. $f \in R[a,b]$ and $\lambda \in R \Rightarrow \lambda f \in R[a,b]$ and $\int_a^b \lambda f = \lambda \int_a^b f$
2. $f \in R[a,b] \Rightarrow |f| \in R[a,b]$ and $\left|\int_a^b f\right| \leq \int_a^b |f|$
3. $f \geq 0$ on $[a,b] \Rightarrow \int_a^b f \geq 0$
4. $f \in C[a,b] \Rightarrow f \in R[a,b]$
5. If f is bounded on $[a,b]$ with finite number of discontinuities then $f \in R[a,b]$
6. If f is monotone on $[a,b]$ then $f \in R[a,b]$.

Unit II: Indefinite and improper integrals (15 lectures)

1. Definition of Indefinite Riemann Integral function $F(x) = \int_a^x f(t)dt$ and its continuity.
2. 1st and 2nd Fundamental theorems of Calculus
3. Mean Value Theorem
4. Integration by parts, Change of Variable formula for integration
5. Improper integrals of types I & II, Absolute convergence, comparison tests.

Unit III: Applications (15 lectures)

1. Definition and properties of beta and gamma functions. Relationship between beta and gamma functions (without proof).
2. Applications of definite Integrals: Area between curves, finding volumes by slicing, volumes of solids of revolution-Disks and Washers, Cylindrical Shells, Lengths of plane curves, Areas of surfaces of revolution.

Reference Books:

1. Thomas G. B. and Finney R. L., (1998), *Calculus and Analytic Geometry*, Ninth Ed. (ISE Reprint), Addison Wesley, Reading Mass.
2. R. R. Goldberg, (1964), *Methods of Real Analysis*, Oxford and IBH.
3. Ajit Kumar, S. Kumaresan, (2016), *A Basic Course in Real Analysis*, CRC Press.
4. Apostol T. , (1969) , Second Edition, *Calculus, Vol. 2,* John Wiley, New York.
5. Stewart J. , (2009), *Calculus with early transcendental Functions*, Cengage, Learning.
6. Marsden J.E. and Tromba A.J., (1996) (Fourth Edition), *Vector Calculus*, W.H. Freeman and Co., New York.
7. Bartle R. G. and Sherbet D. R. , (1994), *Introduction to Real analysis*, John Wiley and sons Inc.

Online reference: http://mtts.org.in/useful-links/

SIUSMAT42: ALGEBRA IV

Unit I: Groups and Subgroups (15 Lectures)

1. Definition of a group, abelian group, order of a group, finite and infinite groups. Examples of groups including:
   a. Z, Q, R, C under addition.
   b. $Q^*(= Q - \{0\})$, $R^*(= R - \{0\})$, $C^*(= C - \{0\})$, Q^+ (positive rational numbers) under multiplication.
   c. Z_n ,the set of residue classes modulo n under addition.
   d. $U(n)$, the group of prime residue classes modulo n under multiplication.
   e. The symmetric group Sn.
   f. The group of symmetries of a plane figure. The Dihedral group Dn as the group of symmetries of a regular polygon of n sides (for n=3, 4).
   g. Klein 4-group.
   h. Matrix groups $Mn \times n(R)$ under addition of matrices, $GLn(R)$, the set of invertible real matrices, under multiplication of matrices.
   i. Examples such as S^1 as subgroup of C, μn the subgroup of $n-$th roots of unity.
2. Properties such as
   1) In a group $(G,.)$ the following indices rules are true for all integers n, m.
      i) $a^n a^m = a^{n+m}$ for all a in G.
      ii) $(a^n)^m = a^{nm}$ for all a in G.
      iii) $(ab)^n = a^n b^n$ f or all a, b in G whenever $ab=ba$.

   2) In a group $(G,.)$ the following are true:
      i) The identity element e of G is unique.
      ii) The inverse of every element in G is unique.
      iii) $(a^{-1})^{-1} = a$ for all a in G.
      iv) $(a.b)^{-1} = b^{-1}a^{-1}$ for all a, b in G.
      v) If $a2 = e$ for every a in G then $(G,.)$ is an abelian group.
      vi) $(aba^{-1})n = abna^{-1}$ for every a, b in G and for every integer n.
      vii) If $(a.b)^2 = a^2.b^2$ for every a, b in G then $(G,.)$ is an abelian group.

viii) $(Z_n^*, \ .)_n$ is a group if and only if n is a prime.

3) Properties of order of an element such as :(n nd m are integers.)
   i) If $o(a) = n$ then $am = e$ if and only if n/m.
   ii) If $o(a) = nm$ then $o(an) = m$.
   iii) If $o(a) = n$ then $o(am) = \frac{n}{(n, m)}$ where (n, m) is the GCD of n and m.
   iv) $o(aba^{-1}) = o(b)$ *and* $o(ab) = o(ba)$.
   v) *If* $o(a) = m$ *and* $o(b) = m$, $ab = ba$, $(n, m) = 1$ *then* $o(ab) = nm$.

3. Subgroups
   a. Definition, necessary and sufficient condition for a non-empty set to be a Sub-group.
   b. The center $Z(G)$ of a group is a subgroup.
   c. Intersection of two (or a family of) subgroups is a subgroup.
   d. Union of two subgroups is not a subgroup in general. Union of two subgroups is a subgroup if and only if one is contained in the other.
   e. If H and K are subgroups of a group G then HK is a subgroup of G if and only if $HK = KH$.

Unit II : Cyclic groups and cyclic subgroups (15 Lectures)

1. Cyclic subgroup of a group, cyclic groups, (examples including Z, Zn and μn).
2. Properties such as:
   (i) Every cyclic group is abelian.
   (ii) Finite cyclic groups, infinite cyclic groups and their generators.
   (iii) A finite cyclic group as a unique subgroup for each divisor of the order of the group.
   (iv) Subgroup of a cyclic group is cyclic.
   (v) In a finite group G, $G =< a >$ if and only if $o(G) = o(a)$.
   (vi) If $G =< a >$ and $o(a) = n$ then $G =< am >$ if and only if $(n, m) = 1$.
   (vii) If G is a cyclic group of order pn and $H \subset G$, $K \subset G$ then prove that either $H \subseteq K$ or $K \subseteq H$.

Unit III : Lagrange's Theorem and Group homomorphism (15 Lectures)

1. Definition of Coset and properties such as:
   1) IF H is a subgroup of a group G and $x \in G$ then
      (i) $xH = H$ if and only if $x \in H$.
      (ii) $Hx = H$ if and only if $x \in H$.
2.
   1) If H is a subgroup of a group G and $x, y \in G$ then
      (i) $xH = yH$ if and only if $x - 1y \in H$.
      (ii) $Hx = Hy$ if and only if $xy - 1 \in H$.

2) Lagrange's theorem and consequences such as Fermat's Little theorem, Euler's theorem and if a group G has no nontrivial subgroups then order of G is a prime and G is Cyclic.

3. Group homomorphisms and isomorphisms, automorphisms

Definition. Kernel and image of a group homomorphism. Examples including inner automorphisms.

Properties such as:

(1) $f : G \to G'$ is a group homomorphism then $ker f \subset G$.
(2) $f : G \to G'$ is a group homomorphism then $ker f = \{e\}$ if and only if f is 1-1.
(3) $f : G \to G'$ is a group homomorphism then

G is abelian if and only if G' is abelian. is cyclic if and only if G' is cyclic.

Recommended Books:

1. I. N. Herstein,(1975), *Topics in Algebra*, Wiley Eastern Limited, Second edition.
2. N. S. Gopalkrishnan,(1986), *University Algebra*, Wiley Eastern Limited.
3. M. Artin, (1975), *Algebra,* Prentice Hall of India, New Delhi.
4. P.B.Bhattacharya, S.K.Jain, S.Nagpaul. (1995), *Abstract Algebra,* 2nd edi., Foundation Books, New Delhi.
5. J.B.Fraleigh, (2003), *A first course in Abstract Algebra*, 3rd edition, Narosa,New Delhi.
6. J. Gallian. (1998), *Contemporary Abstract Algebra.* Narosa, New Delhi.
7. Sharad S.Sane, (2013), *Combinatorial Techniques* Hindustan Book Agency.

Online reference: http://mtts.org.in/useful-links/

SIUSMAT43: ORDINARY DIFFERENTIAL EQUATIONS

Unit I : First order First degree Differential equations (15 Lectures)

1. Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and nonlinear ODE.
2. Existence and Uniqueness Theorem for the solution of a second order initial value problem(statement only), Definition of Lipschitz function, Examples based on verifying the conditions of existence and uniqueness theorem
3. Review of Solution of homogeneous and non-homogeneous differential equations of first order and first degree. Notion of partial derivatives. Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for $Mdx+Ndy=0$ to be exact. Non-exact equations: Rules for finding integrating factors(without proof)for non-exact equations
4. Linear and reducible linear equations of first order, finding solutions of first order differential equations, applications to orthogonal trajectories, population growth and finding the current at a given time.

Unit II : Second order Linear Differential equations(15 Lectures)

1. Homogeneous and non-homogeneous second order linear differential 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. Complementary functions and particular integrals.
2. 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.
3. Non- homogeneous equations: The method of undetermined coefficients. The method of variation of parameters.

Unit III : Linear System of ODEs (15 Lectures)

1. Existence and uniqueness theorems.
2. Study of homogeneous and non-homogeneous linear system of ODEs in two variables.
3. The Wronskian of two solutions of a homogeneous linear system of ODEs in two variables and related results.
4. Explicit solutions of Homogeneous and non-homogeneous linear systems with constant coefficients in two variables, examples.
5. Nonlinear systems: Local existence and Uniqueness, Introduction to Volterra's prey-predator equations.

Recommended Text Books for Unit I and II:

1. G. F. Simmons, (2003) ,*Differential equations with applications and historical notes*, McGraw Hill.
2. E. A. Coddington, (1989) *An introduction to ordinary differential equations*, Dover Books.

Recommended Text Book for Unit III:

1. Hirsch, Smale & Devaney,(2003) *Differential equations, Dynamical Systems and Introduction to Chaos*, Elsevier Academic press

2. Lawrence Perko, (2012) *Differential equations and Dynamical Systems*, Springer

3. D. G. Zill, (2014) *A First Course in Differential equations and its Modelling applications*, Brooks/Cole Cengage Learning

SIUSMATP4: Practicals in SIUSMAT41, SIUSMAT42, SIUSMAT43

Practicals in SIUSMAT41

1. Calculation of upper sum,lower sum and Riemann integral.
2. Problems on properties of Riemann integral.
3. Problems on fundamental theorem of calculus, mean value theorems, integration by parts.
4. Convergence of improper integrals, applications of comparison tests.
5. Beta Gamma Functions
6. Problems on area, volume, length of arc.
7. Miscellaneous Theoretical Questions based on full paper.

Practicals in SIUSMAT42

1. Examples and properties of groups.
2. Group of symmetry of equilateral triangle, rectangle,square.
3. Subgroups.
4. Cyclic groups,cyclic subgroups,finding generators of every subgroup of a cyclic group.
5. Left and right cosets of a subgroup, Lagrange's Theorem.
6. Group homomorphisms, isomorphisms.
7. Miscellaneous Theoretical questions based on full paper.

Practicals in SIUSMAT43

1. Solving exact and non-exact equations.
2. Linear and reducible to linear equations , applications to orthogonal trajectories, population growth, and finding the current at a given time.
3. Finding general solution of homogeneous and non-homogeneous equations, use of known solutions to find the general solution of homogeneous equations.
4. Solving equations using method of undetermined coefficients and method of variation of parameters.
5. Solving second order linear ODEs
6. Solving a system of first order linear ODES.
7. Miscellaneous Theoretical questions from all units.

Teaching Pattern
1. Three lectures per week per course in each semester.
2. One practical per week per batch for each course. (5 lectures)
3. Minimum 6 practicals to be conducted in each paper in each semester.

Guidelines about conduct of Practicals

The Practicals should be conducted in batches formed as per the University circular. The Practical session should consist of discussion between the teacher and the students in which students should participate actively. The students are supposed to maintain journal for practicals.

Scheme of Evaluation for Semesters III & IV

The performance of the learners shall be evaluated in three ways:
(a) Continuous Internal Assessment of 40 marks in each course in each semester.
(b) Semester End Examinations of 60 marks in each course at the end of each semester.
(c) A combined Practical exam of 150 marks for all the three courses at the end of each semester.

(a)Internal Assessment in each Course in each semester

Sr No	Evaluation type	Marks
1	One class test	20
2	Presentation/ Project /Assignment	10
3	Viva Voce	10
Total		40

(b) Semester end examination in each course at the end of each semester (60 marks)

Duration – 2 hours .
Question Paper Pattern:- Four questions each of 15 marks.
One question on each unit (Questions 1, 2, 3).
Question 4 will be based on entire syllabus.
All questions shall be compulsory with not more than 50% internal choice within the questions. Question may be subdivided into sub-questions a, b, c.

(c)Practical Examination in each course at the end of each semester

Sr No	Evaluation type	Marks in each course			Total
1	One practical test	40	40	40	120
2	Journal for practical	10	10	10	30
Total		50	50	50	150

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SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE, CGPA 3.51/4.00

BEST COLLEGE AWARD - UNIVERSITY OF MUMBAI

SIES College of Arts, Science and Commerce

(Autonomous)

Affiliated to Mumbai University

Syllabus under Autonomy - July 2018

Program: T. Y. B.Sc.

Course: Mathematics

Credit Based Semester and Grading System (CBSGS)

with effect from the academic year 2018-19

Program: T. Y. B.Sc.
Course: Mathematics

Broad Objectives:

To provide a degree programme in mathematics which is intellectually challenging and rigorous and whose graduates are well placed to pursue post graduate studies or to enter employment.
On successful completion of this course, all students should

1. have learnt to apply critical and analytical reasoning and to present logical and concise arguments.
2. have developed problem solving skills
3. have covered the core topics of advanced mathematics which our Department considers appropriate to their degree programme.
4. be able to comprehend high levels of abstraction in study of pure mathematics.

Learning Outcomes

Semester V

SIUSMAT51 : Multivariable Integral Calculus

This course is an extension of Integral calculus introduced in previous semester. In this course, students are introduced to Integral Calculus of several variables. They should be enabled to

- Understand the concept of Riemann Integral on a rectangle and a box.
- Apply Fubini's theorem for computation of integrals.
- Compute Areas, Volumes, Centre of Mass, using integrals.
- Understand the concept of parametric curve and surface.
- Compute line and surface integrals.
- Study the correlation between various integrals through Greens, Stokes and Gauss theorems.

SIUSMAT52 : LINEAR ALGEBRA

This course is an extension of Linear algebra introduced in second year. The concept of vector spaces is extended to quotient spaces. The course aims to enable the students to

- Understand quotient spaces,finding its dimension , orthogonal transformations,isometry.
- Cayley Hamilton theorem and its applications.
- Find eigenvalues and eigenvectors.
- Understand diagonalization and diagonalize the matrix.
- Understand orthogonal diagonalization, orthogonally diagonalize the matrix.

SIUSMAT53 : Topology of Metric Spaces

This course aims at introducing the students to the concept of metric space and to enable them to

- Discuss examples of Metric Spaces, Normed Linear Spaces
- Sketch Open Balls in R^2, classify Open and Closed sets, Equivalent Metrics
- Understand the concepts like Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure, and apply in problem solving.
- Discuss Sequences with respect to Boundedness and, Convergence.
- Understand the concept of Cauchy sequences and Complete Metric Spaces.
- Understand the concept of Compact Sets.

SIUSMAT54 : Number Theory and Its applications I

This course presents rigorous development of Number Theory using axioms, definitions, examples and Theorems. It aims to enable the students to

- Understand the basic structure and properties of integers.
- Improve their ability of mathematical thinking.
- Understand the Concepts such as secrecy, espionage, code cracking through real life examples.
- Understand and be able to use modern cryptographic methods .

SEMESTER V				
Multivariable Integral Calculus				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT51	I	Multiple Integrals	2.5	3
	II	Line Integrals		
	III	Surface Integrals		
LINEAR ALGEBRA				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT52	I	Quotient spaces and Orthogonal Linear Transformations	2.5	3
	II	Eigen values and Eigen vectors		
	III	Diagonalisation		
Topology of Metric Spaces				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT53	I	Metric spaces	2.5	3
	II	Sequences and Complete metric spaces		
	III	Compact Sets		
Number Theory and Its applications I				
Course Code	UNIT	TOPICS	Credits	L/Week
SIUSMAT54	I	Congruences and Factorization	2.5	3
	II	Diophantine equations and their solutions		
	III	Primitive Roots and Cryptography		
PRACTICALS				
SIUSMATP5	Practicals based on Courses **SIUSMAT51, SIUSMAT52**		3	6
SIUSMATP6	Practicals based on Courses **SIUSMAT53, SIUSMAT54**		3	6

Teaching Pattern

1. Three lectures per week per course (1 lecture/period is of 48 minutes duration).

2. One practical of three periods per week per course (1 lecture/period is of 48 minutes duration).

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and examples.

SEMESTER V

Course : Multivariable Integral Calculus
Course Code: SIUSMAT51

Unit I- Multiple Integrals (15 Lectures)

(i) Definition of double (resp: triple) integral of a bounded function on a rectangle (resp:box). Geometric interpretation as area and volume. Fubini's Theorem over rectangles and on any closed bounded sets, Iterated Integrals. Integrability and the integral over arbitrary bounded domains.

(ii) Integrability of the sums, scalar multiples, products of integrable functions.

(iii) Integrability of continuous functions. More generally, integrability of functions with a set of discontinuities of measure zero. (concept and examples only)

(iv) Domain additivity of the integral. Change of variables formula (Statement only).

(v) Polar, cylindrical and spherical coordinates, and integration using these coordinates. Differentiation under the integral sign using Leibnitz Rule. Applications to finding the center of gravity and moments of inertia.

Unit II : Line Integrals (15 Lectures)

(i) Review of Scalar and Vector fields on R^n , Vector Differential Operators, Gradient, Curl, Divergence.

(ii) Paths (parametrized curves) in R^n (emphasis on R^2 and R^3), Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths.

(iii) Definition of the line integral of a scalar and a vector field over a piecewise smooth path. Basic properties of line integrals including linearity, path additivity and behavior under a change of parameters. Examples.

(iv) Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions for a vector field to be conservative.

(v) Green's Theorem (proof in the case of rectangular domains). Applications to evaluation of line integrals.

Unit III : Surface Integrals (15 Lectures)

(i) Parameterized surfaces. Smoothly equivalent parameterizations. Surface Area.

(ii) Definition of surface integrals of scalar fields and of vector fields . Examples.

(iii) Curl , divergence of a vector field. Elementary identities involving gradient, curl and divergence.

(iv) Stokes' Theorem (proof using Green's Theorem) , Examples.

(v) Gauss Divergence Theorem (proof only in the case of cubical domains). Examples.

Reference Books for Multivariable Calculus:

1. Apostol T. , (1969) , Second Edition, *Calculus, Vol. 2,* John Wiley, New York.
2. Courant R. and John F., (1989), *Introduction to Calculus and Analysis*, Vol.2, Springer Verlag, New York.
3. Ghorpade S. R. and Limaye B., (2009), *A course in Multivariable Calculus and Analysis*, Springer International Edition.
4. Marsden J.E. and Tromba A.J.,(1996) (Fourth Edition), *Vector Calculus*, W.H. Freeman and Co., New York.
5. Protter M.H. and Morrey C.B. Jr., (1995), *Intermediate Calculus*, Second Ed., Springer-Verlag, New York.
6. Stewart J. , (2009), *Calculus with early transcendental Functions*, Cengage, Learning.
7. Thomas G. B. and Finney R. L., 1998, *Calculus and Analytic Geometry*, Ninth Ed. (ISE Reprint), Addison Wesley, Reading Mass.
8. Widder D. V., (1989), *Advanced Calculus*, Second Ed., Dover Pub., New York.

Course: Linear Algebra

Course Code: SIUSMAT52

Unit I. Quotient Spaces and Orthogonal Linear Transformations (15 Lectures)

Review of vector spaces over R , sub spaces and linear transformation.

Quotient Spaces: For a real vector space V and a subspace W, the cosets v + W and the quotient space V/W, First Isomorphism theorem of real vector spaces (fundamental theorem of homomorphism of vector spaces), Dimension and basis of the quotient space V/W , when V is finite dimensional.

Orthogonal transformations: Isometries of a real finite dimensional inner product space, Translations and Reflections with respect to a hyperplane, Orthogonal matrices over R , Equivalence of orthogonal transformations and isometries fixing origin on a finite dimensional inner product space, Orthogonal transformation of R^2 , Any orthogonal transformation in R^2 is a reflection or a rotation, Characterization of isometries as composites of orthogonal transformations and translation. Characteristic polynomial of an $n \times n$ real matrix. Cayley Hamilton Theorem and its Applications

Unit II : Eigenvalues and Eigen vectors (15 Lectures)

Eigenvalues and Eigenvectors of a linear transformation $T : V \to V$, where V is a finite dimensional real vector space and examples, Eigenvalues and Eigenvectors of nxn real matrices, The linear independence of eigenvectors corresponding to distinct eigenvalues of a linear transformation and a Matrix. The characteristic polynomial of an n real matrix and a linear transformation of a finite dimensional real vector space to itself, characteristic roots, Similar matrices, Relation with change of basis, Invariance of the characteristic polynomial and (hence of the) eigenvalues of similar matrices, Every square matrix is similar to an upper triangular matrix. Minimal Polynomial of a matrix, Examples like minimal polynomial of scalar matrix, diagonal matrix, similar matrix, Invariant subspaces.

Unit III: Diagonalisation (15 Lectures)

Geometric multiplicity and Algebraic multiplicity of eigenvalues of an nxn real matrix, an nxn matrix A is diagonalizable if and only if has a basis of eigenvectors of A if and only if the sum of dimension of eigenspaces of A is n if and only if the algebraic and geometric multiplicities of eigenvalues of A coincide, Examples of non diagonalizable matrices, Diagonalisation of a linear transformation $T : V \to V$,where V is finite dimensional real vector space and examples. Orthogonal diagonalisation and Quadratic Forms.Diagonalisation of real Symmetric matrices, Examples, Applications to real Quadratic forms, Rank and Signature of a Real Quadratic form, Classification of conics in R^2 and quadric surfaces in R^3.Positive definite and semidefinite matrices, Characterization of positive definite matrices in terms of principal minors. Applications of Diagonalisation.

Recommended Books:

1. Gopalkrishnan N.S ,(1994), *University Algebra,* Wiley Eastern Limited
2. Kumaresan S.,(2011), *Linear Algebra: A Geometric Approach,*PHI Learning Private Ltd.

Additional Reference Books

1. T. Bancho and J. Wermer,(2014), *Linear Algebra through Geometry*, Springer.

2. L. Smith,(1978), *Linear Algebra*,Springer.

3. M. R. Adhikari and Avishek Adhikari,(1999) *Introduction to linear Algebra,* Asian Books Private Ltd.

4. K Hoffman and Kunze, (1971),*Linear Algebra,* Prentice Hall of India, New Delhi.

5. Anton,(2010),*Linear Algebra and Applications.*John Wiley and Sons

Course: Topology of Metric Spaces

Course Code: SIUSMAT53

Unit I: Metric spaces (15 Lectures)

Definition, examples of metric spaces R; R^2 ,Euclidean space R^n with its Euclidean, sup and sum metric, C (complex numbers), the spaces l^1 and l^2 of sequences and the space C[a; b], of real valued continuous functions on [a; b]. Discrete metric space.

Distance metric induced by the norm, translation invariance of the metric induced by the norm. Metric subspaces, Product of two metric spaces. Open balls and open set in a metric space, examples of open sets in various metric spaces. Hausdorff property. Interior of a set. Properties of open sets. Structure of an open set in R. Equivalent metrics. Distance of a point from a set, between sets, diameter of a set in a metric space and bounded sets. Closed ball in a metric space, Closed sets definition, examples. Limit point of a set, isolated point, a closed set contains all its limit points, Closure of a set and boundary of a set.

Unit II: Sequences and Complete metric spaces (15 Lectures)

Sequences in a metric space, Convergent sequence in metric space, Cauchy sequence in a metric space, subsequences, examples of convergent and Cauchy sequence in finite metric spaces, R^n with different metrics and other metric spaces.

Characterization of limit points and closure points in terms of sequences, Definition and examples of relative openness/closeness in subspaces.Dense subsets in a metric space and Separability. Definition of complete metric spaces, Examples of complete metric spaces, Completeness property in subspaces, Nested Interval theorem in R, Cantor's Intersection Theorem, Applications of Cantor's Intersection Theorem:

(i) The set of real Numbers is uncountable.
(ii) Density of rational Numbers(Between any two real numbers there exists a rational number)
(iii) Intermediate Value theorem: Let $f : [a, b] \longrightarrow R$ be continuous, and assume that f(a) and f(b) are of different signs say, f(a) < 0 and f(b) >0. Then there exists c in (a, b) such that f(c) = 0.

Unit III: Compact sets (15 lectures)

Definition of compact metric space using open cover, examples of compact sets in different metric spaces R; R^2; R^n, Properties of compact sets: A compact set is closed and bounded, (Converse is not true). Every infinite bounded subset of compact metric space has a limit point. A closed subset of a compact set is compact. Union and Intersection of Compact sets. Equivalent statements for compact sets in R:

(i) Sequentially compactness property.
(ii) Heine-Borel property: Let I be a closed and bounded interval. Let *G* be a family of open intervals such that I is contained in the union of members of *G* then I is contained in the union of a finite number of open intervals of the given family *G*.
(iii) Closed and boundedness property.
(iv) Bolzano-Weierstrass property: Every bounded sequence of real numbers has a convergent subsequence.

Reference books in Topology of Metric Spaces:

1. Kumaresan S.,(2005), *Topology of Metric spaces*, Narosa Publishing House, New Delhi
2. Copson E. T. ,(1996), *Metric Spaces*, Universal Book Stall, New Delhi.
3. Rudin W. , (1976) , *Principles of Mathematical Analysis*. McGraw-Hill, Auckland
4. Apostol T. , (1974) , *Mathematical Analysis*, Narosa Publishing House, New Delhi
5. Goldberg R. R., (1970), *Methods of Real Analysis,* Oxford and IBH Pub. Co., New Delhi.
6. Jain P. K. , Ahmed K. , (1996), *Metric Spaces*. Narosa Publishing House, New Delhi
7. Somasundaram D., Choudhary B.,(1996), *A First Course in Mathematical Analysis.* Narosa, New Delhi
8. Simmons G.F., (1963), *Introduction to Topology and Modern Analysis*, McGraw-Hi, New York.
9. Sutherland W.(1975), *Introduction to Metric and Topological Spaces*, Oxford University Press.

Additional References:

Expository articles of MTTS programme on MTTS website.

Course: Number Theory and its applications I

Course Code: SIUSMAT54

Unit I. Congruences and Factorization (15 Lectures)

Review of Divisibility, Primes and The fundamental theorem of Arithmetic.

Congruences : Definition and elementary properties, Complete residue system modulo m, Reduced residue system modulo m, Euler's function and its properties, Fermat's little Theorem, Euler's generalization of Fermat's little Theorem, Wilson's theorem,
Linear congruence, The Chinese remainder Theorem, Congruences of Higher degree,
The Fermat-Kraitchik Factorization Method.

Unit II. Diophantine equations and their solutions (15 Lectures)

The linear Diophantine equation $ax + by = c$.
The equations $x^2 + y^2 = p$; where p is a prime.
The equation $x^2 + y^2 = z^2$, Pythagorean triples, primitive solutions.
The equations $x^4 + y^4 = z^2$ and $x^4 + y^4 = z^4$ have no solutions (x, y, z) with $xyz \neq 0$.
Every positive integer n can be expressed as sum of squares of four integers.
Assorted examples :section 5.4 of Number theory by Niven- Zuckerman -Montgomery.

Unit III. Primitive Roots and Cryptography (15 Lectures)

Order of an integer and Primitive Roots.
Basic notions such as encryption (enciphering) and decryption (deciphering), Cryptosystems, symmetric key cryptography, Simple examples such as *Shift cipher*, *Affine cipher*, *Hill's cipher*, *Vigenère cipher*.
Concept of Public Key Cryptosystem; EIGamal cryptosystem, RSA Algorithm.
An application of Primitive Roots to Cryptography.

References:

1. Niven, H. Zuckerman and H. Montgomery, (1991) *An Introduction to the Theory of Numbers,* John Wiley & Sons. Inc.
2. David M. Burton,(2010) *An Introduction to the Theory of Numbers.* Tata McGraw Hill Edition.
3. G. H. Hardy and E.M. Wright. (1981)*An Introduction to the Theory of Numbers.* The English Language Book Society and Oxford University Press, 1981.
4. Neville Robins.(2005) *Beginning Number Theory*. Narosa Publications.
5. S.D. Adhikari. (1999) *An introduction to Commutative Algebra and Number Theory*. Narosa Publishing House.
6. N. Koblitz.(2012)*A course in Number theory and Cryptography*, Springer.
7. M. Artin, (2015)*Algebra.* Prentice Hall.
8. K. Ireland, M. Rosen. (1982)*A classical introduction to Modern Number Theory*. Second edition, Springer Verlag.
9. William Stalling.(2017) *Cryptology and network security*. Seventh edition, Pearson
10. Koshy, (2002) *Number theory and applications*, Academic Press Inc.

Course SIUSMATP5: Practicals (Based on SIUSMAT51 and SIUSMAT52)

Practicals based on SIUSMAT51

1. Evaluation of double and triple integrals.
2. Change of variables in double and triple integrals and applications
3. Line integrals of scalar and vector fields
4. Green's theorem, conservative field and applications
5. Evaluation of surface integrals
6. Stokes and Gauss divergence theorem
7. Miscellaneous theory questions on units 1, 2 and 3.

Practicals based on SIUSMAT52

1. Quotient Spaces, Orthogonal Transformations.
2. Cayley Hamilton Theorem and Applications
3. Eigen Values & Eigen Vectors of a linear Transformation/ Square Matrices
4. Similar Matrices, Minimal Polynomial, Invariant Subspaces
5. Diagonalisation of a matrix
6. Orthogonal Diagonalisation and Quadratic Forms.
7. Miscellaneous Theory Questions based on units 1, 2, 3

Course SIUSMATP6: Practicals (Based on SIUSMAT53 and SIUSMAT54)

Practicals based on SIUSMAT53

1. Examples of Metric Spaces, Normed Linear Spaces,
2. Sketching of Open Balls in R^2, Open and Closed sets, Equivalent Metrics
3. Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure.
4. Limit Points ,Sequences , Bounded , Convergent Sequences.
5. Cauchy sequences and Complete Metric Spaces.
6. Examples of Compact Sets
7. Miscellaneous Theory Questions based on units 1,2 and 3.

Practicals based on SIUSMAT54

Use of non-programmable scientific calculator is allowed in practicals of this paper.

1. Congruences.
2. Linear congruences and congruences of Higher degree.
3. Linear diophantine equation.
4. Pythagorean triples and sum of squares.
5. Cryptosystems (Private Key).
6. Cryptosystems (Public Key) and primitive roots.
7. Miscellaneous theoretical questions based on units 1, 2, and 3.

Program: T. Y. B.Sc.
Course: Mathematics

Learning Outcomes

Semester VI

SIUSMAT61 : Basic complex analysis

This course aims to introduce students to The Complex Plane C . It is useful for the students who wish to pursue higher study in mathematics to be able to understand the similarities and differences in the set of real numbers and that of complex numbers. The course should enable students to

- Understand the Complex Plane. Basic properties of complex numbers.
- Understand the concept of an Analytic function and Cauchy Riemann equations.
- Discuss convergence of Complex series and sequences.
- Be able to compute contour integrals
- Understand and apply Cauchy's Theorem and Cauchy Integral Formula.
- Construct Taylor's series of analytic functions.
- Discuss the type of singularities of a function and use Laurent's Series to classify them.

SIUSMAT62 : Algebra

This course introduces topics of Abstract algebra,It is an extension some ideas introduced in Second year. The students learn to write proofs based on abstract ideas.The course aims to enable the students to

- Understand the concept of groups further,such as subgroups,Normal subgroups.
- Learn the proofs of standard theorems such as isomorphism theorems
- Solve the theoretical problems based on these concepts.
- Learn Ring theory,integral domains,fields.
- Learn polynomial rings and concept of irreducible elements, Einstein's criterion

SIUSMAT63 : Topology of Metric Spaces and Real Analysis

This course introduces topics of Metric spaces and also revisits some concepts of Real Analysis introduced in previous semesters. The course should enable students to

- Discuss Pointwise and uniform convergence of sequence of functions and series of functions and their properties.
- Understand the concept of Continuity in Metric Spaces
- Understand the concept of Uniform Continuity, Contraction maps, Fixed point theorem
- Understand the concept of Connected Sets , Connected Metric Spaces
- Discuss Path Connectedness, Convex sets, and understand the relation between Continuity and Connectedness

SIUSMAT64 : Number Theory and Its applications II

This course introduces students to the concept of simple continued fractions(finite and infinite), the convergence properties to reals, solution of Pell's equation
The students who successfully complete this course will be able to

- discuss results on Fermat primes, Mersenne primes
- understand the concept of pseudoprimes
- solve quadratic congruences using quadratic reciprocity
- discuss various special arithmetic functions.

<table>
<tr><th colspan="5">SEMESTER VI</th></tr>
<tr><th colspan="5">Basic complex analysis</th></tr>
<tr><td>Course Code</td><td>UNIT</td><td>TOPICS</td><td>Credits</td><td>L/Week</td></tr>
<tr><td rowspan="3">SIUSMAT61</td><td>I</td><td>Introduction to Complex Analysis</td><td rowspan="3">2.5</td><td rowspan="3">3</td></tr>
<tr><td>II</td><td>Cauchy Integral Formula</td></tr>
<tr><td>III</td><td>Complex power series, Laurent series and isolated singularities</td></tr>
<tr><th colspan="5">Algebra</th></tr>
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<tr><td rowspan="3">SIUSMAT62</td><td>I</td><td>Group Theory</td><td rowspan="3">2.5</td><td rowspan="3">3</td></tr>
<tr><td>II</td><td>Ring Theory</td></tr>
<tr><td>III</td><td>Polynomial Rings, Field theory, Homomorphism</td></tr>
<tr><th colspan="5">Topology of Metric Spaces and Real Analysis</th></tr>
<tr><td>Course Code</td><td>UNIT</td><td>TOPICS</td><td>Credits</td><td>L/Week</td></tr>
<tr><td rowspan="3">SIUSMAT63</td><td>I</td><td>Sequences and series of functions</td><td rowspan="3">2.5</td><td rowspan="3">3</td></tr>
<tr><td>II</td><td>Continuous functions on Metric spaces</td></tr>
<tr><td>III</td><td>Connected sets</td></tr>
<tr><th colspan="5">Number Theory and Its applications II</th></tr>
<tr><td>Course Code</td><td>UNIT</td><td>TOPICS</td><td>Credits</td><td>L/Week</td></tr>
<tr><td rowspan="3">SIUSMAT64</td><td>I</td><td>Quadratic Reciprocity</td><td rowspan="3">2.5</td><td rowspan="3">3</td></tr>
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<tr><th colspan="5">PRACTICALS</th></tr>
<tr><td>SIUSMATP7</td><td colspan="2">Practicals based on Courses SIUSMAT61, SIUSMAT62</td><td>3</td><td>6</td></tr>
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</table>

Teaching Pattern

1. Three lectures per week per course (1 lecture/period is of 48 minutes duration).
2. One practical of three periods per week per course (1 lecture/period is of 48 minutes duration).

SEMESTER VI

Course :Basic Complex Analysis
Course Code: SIUSMAT61

Prerequisites: Complex plane, polar coordinates, powers and roots of complex numbers, De Moivre's formula,

Unit I: Introduction to Complex Analysis (15 Lectures)

(i) Bounded and unbounded sets, Sketching of a set in complex plane, Complex functions, Elementary functions like e^z & z^2 and their geometric properties, point at infinity- extended complex plane (Stereographic projection).

(ii) Limit of a function at a point, theorems on limits, Sequences in C, convergence of sequences and results using properties of real sequences, Continuity of functions at a point and algebra of continuous functions.

(iii) Derivative of complex functions, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, Analytic functions, algebra of analytic functions, chain rule.

(iv) Theorem: If $f' = 0$ in a domain D, then f must be constant throughout D. Harmonic functions and harmonic conjugate.

Unit II : Cauchy Integral Formula (15 Lectures)

(i) Evaluation and basic properties of contour integral including absolute inequality and M-L inequality.

(ii) Cauchy's theorem for simply and doubly connected domains, Cauchy - Goursat theorem(only statement)

(iii) Cauchy integral formula, Extension of Cauchy integral formula for derivatives, Cauchy estimates(Cauchy Inequality), Morera's Theorem

Unit III : Complex power series, Laurent series and isolated singularities. (15 Lectures)

(i) Liouville's theorem and applications including proof of Fundamental Theorem of Algebra

(ii) Linear Fractional Transformations: definition and examples.

(iii) Power series of complex numbers and related results , radius of convergence, disc of convergence, uniqueness of series representation, examples.

(iv) Taylor's theorem for analytic function, Definition of Laurent series , Definition of isolated singularity, statement (without proof) of existence of Laurent series expansion in neighbourhood of an isolated singularity, classification of isolated singularities using Laurent series expansion, examples.

Reference Books :

1. Brown J.W. and Churchill R.V., (2004), *Complex analysis and Applications*. McGraw-Hill Higher Education.

Other References:

1. Ahlfors L. ,(1990) *Complex Analysis*, Third Edition. McGraw Hill Education.
2. Greene R. E. and Krantz S. G. , (2006), *Function theory of one complex variable,* American Mathematical Society.
3. Gamelin T.W., (2000), *Complex analysis,* Springer.

Course : Algebra
Course Code: SIUSMAT62

Unit I. Group Theory (15 Lectures)
Review of Groups, Subgroups, Abelian groups, Order of a group, Finite and infinite groups, Cyclic groups, The Center $Z(G)$ of a group G, Cosets, Lagrange's theorem, Group homomorphisms, isomorphisms, automorphisms, inner automorphisms (No questions to be asked)
Normal subgroups: Normal subgroups of a group, definition and examples including center of a group, Quotient group, Alternating group A_n, Cycles. Listing normal subgroups of A_4; S_3. First Isomorphism theorem (or Fundamental Theorem of homomorphisms of groups), Second Isomorphism theorem, third Isomorphism theorem, Cayley's theorem, External direct product of a group, Properties of external direct products, Order of an element in a direct product, criterion for direct product to be cyclic, Classification of groups of order 7.

Unit II. Ring Theory (15 Lectures)
Motivation: Integers & Polynomials.
Definition of a ring (The definition should include the existence of a unity element), zero divisor, unit, the multiplicative group of units of a ring. Basic Properties & examples of rings,including $Z; R;\ Q;\ C;\ M_n\ (R);\ Q[X];\ R[X];\ C[X];\ Z[i];\ Z[\sqrt{2}\ ];\ Z[\sqrt{-5}];\ Z_n$.

Definitions of Commutative ring, integral domain (ID), Division ring, examples. Theorem such as: A commutative ring R is an integral domain if and only if for $a;\ b;\ c \in R$ with $a\neq 0$ the relation $ab = ac$ implies that $b = c$. Definitions of Subring, examples. Ring homomorphisms, Properties of ring homomorphisms, Kernel of ring homomorphism, Ideals, Operations on ideals and Quotient rings, examples. Factor theorem and First and second Isomorphism theorems for rings, Correspondence Theorem for rings: If $f : R \rightarrow R$' is a surjective ring homomorphism, then there is a 1- 1 correspondence between the ideals of R containing the $kerf$ and the ideals of R. Definitions of characteristic of a ring, Characteristic of an ID.

Unit III. Polynomial Rings and Field theory (15 Lectures)
Principal ideal, maximal ideal, prime ideal, the characterization of the prime and maximal ideals in terms of quotient rings. Polynomial rings, R[X] when R is an integral domain/ Field. Divisibility in Integral Domain, Definitions of associates, irreducible and primes. Prime (irreducible) elements in R [X]; Q [X]; $Z_p\ [X]$. Eisenstein's criterion for irreducibility of a polynomial over Z. Prime and maximal ideals in polynomial rings. Definition of field, subfield and examples, characteristic of fields. Any field is an ID and a finite ID is a field. Characterization of fields in terms of maximal ideals, irreducible polynomials. Construction of quotient field of an integral domain (Emphasis on $Z;\ Q$). A field contains a subfield isomorphic to Z_p or Q.

Recommended Books

1. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul,(1995) *Abstract Algebra,* Second edition, Foundation Books, New Delhi, 1995.

2. N. S. Gopalakrishnan,(1994) *University Algebra*, Wiley Eastern Limited.

3. N. Herstein,(1975), *Topics in Algebra*, Wiley Eastern Limited, Second edition.

4. M. Artin, (2015),*Algebra*, Prentice Hall of India, New Delhi.

5. J. B. Fraleigh, (1998), *A First course in Abstract Algebra*, sixth edition, Narosa, New Delhi.

6. J. Gallian,(2012), *Contemporary Abstract Algebra,* Narosa, New Delhi.

Additional Reference Books:

1. S. Adhikari, (1999),*An Introduction to Commutative Algebra and Number theory,* Narosa Publishing House.

2. U. M. Swamy,,A. V. S. N. Murthy,(2011),*Abstract and Modern* Algebra, Pearson.

3. Sen, Ghosh and Mukhopadhyay, (2006),*Topics in Abstract Algebra*, Universities press

Course: Topology of Metric Spaces and Real Analysis

Course Code: SIUSMAT63

Unit I : Sequence and series of functions:(15 lectures)

Sequence of functions - pointwise and uniform convergence of sequences of real- valued functions, examples. Uniform convergence implies pointwise convergence, example to show converse is not true, series of functions, convergence of series of functions, Weierstrass M-test. Examples. Properties of uniform convergence: Continuity of the uniform limit of a sequence of continuous function, conditions under which integral and the derivative of sequence of functions converge to the integral and derivative of uniform limit on a closed and bounded interval. Examples. Consequences of these properties for series of functions, term by term differentiation and integration. Power series in R centered at origin and at some point in R, radius of convergence, region (interval) of convergence, uniform convergence, term by-term differentiation and integration of power series, Examples. Uniqueness of series representation, functions represented by power series, classical functions defined by power series such as exponential, cosine and sine functions, the basic properties of these functions.

Unit II : Continuous functions (15 Lectures)

Continuous functions on metric spaces Epsilon-delta definition of continuity at a point of a function from one metric space to another. Characterization of continuity at a point in terms of sequences, open sets and closed sets and examples, Algebra of continuous real valued functions on a metric space. Continuity of composite continuous function. Continuous image of compact set is compact, Uniform continuity in a metric space, definition and examples (emphasis on R). Let (X, d) and (Y, d) be metric spaces and $f : X \longrightarrow Y$ be continuous. If (X, d) is compact metric, then $f : X \longrightarrow Y$ is uniformly continuous. Contraction mapping and fixed point theorem, Applications.

Unit III: Connected sets: (15 Lectures)

Separated sets- Definition and examples, disconnected sets, disconnected and connected metric spaces, Connected subsets of a metric space, Connected subsets of R. A subset of R is connected if and only if it is an interval. A continuous image of a connected set is connected. Characterization of a connected space, viz. a metric space is connected if and only if every continuous function from X to {1, -1} is a constant function. Path connectedness in R^n, definition and examples. A path connected subset of R^n is connected, convex sets are path connected. Connected components. An example of a connected subset of R^n which is not path connected.

Reference Books:

1. Kumaresan S., (2005), *Topology of Metric spaces*, Narosa Publishing House, New Delhi
2. Copson E. T. , (1996), *Metric Spaces*, Universal Book Stall, New Delhi.
3. Rudin W. , (1976) , *Principles of Mathematical Analysis*. McGraw-Hill, Auckland
4. Apostol T. , (1974) , *Mathematical Analysis*, Narosa Publishing House, New Delhi
5. Goldberg R. R., (1970), *Methods of Real Analysis,* Oxford and IBH Pub. Co., New Delhi.
6. Jain P. K. , Ahmed K. , (1996), *Metric Spaces*. Narosa Publishing House, New Delhi
7. Somasundaram D., Choudhary B., (1996), *A First Course in Mathematical Analysis.* Narosa, New Delhi
8. Simmons G.F., (1963), *Introduction to Topology and Modern Analysis*, McGraw-Hi, New York.
9. Sutherland W. (1975), *Introduction to Metric and Topological Spaces*, Oxford University Press.

Course: Number Theory and its applications II

Course Code: SIUSMAT64

Unit I. Quadratic Reciprocity (15 Lectures)

Quadratic residues and Legendre Symbol, Gauss Lemma, Theorem on Legendre Symbol $\left(\frac{2}{p}\right)$ and $\left(\frac{3}{p}\right)$, and associated results. If p is an odd prime and a is an odd integer with (a, p) = 1 then $\left(\frac{a}{p}\right) = (-1)^t$ where $t = \sum_{k=1}^{\frac{p-1}{2}} [\frac{ka}{p}]$. Quadratic Reciprocity law.

The Jacobi Symbol and law of reciprocity for Jacobi Symbol.
Quadratic Congruences with Composite moduli.

Unit II. Continued Fractions (15 Lectures)

Finite continued fractions. Infinite continued fractions and representation of an irrational number by an infinite simple continued fraction,
Rational approximations to irrational numbers and order of convergence,
Best possible approximations.
Periodic continued fractions.

Unit III. Pell's equation, Arithmetic functions and Special numbers (15 Lectures)

Pell's equation $x^2 - dy^2 = 1$, where d is not a square of an integer.
Solutions of Pell's equation (The proofs of convergence theorems to be omitted). Arithmetic functions of number theory: $d(n)$ (or $\tau(n)$); $\sigma(n)$; $\sigma_k(n)$; $\omega(n)$ and their properties, $\mu(n)$ and the *Möbius* inversion formula.
Special numbers: Fermat numbers, Mersenne numbers, Perfect numbers, Amicable numbers, Pseudoprimes, Carmichael numbers.

Recommended Books/ References:

1. Niven, H. Zuckerman and H. Montgomery, (1991)*An Introduction to the Theory of Numbers,* John Wiley & Sons. Inc.

2. David M. Burton,(2010)*An Introduction to the Theory of Numbers.* Tata McGraw Hill Edition.

3. G. H. Hardy and E.M. Wright. (1981)*An Introduction to the Theory of Numbers.* Low priced edition*.* The English Language Book Society and Oxford University Press, 1981.

4. Neville Robins.(2005) *Beginning Number Theory*. Narosa Publications.

5. S.D. Adhikari. (1999) *An introduction to Commutative Algebra and Number Theory*. Narosa Publishing House.

6. N. Koblitz.(2012) *A course in Number theory and Cryptography*, Springer.

7. M. Artin, (2015) *Algebra.* Prentice Hall.

8. K. Ireland, M. Rosen. (1982) *A classical introduction to Modern Number Theory*. Second edition, Springer Verlag.

9. William Stalling.(2017) *Cryptology and network security*. Seventh edition

10. Koshy, (2002) *Number theory and applications*,

Practicals (Based on SIUSMAT61 and SIUSMAT62)

Practicals based on SIUSMAT61

1. Limit continuity and derivatives of functions of complex variables
2. Stereographic Projection , Analytic function, finding harmonic conjugate
3. Contour Integral, Cauchy Integral Formula , Mobius transformations
4. Taylor's Theorem , Exponential , Trigonometric, Hyperbolic functions
5. Power Series , Radius of Convergence, Laurent's Series
6. Finding isolated singularities, removable, pole and essential, Cauchy Residue theorem.
7. Miscellaneous theory questions based on Unit 1, 2 and 3.

Practicals based on SIUSMAT62

1. Normal Subgroups and quotient groups.
2. Cayley's Theorem and external direct product of groups.
3. Rings, Subrings, Ideals, Ring Homomorphism and Isomorphism
4. Prime Ideals and Maximal Ideals
5. Polynomial Rings
6. Fields.
7. Miscellaneous Theory questions based on Unit 1, 2 and 3.

Course SIUSMATP8: Practicals (Based on SIUSMAT63 and SIUSMAT64)

Practicals based on SIUSMAT63

- Point wise and uniform convergence of sequence of functions and properties.
- Point wise and uniform convergence of series of functions and properties.
- Continuity in Metric Spaces
- Uniform Continuity, Contraction maps, Fixed point theorem
- Connected Sets , Connected Metric Spaces
- Path Connectedness, Convex sets, Continuity and Connectedness
- Miscellaneous Theoretical questions based on unit 1, 2 and 3.

Practicals based on SIUSMAT64

1. Legendre Symbol.
2. Jacobi Symbol and Quadratic congruences with composite moduli.
3. Finite continued fractions.
4. Infinite continued fractions.
5. Pell's equations and Arithmetic functions of number theory.
6. Special Numbers.
7. Miscellaneous Theoretical questions based on unit 1, 2 and 3.

Scheme of Evaluation for Semesters V & VI

The performance of the learners shall be evaluated in three ways:

(a) Continuous Internal Assessment of 40 marks in each course in each semester.

(b) Semester End Examinations of 60 marks in each course at the end of each semester.

(c) A Practical exam of 200 marks for all the four courses at the end of each semester.

(a) Internal Assessment in each Course in each semester

Sr No	Evaluation type	Marks
1	One class test	20
2	Presentation/ Project /Assignment	10
3	Viva Voce	10
Total		40

(b) Semester end examination in each course at the end of each semester (60 marks)

Duration – 2 hours .

Question Paper Pattern:- Four questions each of 15 marks.

Question Nos 1, 2 and 3 will be on unit I, II, III respectively.

Question 4 will be based on entire syllabus.

All questions shall be compulsory with not more than 50% internal choice within the questions. Question may be subdivided into sub-questions a, b, c.

(c) Practical Examination of 100 marks in each course at the end of each semester

Practical Course	Sem	Part A	Parts B	Marks out of	Duration	Journal	Viva
SIUSMATP 5	V	Questions based on SIUSMAT51	Questions based on SIUSMAT52	80	3 Hours	10 marks	10 marks
SIUSMATP 6	V	Questions based on SIUSMAT53	Questions based on SIUSMAT54	80	3 Hours	10 marks	10 marks
SIUSMATP 7	VI	Questions based on SIUSMAT61	Questions based on SIUSMAT62	80	3 Hours	10 marks	10 marks
SIUSMATP 8	VI	Questions based on SIUSMAT63	Questions based on SIUSMAT64	80	3 Hours	10 marks	10 marks

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SIES College of Arts, Science & Commerce

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE, CGPA 3.51/4.00

BEST COLLEGE AWARD - UNIVERSITY OF MUMBAI

SIES College of Arts, Science and Commerce

(Autonomous)

Affiliated to Mumbai University

Syllabus under Autonomy - June 2018

Program: T.Y. B.Sc.

Course: APPLIED COMPONENT

Computer Programming and Applications

Credit Based Semester and Grading System (CBSGS) with effect from the academic year 2018-19

Broad Objectives:-

The course divided into two semesters, has the following goals for its learners:-

1. To have database management system and SQL commands along with PL/SQL Using Oracle thereby giving the student mastery on an open source based toolkit which has more scope in the job market.

2. The retention of "Introduction to C Programming " in Semester V is based on the fact that C still has the charm to be the first programming language to be taught.

3. In Sem VI, "Introduction to Java Programming" is done through the framework of object oriented systems. Applets and Graphics programming give the learner an engaging and interesting treat.

4. Students will also be exposed to Python Programming in Sem VI since it has gained importance than other programming languages and holds a lot of promise for developers. Apart from being an open source programming language, it is also one of the most versatile programming languages.

SEMESTER V				
THEORY				
Course Code	UNIT	TOPICS	Credits	L or P/Week
SIUSCPA51	I	**Introduction to C Programming**	2	4L
	II	**Functions, Pointers and Structures**		
	III	**Relational Database Management System**		
	IV	**Introduction to PL/SQL**		
PRACTICALS				
SIUSCPAP5	Practicals based on **SIUSCPA51**		2	2P(1P=2L) per batch

Course Objectives:-[Sem V]

On successful completion of this course students should be able to:

- Write C programs using loops, conditionals, switch, break and continue statements.
- Handle one and two dimensional arrays
- Understand the concept of functional hierarchical code
- Ability to handle pointers and structures
- Create database tables with and without constraints
- Update and alter table structures
- Retrieve data from single or multiple tables
- Process data with date, string and aggregate functions
- Write simple PL/SQL block codes with and without loops.

Course code SIUSCPA51	SEMESTER V Course Title Computer Programming and Applications

Unit I

Introduction to C Programming (15 L)

(a) Structure of C program: Header and body, Concept of header files, Use of comments, Compilation of a program.

(b) Data Concepts: Variables, Constants, data types like: int, float char, double and void. Qualifiers: short and long size qualifiers, signed and unsigned qualifiers. Declaring variables, Scope of the variables according to block, Hierarchy of data types.

(c) Types of operators: Arithmetic, Relational, Logical, Compound Assignment, Increment and decrement, Conditional or ternary operators. Precedence and order of evaluation. Statements and Expressions.

(d) Mathematical functions : sin(), cos(), tan(), exp(), ceil(), floor(), log(), log10(), pow(), sqrt().

(e) Type conversions: Automatic and Explicit type conversion.

(f) Data Input and Output functions: Formatted I/O: printf(), scanf(). Character I/O format: getch(), getche(), getchar(), getc(), gets(), putchar(), putc(), puts().

(g) Arrays: (One and two dimensional), declaring array variables, initialization of arrays, accessing array elements.

(h) Strings: Declaring and initializing String variables, Character and string handling functions (strcpy, strcat, strchr, strcmp, strlen, strstr).

(i) Iterations: Control statements for decision making: (a) Branching: if statement, if..else statement , else.. if statement, nested if statement, switch statement. (b) Looping: while loop, do while, for loop, nested loop. (c) Loop interruption statements: break, continue.

Unit II

Functions, Pointers and Structures (15 L)

(a)Functions: Global and local variables, Function definition, return statement, calling a function.

(b)Recursion: Definition, Recursion functions for factorial, Fibonacci sequence, exponential function, G.C.D.

(c)Storage classes: Automatic variables, External variables, Static variables, Register variables.

(d)Pointer: Fundamentals, Pointer variables, Referencing and de-referencing, Pointer Arithmetic, Pointers and Arrays, Array of Pointers, Pointers as function arguments.

(e)Structure: Declaration of structure, reading and assignment of structure variables, Array of structures.

Unit III

Relational Database Management System (15L)

(a) **Introduction to Database Concepts:** Database, Overview of database management system. Three levels of Architecture, Database design, Logical and physical data independence, DBMS Models, Database Languages- Data Definition Language (DDL) and Data Manipulation Languages (DML).

(b) Entity Relationship Model: Entity, entity sets, attributes, mapping cardinalities, keys, relations, Designing ER diagram, integrity constraints over relations, Conversion of ER to relations with and without constraints.

(c) SQL commands and Functions:

(i) **Creating and altering tables:** CREATE statement with constraints like KEY, CHECK, DEFAULT, ALTER and DROP statement.

(ii) **Handling data using SQL:** selecting data using SELECT statement, FROM clause, WHERE clause, IN, BETWEEN, LIKE, HAVING clause, ORDER BY, GROUP BY,DISTINCT and ALL predicates, Adding data with INSERT statement, changing data with UPDATE statement, removing data with DELETE statement.

(iii) **Functions:** Aggregate functions-AVG, SUM, MIN, MAX and COUNT, Date functions- ADD_MONTHS(), CURRENT_DATE(), LAST_DAY(), MONTHS_BETWEEN(), NEXT_DAY(). String functions- LOWER(), UPPER(), LTRIM(), RTRIM(), TRIM(), INSTR(), RIGHT(), LEFT(), LENGTH(), SUBSTR(). Numeric functions: ABS(), EXP(), LOG(), SQRT(), POWER(), SIGN(), ROUND(number).

(iv) **Joining tables:** Inner, outer, full and cross joins, union.

Unit IV **Introduction to PL/SQL (15L)**

(a) Fundamentals of PL/SQL: Defining variables and constants, PL/SQL expressions and comparisons: Logical Operators, Boolean Expressions, CASE Expressions Handling, Null values in Comparisons and Conditional Statements.

(b) PL/SQL data types:-Number types, Character types, Boolean type, datetime and interval types.

(c) Overview of PL/SQL Control Structures: Conditional control: IF and CASE Statements, IF-THEN Statement,IF-THEN-ELSE Statement, IF-THEN-ELSIF Statement, CASE Statement.

(d) Iterative Control: LOOP and EXIT Statements, WHILE LOOP, FOR LOOP, Sequential control: GOTO and NULL Statements.

Course code SIUSCPAP5	Topics for Practical

1. Write a C program that illustrates the concepts of C operators, mathematical functions and iterations.

2. Write a C program that illustrates the concepts of arrays and strings.

3. Write a C program that illustrates the concepts of functions, recursion and storage classes.

4. Write a C program that illustrates the concepts of pointers and structures.

5. Creating, altering and updating a single table with/ without constraints and executing queries.

6. Joining tables and processing queries. Queries containing aggregate, string and date functions fired on a single table.

7. Writing PL/SQL Blocks with basic programming constructs.

8. Writing PL/SQL blocks with control structures

References:

(a) E Balagurusamy,(2004) *Programming in ANSI C (Third Edition)* :TMH

(b)George Koch and Kevin Loney (2002),*ORACLE —The Complete Reference‖*, Tata McGraw Hill,New Delhi.

(c)Ivan Bayross, (2012) —*SQL,PL/SQL -The Programming language of Oracle‖,*B.P.B.Publications, 3rd Revised Edition.

(d) Ramakrishnam, Gehrke, (2003)*Database Management Systems*, McGraw-Hill.

(e)YashwantKanetkar, (2010)*Let us C*: BPB

SEMESTER VI				
THEORY				
Course Code	UNIT	TOPICS	Credits	L or P /Week
SIUSCPA52	I	**Introduction to Java Programming**	2	4L
	II	**Inheritance, Exception Handling**		
	III	**Java Applets and Graphics Programming**		
	IV	**Python 3x**		
PRACTICALS				
SIUSCPAP6	Practicals based on **SIUSCPA52**		2	2P(1P=2L) per batch

Course Objectives:-[Sem VI]
On successful completion of this course students should be able to:

- Write programs in java with and without instance variables and methods
- Understand the concept of arrays, constructors and Overloading methods
- Understand error handling using exceptions and inheritance by creating suitable classes
- Write java applets to demonstrate graphics, Font and color classes
- Master the fundamentals of writing Python scripts
- Learn core Python scripting elements such as variables and flow control structures

SEMESTER VI

Course code SIUSCPA52	Course Title Computer Programming and Applications

Unit I **Introduction to Java Programming** **(15 L)**

(a) **Object-Oriented approach**: Features of object-orientations:Abstraction,Inheritance,Encapsulation and Polymorphism.
(b) **Introduction**: History of Java, Java features, different types of Java programs, Differentiate Java with C. Java Virtual Machine.
(c) **Java Basics**: Variables and data types, declaring variables, literals: numeric, Boolean, character and string literals, keywords, type conversion and casting. Standard default values. Java Operators, Loops and Controls No Questions are to be asked on this topic.
(d) **Classes**: Defining a class, creating instance and class members: creating object of a class; accessing instance variables of a class; creating method; naming method of a class; accessing method of a class; overloading method; 'this'keyword, constructor and Finalizer: Basic Constructor; parameterized constructor; calling another constructor; finalize () method; overloading constructor.
(e) **Arrays:** one and two-dimensional array, declaring array variables, creating array objects, accessing array elements.
(f) **Access control**: public access, friendly access, protected access, private access.

Unit II **Inheritance, Exception Handling (15 L)**

(a) **Inheritance**: Various types of inheritance, super and subclasses, keywords-extends'; 'super', overriding method, final and abstract class: final variables and methods; final classes, abstract methods and classes. Concept of interface.
(b) **Exception Handling and Packages:** Need for Exception Handling, Exception Handling techniques: try and catch; multiple catch statements; finally block; usage of throw and throws. Concept of packages. Inter class method: parseInt().

Unit III **Java Applets and Graphics Programming (15 L)**

(a) **Applets**: Difference of applet and application, creating applets, applet life cycle, passing parameters to applets.
(b) **Graphics, Fonts and Color**: The graphics class, painting, repainting and updating an applet, sizing graphics. Font class, draw graphical figures - lines and rectangle, circle and ellipse, drawing arcs, drawing polygons. Working with Colors: Color methods, setting the paint mode.
(c) **AWT package**: Containers: Frame and Dialog classes, Components: Label; Button; Checkbox; TextField, TextArea.

Unit IV **PYTHON 3.x (15 L)**

(a) Introduction: The Python Programming Language, History, features, Installing Python.
Running code in the Interactive Shell, IDLE. Input, Processing and Output, Editing, Saving and Running a Script, Debugging: Syntax Errors, Runtime Errors, Semantic Errors. Experimental Debugging.
(b) Data types and expressions: Variables and the assignment statement,Program Comments and Docstrings, Data types:- Numeric integers and Floating point numbers, Boolean, string. Mathematical operators +,-,*,**,%.PEMDAS. Arithmetic expressions, Mixed-Mode Arithmetic and type Conversion, type(),Input(),print(),program comments.id(),int(),str(),float().
(c) Loops and selection statements:-Definite Iteration: the for loop, Executing statements a given number of times, Specifying the steps using range(),Loops that count down, Boolean and Comparison operators and Expressions, Conditional and alternative statements-Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else. Compound Boolean Expressions, Conditional Iteration: The while Loop-with True condition, the break Statement, random numbers, Loop Logic, errors and testing.

(d) Strings: Assessing characters, indexing, slicing, replacing. Concatenation (+), Repetition (*).Searching a substring with the 'in' operator, Traversing string using while and for. String methods:- find, join, split, lower, upper, len()

Course code SIUSCPAP6	Topics for Practical

0.Programs that illustrate the concept of selection statements, loops, nested loops, breaking out of loop.

1. Programs that illustrate the concept of arrays (one and two dimensional).
2. Programs to create a Java class
   (i) Without instance variables and methods
   (ii) with instance variables and without methods
   (iii) without instance variables and with methods
   (iv) with instance variables and with methods

   Create an object of this class that will invoke the instance variables and methods accordingly.
4. Programs to illustrate the concept of Java class that includes constructor with and without parameters.
5. Programs to illustrate the concept of Java class that includes overloading methods and

inheritance.

6. Programs that illustrate error handling using exception handling.
7. Java applets to demonstrate graphics, Font, Color classes and AWT package.
8. Python programs to convert decimal to binary,octal using string.

References:

(1) E. Balagurusamy(2009), *Programming with Java: A Primer 4th Edition* by Tata McGraw Hill.

(2) E. Balagurusamy(2017), *Problem Solving and Python Programming* by Tata McGraw Hill.

(3) Herbert Schildt,(2013) *Java The Complete Reference, 8th Edition*, Tata McGraw Hill

(4) Ivan Bayross,(2006),*Web Enabled Commercial Applications Development Using Java 2,*BPB Publications, Revised Edition

(5) Kenneth A Lambert chapters 1,2 and 3.(2018) *Fundamentals of Python First Programams 2nd edition*

Internal Assessment of Theory Core Courses Per Semester Per Course (Total 40 marks)

(a) One Assignment/Project	..... 10 Marks.
(b) One Class Test:	……20 Marks.
(c) Active participation in class instructional deliveries	. ..…05 Marks.
(d) Overall conduct as a responsible student, mannerism etc:	…..05 Marks.

Semester End Theory Examination (Total 60 marks)

Theory: At the end of the semester, examination of two and half hours duration and60 marks based on the four units shall be held for each course.

Pattern of Theory question paper at the end of the semester for each course: There shall be Four compulsory Questions of 15 marks each with internal option. Question1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III and Question 4 based on Unit IV

Semester End Practical Examination (Total 100 marks)

Semester V and Semester VI: Total evaluation is as follows:-

1) Semester end Practical exam on computer- 80 marks
2) Viva 10 marks
3) Certified Journal 10 marks

Pattern of Practical question paper:-

1. There shall be four compulsory questions of twenty marks each for the semester end practical examination on computer.
2. The questions to be asked in the practical examination shall be from the list of practical experiments mentioned in the practical topics. A few simple modifications may be expected during the examination.
3. The semester end practical examination on the machine will be of THREE hours.
4. Students should carry a certified journal with minimum of 06 practicals (mentioned in the practical topics) at the time of examination.
5. Number of students per batch for the regular practical should not exceed 20. Not more than two students are allowed to do practical experiment on one computer at a time.

Workload:-

Theory:-4 lectures per week
Practical: -2 practicals each of 2 lecture periods per week per batch. Two lecture periods of the practicals shall be conducted in succession together on a single day.
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