SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

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

Syllabus under NEP - June 2023

Department of Mathematics
Programme: B.Sc.
Sem: I and II

Courses offered in FYBSc

Choice Based Credit System (CBCS)
with effect from the academic year 2023-24

Contents:

1. Course structure with credits and Lectures/ Week

Type	Sem	Course Name/Course Code	Credits	L/P(per week)
Core	**I**	**Differential Calculus of 1 variable**	4	3L+1P
		Unit 1: Properties of Real Numbers and functions of 1 variable		
		Unit 2: Differentiability of functions of one variable and Mean ValueTheorems		
		Unit 3: Applications of Derivatives		
	II	**Algebra and its applications**	4	3L+1P
		Unit 1: Integers and divisibility		
		Unit 2: Functions and Equivalence relations		
		Unit 3: Cryptography		
Note: 1P = 2 hours, 1L = 1 hour, 1T=1 hour				

2. Consolidated Syllabi with Course Outcomes

Semester 1

2.1 Core Course: Mathematics

Total credits : 4 Theory : 3 credits Practicals: 1 credit

This Core course is offered to students of BSc in semester I , who have chosen Mathematics as Major/ Minor subject

Course Name: Differential Calculus of one variable. Credits: 3 Type: Theory Course		
Expected Course Outcomes On completion of this course, students will be able to 1. State definitions, propositions and prove important results based on Supremum, Infimum , bounded sets, properties and inequalities of real numbers, limit, continuity, differentiability. 2. Apply various properties, results and inequalities to solve problems on intervals, neighbourhoods, boundedness, derivatives of functions, plotting graphs of functions, apply derivatives to solve problems on Maxima-Minima, increasing and decreasing functions. 3. Determine continuity of a function at a point or on intervals and distinguish between the types of discontinuities at a point, Identify bounded and unbounded sets, analyse if a result is applicable to solve a problem. derivatives and related terms, Plot graphs of standard functions and comment on continuity		
Pre-requisites:	Derivatives, functions of one variable, graphs of functions.	
Unit I	Real Numbers and functions of 1 variable	15 Lectures
	● The set of real numbers, Order property of real numbers, properties of Absolute Value function ● Intervals and neighbourhoods in R , Hausdorff property ● Bounded sets in the set of Real numbers, Supremum and infimum, Basic results: Continuum property (l.u.b. Axiom-statement) and consequences, Archimedean property and its applications. ● Real valued Functions of one variable: Domain, Range	

	• 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, $\frac{1}{x}$, $\frac{1}{x^2}$, log(x), a^x and e^x. (To be done in practical 0 .) • 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, Limit of composite function • Sandwich theorem, Left hand, Right hand limits, Non-existence of limit • Infinite limits and Limits at infinity. • 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 • Algebra of continuous functions • Discontinuous functions, examples of removable and essential discontinuity	
Unit II	Differentiability of functions of one variable and Mean ValueTheorems	15 Lectures
	• Properties of continuous functions on a closed and bounded interval. • Definition of Derivative of a real valued function of one variable at a point. • Differentiable functions are continuous but not conversely • Algebra of differentiable functions, Chain Rule for derivative of a composite function (statement only) • Derivative of inverse functions, Implicit differentiation (only examples) • Higher order derivatives of some standard functions • Leibnitz rule • Geometric interpretation of derivative	

Unit III	Differentiability and Applications	15 Lectures
	● The Mean Value Theorems Rolle's theorem, examples and applications Lagrange's mean value theorem, examples and applications Cauchy's mean value theorems, examples and applications ● Indeterminate forms: L'Hospital's Rule (without proof) as an application of CMVT. Examples.(Problems in Practicals) ● Taylor's theorem (without proof). Taylor's polynomial and applications. ● Applications of first and second derivatives: Monotone increasing and decreasing function, examples, using derivatives. Concave, Convex functions, Points of Inflection ● 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	

Course Name: Mathematics Practicals 1
Credits: 1

Expected Course Outcomes

On completion of this course, students will be able to

1. Apply various definitions, results and methods learnt in two theory courses to solve problems.
2. Test validity of mathematical statements using results and constructing appropriate examples

Practical No.	Title
01	Graphs of real valued functions of one variable, use of a mathematical software to plot graphs. Identifying left, right limits of functions at a point. Discussing continuity using graphs.
02	Properties of real numbers, absolute value, Archimedian property, bounded sets
03	Limit and Continuity of a function. Discontinuous functions
04	Finding derivatives by definition, Use of Leibnitz rule
05	Problems based on MVTs, L' Hospital's rule
06	Problems based on applications, Maxima-Minima, increasing decreasing functions, concavity and points of inflection
07	Problems based on Taylor's theorem, finding Taylor's linear and quadratic polynomial approximation

References

1. Ajitkumar, S. Kumaresan, A Basic Course in Real Analysis, CRC press, 2014
2. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons,1994.
3. James Stewart, Calculus, Third Edition, Brooks/ cole Publishing Company,1994
4. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964..
5. T. M. Apostol, Calculus Vol I, Wiley & Sons (Asia) Pte. Ltd.
6. G. B. Thomas, R.L. Finney ,Calculus and analytic geometry, 3rd Edition onwards.
7. Ghorpade,Limaye, A Course in Calculus and Real Analysis, Springer International Ltd, 2000

Online Resources
1. https://openstax.org/details/books/calculus-volume-1 2. https://archive.org/details/Calculus10thEditionH.Anton

Semester II

2.2 Core Course: Mathematics(Semester II)

Total credits : 4 Theory : 3 credits Practicals: 1 credit

This course is offered to students of BSc in semester II, who have chosen Mathematics as Major/ Minor subject

<table>
<tr><td colspan="3">Course Name: Algebra and its applications
Credits: 3 Type: Theory course</td></tr>
<tr><td colspan="3">Expected Course Outcomes
On completion of this course, students will be able to
1. State definitions of divisibility of integers, GCD, prime, congruence, function and its different types, binary operation, relation and its different types, State the well ordering property, induction theorems, fundamental theorem of Arithmetic, State and prove results based on divisibility, primes, congruences, bijectivity of functions, binary operations, partitions and equivalence relations, primitive roots
2. Apply various results to find GCD, prove propositions based on induction theorems, solve problems based on congruences, check bijectivity of functions, encryption and decryption
3. Identify invertible functions, binary operations, partitions and equivalence relations</td></tr>
<tr><td>Pre-requisites:</td><td colspan="2">Basic Set Theory and Logic</td></tr>
<tr><td>Unit I</td><td>Integers and divisibility</td><td>15 Lectures</td></tr>
<tr><td></td><td colspan="2">● Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of Well-Ordering Principle.
● Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two non-zero integers, basic properties of g.c.d. such as existence and uniqueness and that the g.c.d. of $a, b \in Z$ can be expressed as $ma + nb$, $m, n \in Z$, Euclidean algorithm.
● Euler’s phi function and its properties</td></tr>
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	● Primes, Euclid's lemma, Fundamental Theorem of arithmetic, The set of primes is infinite, there are arbitrarily large gaps between primes. ● Congruence, definition and elementary properties, Results about linear congruence equations. Examples.	
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 equivalence classes are either identical or disjoint, Definition of partition, every partition gives an equivalence relation and vice versa. Congruence is an equivalence relation on Z, Residue classes and partition of Z.	
Unit III	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, Vigénere cipher . ● Concept of Public Key Cryptosystem; EIGamal cryptosystem, RSA Algorithm. An application of Primitive Roots to Cryptography.	

Course Name: Mathematics Practical 2	Credits: 1
Expected Course Outcomes	

On completion of this course, students will be able to

1. Apply various definitions, results and methods learnt in the theory course to solve problems.
2. Test validity of mathematical statements using results and constructing suitable examples

Practical No.	Title
01	Set theory and logic
02	Division Algorithm and Euclidean algorithm, Primes
03	Fundamental Theorem of Arithmetic, Euler's Phi function, Congruences
04	Functions (direct image and inverse image), Injective, surjective, bijective functions, finding inverses of bijective functions
05	Equivalence relations and Partitions
06	Cryptosystems (Public Key) and primitive roots
07	Cryptosystems (Private Key)

References

1. J. P. Tremblay & R. Manohar.(1974).*Discrete Mathematical Structures with Applications to Computer Science,* McGraw Hill
2. David M. Burton.(2015). *Elementary Number Theory,* McGraw Hill Education (India) Private Ltd.
3. Norman L. Biggs.(1989).*Discrete Mathematics*, Clarendon Press, Oxford
4. I. Niven and S. Zuckerman.(1972).*Introduction to the theory of numbers,* Wiley Eastern
5. Kenneth Rosen.(1999). *Discrete Mathematics and its applications*, Mc-Graw Hill International Edition, Mathematics Series.
6. William Stalling. Cryptology and network security.
7. Larry J. Gerstein.(2012). *Introduction to Mathematical Structures and Proofs,* Springer-Verlag, New York

3. Scheme of Evaluation:

33% to 50% Internal Assessment through continuous evaluation in each course of each semester
Remaining weightage to Semester End Examination in each semester

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