Academic Council Meeting No. and Date: 8 / September 04, 2023

Agenda Number : 2 **Resolution Number : 34, 35 / 2.3, 2.24**

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme: Bachelor of Science

Specific Programme: Mathematics

[F.Y.B.Sc. MATHEMATICS]

Level 4.5

Choice Based Grading System

Revised under NEP

From Academic Year 2023-24

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Preamble

Department of Mathematics of VPM'S B. N. Bandodkar College of Science Autonomous has designed the syllabus of F.Y.B.Sc. Mathematics for the academic year 2023-24 under NEP 2020.

Mathematics is the most fundamental subject and an essential tool in the field of Science and Technology. The syllabus has been developed to prepare the students in pursuing research in Mathematics as well as to enhance their analytical skills and knowledge of mathematical tools and techniques required in industry for employment.

In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the board of studies in Mathematics has prepared the syllabus of F.Y.B.Sc. Mathematics. The present syllabi of F. Y. B. Sc. for Semester I and Semester II has been designed as per U.G.C. Model curriculum so that the students learn Mathematics needed for these branches, learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi would consist of two semesters and each semester would comprise of two courses for F.Y.B.Sc Mathematics. Course I is 'Calculus I and Calculus II'. Calculus is applied and needed in every conceivable branch of science. Course II, 'Discrete Mathematics and Combinatorics' develops mathematical reasoning and logical thinking and has applications in science and technology.

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

Eligibility: 12th pass

Duration: 1 Year (includes SEM I and SEM II)

Mode of Conduct: Offline

Total Credits for the Program: 176

Starting year of implementation: 2023- 24

Discipline/Subject: Mathematics

Program Specific Outcomes

- To understand the basic concepts and fundamental theories of Mathematics
- To develop problem solving and computing skills
- To use mathematical concepts learnt for deducing proofs with logical reasoning
- To develop analytical skills and understanding of abstract theories of Mathematics
- To learn various mathematical tools and techniques and apply them in real world

Specific Programme: F.Y.B.Sc. (Mathematics - Major/Minor)

Assessment:

Weightage for assessments (in percentage) For Major and Minor

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40%	60%

F.Y.B.Sc. Mathematics Structure of Programme

Semester I			
Major			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT1T01	Calculus I	**30**	**2**
23BUMT1T02	Discrete Mathematics	**30**	**2**
23BUMT1P01	Practical based on 23BUMT1T01 AND 23BUMT1T02	**60**	**2**
23BU1SEC03	Infinite series and Polynomials	**45**	**2**
	Total	**165**	**8**
Minor			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT1T03	Calculus I	**30**	**2**
23BUMT1T04	Discrete Mathematics	**30**	**2**
23BUMT1P02	Practical based on 23BUMT1T03 AND 23BUMT1T04	**60**	**2**
	Total	**120**	**6**
Generic Elective			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT1T05	Applied Mathematics I	**30**	**2**
	Total	**30**	**2**

Semester II			
Major			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT2T01	Calculus II	**30**	**2**
23BUMT2T02	Combinatorics I	**30**	**2**
23BUMT2P01	Practical based on 23BUMT2T01 AND 23BUMT2T02	**60**	**2**
23BU2SEC03	Applications of Differentiability	**45**	**2**
	Total	**165**	**8**
Minor			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT2T03	Calculus II	**30**	**2**
23BUMT2T04	Combinatorics I	**30**	**2**
23BUMT2P02	Practical based on 23BUMT2T03 AND 23BUMT2T04	**60**	**2**
	Total	**120**	**6**
Generic Elective			
Course Code	**Course Title**	**No. of lectures in hours**	**Credits**
23BUMT2T05	Applied Mathematics II	**30**	**2**
	Total	**30**	**2**

Semester I

Major Courses

23BUMT1T01

CO1	Utilise the real number system and its properties.	L2
CO2	Solve the problems of absolute values, infimum and supremum.	L2
CO3	Explain the concepts related to sequences like bounded, convergent, divergent, Cauchy etc.	L2
CO4	Evaluate the limits of convergent sequences.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT1T01	**Course Title Calculus I**	**Credits 2**	**No. of lectures 30**
Unit I :	**Real Number System** Real number system IR and order properties of IR, absolute value | | and its properties. AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods in IR, Hausdorff property. Bounded sets, statements of L.u.b. axiom and its consequences, supremum and infimum of set, maximum and minimum, Archimedean property and its applications, density theorem of rationals.		**15**
Unit II:	**Sequences in IR** Definition of a sequence in IR and examples, Convergence of sequences, every convergent sequence is bounded. Limit of a convergent sequence and uniqueness of limit, divergent sequence. Convergence of standard sequences. Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem and consequences.		**15**

	Definition of subsequence, subsequence of a convergent sequence is convergent and converges to the same limit, definition of a Cauchy sequences, every convergent sequence is Cauchy sequence and converse.	

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2.	Mathematical Analysis	K.G. Binmore	Cambridge University Press		1982
3.	Introduction to Real Analysis	R. G. Bartle and D. R. Sherbert	John Wiley & Sons		1994
4.	A course in Calculus and Real Analysis	Sudhir Ghorpade and Balmohan Limaye	Springer International Ltd.		2000

23BUMT1T02

CO1	Utilise the integer and rational number system.	L2
CO2	Evaluate the statements of theorems by applying them in problem-solving.	L2
CO3	Analyse the problem and apply the theorems.	L2
CO4	Discuss statements of theorems and their proofs.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT1T02	**Course Title Discrete Mathematics**	**Credits 2**	**No. of lectures 30**
Prerequisites: 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. Complex numbers: Addition and multiplication of complex numbers, modulus, amplitude and			

conjugate of a complex number.		
Unit I :	**Integers & Divisibility.** Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of well-ordering property, Binomial theorem for non-negative exponents, Pascal Triangle. Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of integers a and b and that the g.c.d. can be expressed as ma + nb where m, n are in Z, Euclidean algorithm, Primes, Euclid's lemma, Fundamental theorem of arithmetic, the set of primes is infinite. Congruence, definition and elementary properties, Euler's function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem, Applications.	**15**
Unit II :	**Functions and Equivalence relations.** Definition of a function, domain, codomain and range of a function, composite functions, examples, Direct image f [A] and inverse image $f^{-1}[A]$ of a function. Injective, surjective, bijective functions, Composite of injective, surjective, bijective functions, Invertible functions, Bijective functions are invertible and conversely, Examples of functions including constant, identity, projection, inclusion, Binary operation as a function, properties, examples. Equivalence relations, 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 an equivalence relation on Z, Residue classes, Partition of Z, Addition modulo n, Multiplication modulo n, examples, conjugate classes.	**15**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Elementary Number Theory	David M. Burton	McGraw Hill Education (India) Private Ltd	7^{th}	
2.	Discrete Mathematics	Norman L. Biggs	Clarendon Press, Oxford	Revised	1989
3.	Introduction to the theory of numbers	I. Niven and S. Zuckerman	Wiley Eastern, New Delhi	3^{rd}	1972
4.	A Survey of Modern Algebra	G. Birkoff and S. Maclane	Mac Millan, New York	3^{rd}	1965
5.	Basic Abstract Algebra	P. B. Bhattacharya S. K. Jain and S. R. Nagpaul	New Age International		1994

23BUMT1P01

CO1	Solve the problems based on fundamental concepts.	L3
CO2	Analyse problems and determine bounded sets, bounded sequences.	L3
CO3	Evaluate GCD, LCM, solution of congruence.	L3
CO4	Formulate and validate the result related to properties of integers/ real numbers.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	0	3	0
CO2	1	2	2	0	3	0
CO3	1	2	2	0	3	0
CO4	1	2	2	0	3	0

Course Code 23BUMT1P01	**Course Title Practical based on 23BUMT1T01 and 23BUMT1T02**	**Credits 2**	**No. of hours**
	Practical based on 23BUMT1T01		
Practical 1	Algebraic and order properties of real numbers		4
Practical 2	Inequalities and absolute value property		4
Practical 3	Hausdorff property and LUB axiom property		4
Practical 4	Archimedean property		4
Practical 5	Convergence and divergence of sequences, bounded sequences, Sandwich Theorem.		4
Practical 6	Cauchy sequences, monotonic sequences, non-monotonic sequences.		4
Practical 7	Miscellaneous Theoretical Questions based on full paper I		4
	Practical based on 23BUMT1T02		
Practical 8	Division Algorithm, Euclidean algorithm		4
Practical 9	Primes and the Fundamental theorem of Arithmetic,		4
Practical 10	Functions, Bijective functions.		4

Practical 11	Invertible functions, Compositions of functions.	4
Practical 12	Binary Operation, Equivalence Relations.	4
Practical 13	Partition and Equivalence classes.	4
Practical 14	Miscellaneous Theoretical Questions based on full paper II	4
Practical 15	All multiple choice questions based on paper I and paper II	4
	Total	**60**

Skill Enhancement Course

23BU1SEC03

CO1	Recall and prove elementary results of series	L1
CO2	Recall and prove elementary results of polynomials	L1
CO3	Apply tests of convergence of series	L3
CO4	Apply elementary results of polynomials	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	0	0	0
CO2	2	1	1	0	0	0
CO3	2	0	1	0	1	0
CO4	2	0	1	0	1	0

Course Code 23BU1SEC03	Course Title Infinite series and Polynomials	Credits 2	No. of lectures 45
Unit I:	**Infinite Series** Infinite series in IR. Definition of convergence and divergence. Basic examples including geometric series. Elementary results such as if $\sum_{n=1}^{\infty} a_n$ converges then $a_n \to 0$ but the converse is not true. Cauchy criterion. Algebra of convergent series. Tests for convergence. Comparison Test, Limit Comparison Test, Ratio Test, Root test, Abel Test (without proof), Dirichlet Test (without proof). Examples. The decimal expansion of real numbers. Convergence of $\sum_{n=1}^{\infty} \frac{1}{n^p}$ $(p > 1)$. Divergence of Harmonic series $\sum_{n=1}^{\infty} \frac{1}{n}$. Alternating series, Leibnitz rule, Examples. Absolute convergence. Absolute convergence implies convergence but not conversely. Conditional convergence. **Polynomials** Definition of polynomial, polynomials over F where F= Q, R, C. Algebra of polynomials, degree of polynomials, 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 over F 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 R[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 C[X]. Necessary condition for a rational number to be a root of a polynomial with integer coefficients, simple consequences such as p is an irrational number p is a prime number, nth roots of unity, sum of nth roots of unity.		**15**

Practical 1	Examples of Convergent series and Divergent Series.	**2**
Practical 2	Comparison Test and Limit Form of Comparison Test	**2**
Practical 3	Ratio Test and Root Test	**2**
Practical 4	Abel's Test, Dirichlet's Test and Alternating Series Test	**2**
Practical 5	Leibnitz's Rule and Absolute Convergent	**2**
Practical 6	Conditional Convergent and Cauchy Criterion	**2**

Practical 7	Operations on Polynomials	**2**
Practical 8	Division Algorithm	**2**
Practical 9	Euclidean Algorithm	**2**
Practical 10	Multiplicity of roots	**2**
Practical 11	Roots and coefficient of polynomial	**2**
Practical 12	Factorization of Polynomials	**2**
Practical 13	nth roots of unity	**2**
Practical 14	Multiple Choice Questions Based on Infinite Series	**2**
Practical 15	Multiple Choice Questions Based on Polynomials	**2**
	Total	**45**

Books and References:

Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2.	Calculus and Analytic Geometry	Thomas and Finney	Addison-Wesley		1998
3.	Introduction to Real Analysis	R. G. Bartle and D. R. Sherbert	John Wiley & Sons		1994
4.	Discrete Mathematics	Norman L. Biggs	Clarendon Press, Oxford	Revised	1989
5.	G. Birkoff and S. Maclane	A Survey of Modern Algebra	Mac Millan, New York	3rd	1965
6.	P. B. Bhattacharya S. K. Jain and S. R. Nagpaul	Basic Abstract Algebra	New Age International		1994

Minor Courses

23BUMT1T03

CO1	Utilise the real number system and its properties.	L3
CO2	Solve the problems of absolute values, infimum and supremum.	L3
CO3	Explain the concepts related to sequences like bounded, convergent, divergent, Cauchy etc.	L3
CO4	Evaluate the limits of convergent sequences.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT1T03	**Course Title Calculus I**	**Credits 2**	**No. of lectures 30**
Unit I :	**Real Number System** Real number system IR and order properties of IR, absolute value | | and its properties. AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods in IR, Hausdorff property. Bounded sets, statements of L.u.b. axiom and its consequences, supremum and infimum of set, maximum and minimum, Archimedean property and its applications, density theorem of rationals.		**15**
Unit II:	**Sequences in IR** Definition of a sequence in IR and examples, Convergence of sequences, every convergent sequence is bounded. Limit of a convergent sequence and uniqueness of limit, divergent sequence. Convergence of standard sequences. Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem and consequences. Definition of subsequence, subsequence of a convergent sequence is convergent and converges to the same limit, definition of a Cauchy sequences, every convergent sequence is Cauchy sequence and converse.		**15**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2.	Mathematical Analysis	K.G. Binmore	Cambridge University Press		1982
3.	Introduction to Real Analysis	R. G. Bartle and D. R. Sherbert	John Wiley & Sons		1994
4.	A course in Calculus and Real Analysis	Sudhir Ghorpade and Balmohan Limaye	Springer International Ltd.		2000

23BUMT1T04

CO1	Utilise the integer and rational number system.	L3
CO2	Evaluate the statements of theorems by applying them in problem-solving.	L2
CO3	Analyse the problem and apply the theorems.	L3
CO4	Discuss statements of theorems and their proofs.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT1T04	**Course Title Discrete Mathematics**	**Credits 2**	**No. of lectures 30**

Prerequisites:

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.

Complex numbers: Addition and multiplication of complex numbers, modulus, amplitude and conjugate of a complex number.

Unit I :	**Integers & Divisibility.** Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of well-ordering property, Binomial theorem for non-negative exponents, Pascal Triangle. Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of integers a and b and that the g.c.d. can be expressed as ma + nb where m, n are in Z, Euclidean algorithm, Primes, Euclid's lemma, Fundamental theorem of arithmetic, the set of primes is infinite. Congruence, definition and elementary properties, Euler's function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem, Applications.	**15**
Unit II :	**Functions and Equivalence relations.** Definition of a function, domain, codomain and range of a function, composite functions, examples, Direct image f [A] and inverse image $f^{-1}[A]$ of a function. Injective, surjective, bijective functions, Composite of injective, surjective, bijective functions, Invertible functions, Bijective functions are invertible and conversely, Examples of functions including constant, identity, projection, inclusion, Binary operation as a function, properties, examples. Equivalence relations, 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 an equivalence relation on Z, Residue classes, Partition of Z, Addition modulo n, Multiplication modulo n, examples, conjugate classes.	**15**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Elementary Number Theory	David M. Burton	McGraw Hill Education (India) Private Ltd	7^{th}	
2.	Discrete Mathematics	Norman L. Biggs	Clarendon Press, Oxford	Revised	1989
3.	Introduction to the theory of numbers	I. Niven and S. Zuckerman	Wiley Eastern, New Delhi	3^{rd}	1972
4.	A Survey of Modern Algebra	G. Birkoff and S. Maclane	Mac Millan, New York	3^{rd}	1965
5.	Basic Abstract Algebra	P. B. Bhattacharya S. K. Jain and S. R. Nagpaul	New Age International		1994

23BUMT1P02

CO1	Solve the problems based on fundamental concepts.	L3
CO2	Analyse problems and determine bounded sets, bounded sequences.	L3
CO3	Evaluate GCD, LCM, solution of congruence.	L3
CO4	Formulate and validate the result related to properties of integers/ real numbers.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	0	3	0
CO2	1	2	2	0	3	0
CO3	1	2	2	0	3	0
CO4	1	2	2	0	3	0

Course Code 23BUMT1P02	**Course Title Practical based on 23BUMT1T03 and 23BUMT1T04**	**Credits 2**	**No. of hours**
	Practical based on 23BUMT1T03		
Practical 1	Algebraic and order properties of real numbers		4
Practical 2	Inequalities and absolute value property		4
Practical 3	Hausdorff property and LUB axiom property		4
Practical 4	Archimedean property		4
Practical 5	Convergence and divergence of sequences, bounded sequences, Sandwich Theorem.		4
Practical 6	Cauchy sequences, monotonic sequences, non-monotonic sequences.		4
Practical 7	Miscellaneous Theoretical Questions based on full paper I		4
	Practical based on 23BUMT1T04		
Practical 8	Division Algorithm, Euclidean algorithm		4
Practical 9	Primes and the Fundamental theorem of Arithmetic,		4
Practical 10	Functions, Bijective functions.		4
Practical 11	Invertible functions, Compositions of functions.		4
Practical 12	Binary Operation, Equivalence Relations.		4
Practical 13	Partition and Equivalence classes.		4

Practical 14	Miscellaneous Theoretical Questions based on full paper II	4
Practical 15	All multiple choice questions based on paper I and paper II	4
	Total	**60**

Generic Elective Course

23BUMT1T05

CO1	Recall the number system along with decimal fractions and their operations	L1
CO2	Apply the techniques learnt to solve problems based on basic mathematics such as HCF, LCM, average, surd, indices, square root and cube root	L3
CO3	Find logarithm, permutation, combinations and probability	L1
CO4	Find the profit and loss, simple and compound interest, speed, distance, time, work, ratio, proportion and area	L1

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	0	0	0
CO2	1	0	1	0	0	0
CO3	1	0	1	0	0	0
CO4	1	0	1	0	0	0

Course Code 23BUMT1T05	**Course Title Applied Mathematics I**	**Credits 2**	**No. of lectures 30**
Unit I:	Number System, LCM and HCF, Decimal fractions, Simplifications, square roots and cube roots, Average, problems on ages, Surds and Indices		**15**
Unit II:	Logarithm, Permutation and combinations, Probability, profit and loss, Simple and Compound interest, speed and distance, time and work, Ratio and proportion, Area		**15**

Books and References:

Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Quantitative Aptitude	Dr. R. S. Aggarwal	S. Chand Publishing	Revised Edition	2017
2.	Quantitative Aptitude	Shambhu Nath Jha	Ramesh Publishing House	13th	2020

Semester II

23BUMT2T01

CO1	Determine the limits and continuity of functions.	L2
CO2	Justify existence of limit, continuity of a function.	L2
CO3	Solve the problems on Differentiability of a function.	L3
CO4	Evaluate the derivatives and obtain maxima/minima of functions and other various applications.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT2T01	**Course Title Calculus II**	**Credits 2**	**No. of lectures 30**
Unit I :	**Limits and Continuity** Graphs of functions Definitions of limit of a function, uniqueness of limit if it exists, Algebra of limits, limits of composite functions, Sandwich theorem, left hand limit, right hand limit, non- existence of limit Limit at infinity, infinite limit Continuous functions: Continuity of a real valued function at a point and on a set. Sequential continuity, Algebra of continuous functions, discontinuous functions, examples of removable and essential discontinuity. Intermediate Value theorem and its applications, Bolzano-Weierstrass theorem (statement only): A continuous function on a closed and bounded interval is bounded and attains its bounds.		**15**
Unit II:	**Differentiability of functions** Differentiation of real valued function of one variable: Definition of differentiability of a function at a point of an open interval, examples of differentiable and non-differentiable functions, differentiable functions are continuous but not conversely,		**15**

	algebra of differentiable functions. Chain rule, Higher order derivatives, Leibniz rule, Derivative of inverse functions, Implicit differentiation (only examples)	

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2	Calculus	James Stewart	Brooks/Cole Publishing company		1994
3	Calculus, Vol I	T.M.Apostol	Wiley And Sons (Asia) Pvt. Ltd.		
4	A course in Calculus and Real Analysis	Sudhir Ghorpade and Balmohan Limaye	Springer International Ltd.		2000

23BUMT2T02

CO1	Explain various counting techniques which are used to handle problems on finite set and apply them in day-to-day life.	L2
CO2	Interpret the concept of addition and multiplication principles.	L2
CO3	Evaluate the number of partitions using Sterling numbers.	L2
CO4	Design problem based on principle of inclusion and exclusion.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT2T02	Course Title Combinatorics I	Credits 2	No. of lectures 30
Unit I :	**Preliminary Counting** Finite and infinite sets, countable and uncountable sets examples such as N, Z, N × N, Q (0, 1), R. Addition and multiplication Principle, counting sets of pairs, two ways counting. Stirling numbers of second kind. Simple recursion formulae satisfied by S(n, k) for k =1, 2, · · · , n − 1, n. Pigeonhole principle simple form(only statement).		**15**
Unit II :	**Advanced Counting** Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following with emphasis on combinatorial proofs. • $\sum_{k=0}^{r}\binom{m}{k}\binom{n}{r-k}=\binom{m+n}{r}$ • $\sum_{i=0}^{k}\binom{k}{i}^2=\binom{2k}{k}$ • $\sum_{i=r}^{n}\binom{i}{r}=\binom{n+1}{r+1}$ • $\sum_{i=0}^{n}\binom{n}{i}=2^n$ Non-negative integer solutions of equation $x_1 + x_2 + \cdots + x_k = n$. Principal of inclusion and exclusion, its applications, derangements, explicit formula ford, deriving formula for Euler's function φ(n).		**15**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Discrete Mathematics	Norman Biggs	Oxford University Press		
2.	Introductory Combinatorics	Richard Brualdi	John Wiley and sons		
3.	Combinatorics-Theory and Applications	V. Krishnamurthy	Affiliated East West Press.		
4.	Discrete Mathematics and its Applications	-	Tata McGraw Hills		
5.	Discrete mathematics	-	Schaum's outline series		

23BUMT2P01

CO1	Evaluate the limits and continuity of functions.	L3
CO2	Determine the differentiability of a function and its applications.	L3
CO3	Solve the problems on counting techniques and Sterling numbers.	L3
CO4	Construct examples related to principal of inclusion and exclusion, Euler's function.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	0	3	0
CO2	1	2	2	0	3	0
CO3	1	2	2	0	3	0
CO4	1	2	2	0	3	0

Course Code 23BUMT2P01	**Course Title Practical based on 23BUMT2T01 and 23BUMT2T02**	**Credits 2**	**No. of hours**
	Practical based on 23BUMT2T01		
Practical 1	Graphs of functions. Limit of a function.		4
Practical 2	Continuous and discontinuous function.		4
Practical 3	Algebra of limits and continuous functions		4
Practical 4	Properties of differentiable functions		4
Practical 5	Derivatives of inverse functions and implicit functions.		4
Practical 6	Higher order derivatives, Leibnitz Rule.		4
Practical 7	Miscellaneous Theoretical Questions based on full paper		4
	Practical based on 23BUMT2T02		
Practical 8	Finite, Infinite, Countable and Uncountable sets. Counting principles, Two way counting.		4
Practical 9	Stirling numbers of the second kind, Pigeon-hole principle.		4
Practical 10	Multinomial theorem, identities.		4
Practical 11	Permutation and combination of multi-set.		4
Practical 12	Inclusion – Exclusion principle		4
Practical 13	Euler phi function		4
Practical 14	Miscellaneous Theoretical Questions based on full paper		4
Practical 15	Multiple choice questions on entire syllabus		4
	Total		**60**

Skill Enhancement Course

23BU2SEC03

CO1	Recall and prove the basic results of Derivatives	L1
CO2	Apply the basic results of Derivatives	L3
CO3	Apply second derivative test and Taylor's theorem	L3
CO4	Construct graphs of functions	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	0	0	0
CO2	2	1	1	0	0	0
CO3	2	0	1	0	1	0
CO4	2	0	1	0	1	0

Course Code 23BU2SEC03	**Course Title Applications of Differentiability**	**Credits 2**	**No. of lectures 45**
Unit I:	**Applications of Differentiability** Rolle's Theorem, Lagrange's and Cauchy's Mean Value Theorems, applications and examples, Monotone increasing and decreasing functions, examples. L-Hospital rule (without proof), examples of indeterminate forms, Taylor's theorem with Lagrange's form of remainder with proof, Taylor polynomial and applications. Definition of critical point, local maximum/minimum, necessary condition, stationary points, second derivative test, examples, concave/convex functions, point of inflection. Sketching of graphs of functions using properties.		**15**
Practical 1	**Rolle's Theorem**		**2**
Practical 2	**Lagrange's Theorem**		**2**
Practical 3	**Cauchy's Mean Value Theorem**		**2**
Practical 4	**Monotonic Increasing Functions**		**2**
Practical 5	**Monotonic Decreasing Functions**		**2**
Practical 6	**L-Hospital's Rule**		**2**
Practical 7	**Taylor's Polynomial I**		**2**
Practical 8	**Taylor's Polynomial II**		**2**
Practical 9	**Critical Points**		**2**

Practical 10	**Local Maxima/ Minima**	**2**
Practical 11	**Global Maxima / Minima**	**2**
Practical 12	**Concave up/ Concave down**	**2**
Practical 13	**Graphs of functions I**	**2**
Practical 14	**Graphs of Functions II**	**2**
Practical 15	**Miscellaneous**	**2**
	Total	**45**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2.	Mathematical Analysis	K.G. Binmore	Cambridge University Press		1982
3.	Introduction to Real Analysis	R. G. Bartle and D. R. Sherbert	John Wiley & Sons		1994
4.	Elementary Number Theory	David M. Burton	McGraw Hill Education (India) Private Ltd	7th	
5.	Discrete Mathematics	Norman L. Biggs	Clarendon Press, Oxford	Revised	1989
6.	I. Niven and S. Zuckerman	Introduction to the theory of numbers	Wiley Eastern, New Delhi	3rd	1972

Minor Courses

23BUMT2T03

CO1	Determine the limits and continuity of functions.	L2
CO2	Justify existence of limit, continuity of a function.	L2
CO3	Solve the problems on Differentiability of a function.	L3
CO4	Evaluate the derivatives and obtain maxima/minima of functions and other various applications.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT2T03	Course Title Calculus II	Credits 2	No. of lectures 30
Unit I :	**Limits and Continuity** Graphs of functions Definitions of limit of a function, uniqueness of limit if it exists, Algebra of limits, limits of composite functions, Sandwich theorem, left hand limit, right hand limit, non- existence of limit Limit at infinity, infinite limit Continuous functions: Continuity of a real valued function at a point and on a set. Sequential continuity, Algebra of continuous functions, discontinuous functions, examples of removable and essential discontinuity. Intermediate Value theorem and its applications, Bolzano-Weierstrass theorem (statement only): A continuous function on a closed and bounded interval is bounded and attains its bounds.		**15**
Unit II:	**Differentiability of functions** Differentiation of real valued function of one variable: Definition of differentiability of a function at a point of an open interval, examples of differentiable and non-differentiable functions, differentiable functions are continuous but not conversely, algebra of differentiable functions. Chain rule, Higher order derivatives, Leibniz rule, Derivative of inverse functions, Implicit differentiation (only examples)		**15**

Books and references:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1	Methods of Real Analysis	R. R. Goldberg	Oxford and IBH		1964
2	Calculus	James Stewart	Brooks/Cole Publishing company		1994
3	Calculus, Vol I	T.M.Apostol	Wiley And Sons (Asia) Pvt. Ltd.		
4	A course in Calculus and Real Analysis	Sudhir Ghorpade and Balmohan Limaye	Springer International Ltd.		2000

23BUMT2T04

CO1	Explain various counting techniques which are used to handle problems on finite set and apply them in day-to-day life.	L2
CO2	Interpret the concept of addition and multiplication principles.	L2
CO3	Evaluate the number of partitions using Sterling numbers.	L2
CO4	Design problem based on principle of inclusion and exclusion.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	0	1	0
CO2	2	2	1	0	1	0
CO3	2	2	1	0	1	0
CO4	2	2	1	0	1	0

Course Code 23BUMT2T04	**Course Title Combinatorics I**	**Credits 2**	**No. of lectures 30**
Unit I :	**Preliminary Counting** Finite and infinite sets, countable and uncountable sets examples such as N, Z, N × N, Q (0, 1), R. Addition and multiplication Principle, counting sets of pairs, two ways counting. Stirling numbers of second kind. Simple recursion formulae satisfied by S(n, k) for k =1, 2, · · · , n − 1, n. Pigeonhole principle simple form(only statement).		**15**
Unit II :	**Advanced Counting** Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following with emphasis on combinatorial proofs. • $\sum_{k=0}^{r}\binom{m}{k}\binom{n}{r-k}=\binom{m+n}{r}$ • $\sum_{i=0}^{k}\binom{k}{i}^2=\binom{2k}{k}$ • $\sum_{i=r}^{n}\binom{i}{r}=\binom{n+1}{r+1}$ • $\sum_{i=0}^{n}\binom{n}{i}=2^n$ Non-negative integer solutions of equation $x_1 + x_2 + \cdots + x_k = n$. Principal of inclusion and exclusion, its applications, derangements, explicit formula for d_n, deriving formula for Euler's function φ(n).		**15**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Discrete Mathematics	Norman Biggs	Oxford University Press		
2.	Introductory Combinatorics	Richard Brualdi	John Wiley and sons		
3.	Combinatorics-Theory and Applications	V. Krishnamurthy	Affiliated East West Press.		
4.	Discrete Mathematics and its Applications	-	Tata McGraw Hills		
5.	Discrete mathematics	-	Schaum's outline series		

23BUMT2P02

CO1	Evaluate the limits and continuity of functions.	L3
CO2	Determine the differentiability of a function and its applications.	L3
CO3	Solve the problems on counting techniques and Sterling numbers.	L3
CO4	Construct examples related to principal of inclusion and exclusion, Euler's function.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	0	3	0
CO2	1	2	2	0	3	0
CO3	1	2	2	0	3	0
CO4	1	2	2	0	3	0

Course Code 23BUMT2P02	**Course Title Practical based on 23BUMT2T03 and 23BUMT2T04**	**Credits 2**	**No. of hours**
	Practical based on 23BUMT2T03		
Practical 1	Graphs of functions. Limit of a function.		4
Practical 2	Continuous and discontinuous function.		4
Practical 3	Algebra of limits and continuous functions		4
Practical 4	Properties of differentiable functions		4
Practical 5	Derivatives of inverse functions and implicit functions.		4
Practical 6	Higher order derivatives, Leibnitz Rule.		4
Practical 7	Miscellaneous Theoretical Questions based on full paper		4

	Practical based on 23BUMT2T04	
Practical 8	Finite, Infinite, Countable and Uncountable sets. Counting principles, Two way counting.	4
Practical 9	Stirling numbers of the second kind, Pigeon-hole principle.	4
Practical 10	Multinomial theorem, identities.	4
Practical 11	Permutation and combination of multi-set.	4
Practical 12	Inclusion – Exclusion principle	4
Practical 13	Euler phi function	4
Practical 14	Miscellaneous Theoretical Questions based on full paper	4
Practical 15	Multiple choice questions on entire syllabus	4
	Total	**60**

Generic Elective Course

23BUMT2T05

CO1	Interpret the various types of data representation	L2
CO2	Construct graphical representations for data	L3
CO3	Define basic concepts of Set theory, Matrices, Relations, Functions and Matrices	L1
CO4	Classify the types of functions, relations and matrices	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	0	0	0
CO2	1	1	1	0	0	0
CO3	1	0	1	0	0	0
CO4	1	0	1	0	0	0

Course Code 23BUMT2T05	**Course Title Applied Mathematics II**	**Credits 2**	**No. of lectures 30**
Unit I:	Data interpretation, Tables, Column Graphs, Bar Graphs, Line Chart, Pie Chart		**15**
Unit II:	Set theory, Matrices, Relations and functions, Equations and Matrices		**15**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Quantitative Aptitude	Dr. R. S. Aggarwal	S. Chand Publishing	Revised Edition	2017
2.	Quantitative Aptitude	Shambhu Nath Jha	Ramesh Publishing House	13th	2020

Curriculum mapping for the Undergraduate Degree Programme F.Y.B.Sc Mathematics

	SEMESTER – I	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUMT1T01	Calculus I							
23BUMT1T02	Discrete Mathematics							
23BUMT1P01	Practical based on 23BUMT1T01 and 23BUMT1T02			✓				
23BU1SEC03	Infinite series and Polynomials			✓				
Course Code	**Minor Course Title**							
23BUMT1T03	Calculus I							
23BUMT1T04	Discrete Mathematics							
23BUMT1P02	Practical based on 23BUMT1T03 and 23BUMT1T04			✓				
Course Code	**Generic - Course Title**							
23BUMT1T05	Applied Mathematics I	✓						
08	***Total***	**1**	**0**	**3**	**0**	**0**	**0**	**0**

	SEMESTER – II	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUMT2T01	Calculus II							
23BUMT2T02	Combinatorics I							
23BUMT2P01	Practical based on 23BUMT2T01 and 23BUMT2T02			✓				
23BU2SEC03	Applications of Differentiability			✓				
Course Code	**Minor Course Title**							
23BUMT2T03	Calculus II							
23BUMT2T04	Combinatorics I							
23BUMT2P02	Practical based on 23BUMT2T03 and 23BUMT2T04			✓				
Course Code	**Generic - Course Title**							
23BUMT2T05	Applied Mathematics II	✓						
08	***Total***	**1**	**0**	**3**	**0**	**0**	**0**	**0**