Academic Council Meeting No. and Date : 2 / April 30, 2021

Agenda Number : 4 **Resolution Number : 4.4 and 4.20**

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)]

Revised under Autonomy

From academic year 2021 - 2022

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Preamble

VPM'S B. N. Bandodkar College of Science Autonomous has changed the syllabus of F.Y.B.Sc. Mathematics from the academic year 2021-22.

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 along with the thorough knowledge of History of Mathematics. Course II, 'Algebra I and Discrete Mathematics' develops mathematical reasoning and logical thinking and has applications in science and technology.

Course Outcome

- Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling, solving and interpreting.
- Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
- Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.
- A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences

Program Specific Outcomes

- To understand the basic concepts and fundamental theories of Mathematics
- To develop problem solving and computing skills
- To learn the history of Mathematics and work of few eminent Indian Mathematicians
- To use mathematical concepts learnt for deducing proofs with logical reasoning
- To learn application of theory of Mathematics in related subjects like Physics, Statistics and Computer Science
- To develop analytical skills and understanding of abstract theories of Mathematics
- To learn various mathematical tools and techniques and apply them in real world

Eligibility :

Passed 12^{th} standard (HSC) of Maharashtra State Board / CBSE / ICSE board with Mathematics as one of the subject.

Duration : 3 years

Mode of Conduct :

Laboratory practicals / Offline lectures / Online lectures

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

F.Y.B.Sc. (MATHEMATICS)

Structure of Program

Course Code	Course Title	No. of lectures	Credits
	SEMESTER I		
BNBUSMT1T1	Calculus I	**45**	**2**
BNBUSMT1T2	Linear Algebra	**45**	**2**
BNBUSMT1P1	Practical based on BNBUSMT1T1 and BNBUSMT1T2	**60**	**2**

SEMESTER II			
BNBUSMT2T1	Calculus II	**45**	**2**
BNBUSMT2T2	Discrete Mathematics	**45**	**2**
BNBUSMT2P1	Practical based on BNBUSMT2T1 and BNBUSMT2T2	**60**	**2**

Semester I

Course Code	Course Title	Credits	No. of lectures
BNBUSMT1T1	**Calculus I**	2	45

Course Outcomes: Upon completion of this course, students will learn about

- Historical concepts of Mathematics
- Mathematical aspects of Real Number system
- Sequences of real numbers

Unit I :	**History of Mathematics** Development of number system and numerals in India and across the world. Contribution of Indian Mathematicians like Bhaskaracharya, Madhava and Ramanujan in Mathematics Historical development of Calculus and Algebra	**15**
Unit II :	**Real Number System** Real number system R and order properties of R, absolute value | | and its properties. AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods, Hausdorff property. Bounded sets, statements of L.u.b. axiom and its consequences, supremum and infimum, maximum and minimum, Archimedean property and its applications, density of rationals.	**15**
Unit III :	**Sequences In R** Definition of a sequence in Rand examples, Convergence of sequences, every convergent sequence is bounded. Limit of a convergent sequence and uniqueness of limit, divergent sequences. Convergence of standard sequences Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem and consequences as convergence of 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 a Cauchy sequence and converse.	**15**

Course Code	Course Title	Credits	No. of lectures
BNBUSMT1T2	**Linear Algebra**	2	45

Course Outcomes: Upon completion of this course, students will learn about

- Divisibility of integers.
- Properties of equivalence relations and partitions.
- Roots of polynomials.

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**
Unit III :	**Polynomials.** Definition of polynomial, polynomials over F where F = Q, R, 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 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 where p is a prime number, nth roots of unity, sum of nth roots of unity.	**15**

Course Code BNBUSMT1P1	Course Title **Practical based on BNBUSMT1T1, BNBUSMT1T2**	Credits 2	No. of lectures
	Practical based on BNBUSMT1T1		
Practical 1	Algebraic and order properties of real numbers		**3**
Practical 2	Inequalities and absolute value property		**3**
Practical 3	Hausdorff property and LUB axiom property		**3**
Practical 4	Archiemdean property		**3**
Practical 5	Convergence and divergence of sequences, bounded sequences, Sandwich Theorem.		**3**
Practical 6	Cauchy sequences, monotonic sequences, non-monotonic sequences.		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper		**3**
	Practical based on BNBUSMT102		
Practical 1	Division Algorithm, Euclidean algorithm		**3**
Practical 2	Primes and the Fundamental theorem of Arithmetic,		**3**
Practical 3	Functions, Bijective and Invertible functions, Compositions of functions.		**3**
Practical 4	Binary Operation, Equivalence Relations, Partition and Equivalence classes.		**3**
Practical 5	Polynomial (I)		**3**
Practical 6	Polynomial (II)		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper		**3**
	Total		

References

Course Code	Course Title
BNBUSMT1T1	Calculus I

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
5.	The History of Mathematics	Roger L Cooke	John Wiley & Sons	---	2013
6.	The History of Mathematics, An Introduction	David M Burton	McGraw Hill	---	2011

Course Code	Course Title
BNBUSMT1T2	Linear Algebra

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Elementary Number Theory	David M. Burton	McGraw Hill Education (India) Private Ltd	7th	---
2.	Discrete Mathematics	Norman L. Biggs	Clarendon Press, Oxford	Revised	1989
3.	I. Niven and S. Zuckerman	Introduction to the theory of numbers	Wiley Eastern, New Delhi	3rd	1972
4.	G. Birkoff and S. Maclane	A Survey of Modern Algebra	Mac Millan, New York	3rd	1965
5.	N. S. Gopalkrishnan	University Algebra	New Age International Ltd	Reprint	2013
6.	I .N. Herstein	Topics in Algebra	John Wiley	---	2006
7.	P. B. Bhattacharya S. K. Jain and S. R. Nagpaul	Basic Abstract Algebra	New Age International	---	1994
8.	Kenneth Rosen	Discrete Mathematics and its applications	Mc-Graw Hill International Edition, Mathematics Series.	---	---

Semester II

Course Code	Course Title	Credits	No. of lectures
BNBUSMT2T1	CALCULUS II	2	45

Learning Outcomes: Students would gain enough knowledge of

- ❖ Definition of Limits of functions
- ❖ Definition of Continuity of functions and its applications
- ❖ Derivative and its applications

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 :	**Differentiabilty 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**
Unit III :	**Applications of Differentiabilty** 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**

Course Code	Course Title	Credits	No. of lectures
BNBUSMT2T2	**Discrete Mathematics**	**2**	**45**

Learning Outcomes: Students would gain enough knowledge

- ❖ Counting principles
- ❖ Permutation and Combination
- ❖ Recurrence relation

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**
Unit III :	**Permutations and Recurrence relation.** Permutation of objects, S_n, composition of permutations, results such as every permutation is a product of disjoint cycles, every cycle is a product of transpositions, signature of a permutation, even and odd permutations, cardinality of S_n, A_n. Recurrence Relations, definition of homogeneous, non-homogeneous, linear, non-linear recurrence relation, obtaining recurrence relations of Tower of Hanoi, Fibonacci sequence, etc. 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.	**15**

Course Code BNBUSMT2P1	Course Title **Practical based on BNBUSMT2T1, BNBUSMT2T2**	Credits 2	No. of lectures
	Practical based on BNBUSMT2T1		
Practical 1	Limit of a function and Sandwich theorem, Continuous and discontinuous function.		**3**
Practical 2	Algebra of limits and continuous functions, Intermediate Value theorem		**3**
Practical 3	Properties of differentiable functions, derivatives of inverse functions and implicit functions.		**3**
Practical 4	Higher order derivatives, Leibnitz Rule.		**3**
Practical 5	Mean value theorems and its applications, L'Hospital's Rule, Increasing and Decreasing functions.		**3**
Practical 6	Extreme values, Taylor's Theorem and Curve Sketching.		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper.		**3**
	Practical based on BNBUSMT2T2		
Practical 1	Finite, Infinite, Countable and Uncountable sets. Counting principles, Two way counting.		**3**
Practical 2	Stirling numbers of second kind, Pigeon hole principle.		**3**
Practical 3	Multinomial theorem, identities, permutation and combination of multi-set.		**3**
Practical 4	Inclusion-Exclusion principle. Euler phi function.		**3**
Practical 5	Composition of permutations, signature of permutation, inverse of permutation		**3**
Practical 6	Recurrence relation.		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper		**3**
	Total		

References

Course Code	Course Title
BNBUSMT2T1	CALCULUS II

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

Course Code	Course Title
BNBUSMT2T2	Discrete Mathematics

Books and References:

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

Evaluation Scheme

Internals

Class Test	Assignment	Active Participation & Leadership qualities	Total
20	10	10	40
Certification of Swayam / NPTEL in concern course			

Internal Examination: **Based on Unit 1 / Unit 2 / Unit 3**

Duration: 1 Hour **Total Marks: 20**

	Answer the following	20
Q. 1		
Q. 2		
Q. 3		
Q. 4		
Q. 5		

Theory Examination: **Suggested Format of Question paper**

Duration: 2 Hours **Total Marks: 60**

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following		**16**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**16**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**16**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
Q. 4	Answer ***any two*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit II	
	c	Based on Unit III	

** (4 questions of 8 marks each / 8 questions of 4 marks can be asked with 50% options)

Marks Distribution and Passing Criterion for Each Semester

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT1T1	**40**	**16**	**60**	24	BNBUSMT1P1	**100**	**40**
BNBUSMT1T2	**40**	**16**	**60**	24			

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT2T1	**40**	**16**	**60**	24	BNBUSMT2P1	**100**	**40**
BNBUSMT2T2	**40**	**16**	**60**	24			

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