The Kelkar Education Trust's
Vinayak Ganesh Vaze College of Arts, Science & Commerce
(Autonomous)
Mithaghar Road, Mulund East, Mumbai-400081, India
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Syllabus for B. Sc. First Year Programme

Mathematics

Syllabus as per Choice Based Credit System (NEP-2020)

(July 2023 Onwards)

Board of Studies in Mathematics

V.G Vaze College of Arts, Science and Commerce (Autonomous)

Submitted by

Department of Mathematics
Vinayak Ganesh Vaze College of Arts, Science and Commerce (Autonomous)
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The Kelkar Education Trust's

Vinayak Ganesh Vaze College of Arts, Science & Commerce

(Autonomous)

❖ **Syllabus as per Choice Based Credit System (NEP 2020)**

Syllabus for Approval

Subject: Mathematics

Sr. No.	Heading	Particulars
1	Title of Programme	**First Year B. Sc. Mathematics: Semester I and II**
2	Eligibility for Admission	HSC PASS
3	Passing marks	More than 35% in HSC board exam
4	Ordinances/Regulations (if any)	---
5	No. of Years/Semesters	One year/Two semester
6	Level	U.G. Part-III : Level - 4.5
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic year	2023-2024

Date: ……. **Signature:**

BOS Chairperson: …….

First Year B. Sc. Program in Mathematics (Level 4.5)

Semester	Core Course & Credits		NSQF Course & Credits	
Sem - I	**MAJOR**	No. of Lectures	**VSC/SEC**	No. of Lectures
	Mandatory* Credits 4		**VSC Credits 2**	
	Course 1 Cr. 2: Algebra-I	2L	Course 1 Cr. 2: Calculus-I	2L
	Course 2 Cr. 2: Practical based on course 1	(2P)4L	Course 2 Cr. 2: Practical based on course 1	(2P)4L
	MINOR Credits 4 (2+2)		AEC,VEC,IKS	
	Course 1 Cr. 2: Algebra-I	2L	AEC - 2 Credit	**2L**
	Course 2 Cr. 2: Practical based on Algebra-I	(2P)4L	VEC-2 Credit	**2L**
			IKS - 2 Credit	**2L**
Sem - II	**MAJOR**		**VSC/SEC**	
	Mandatory* Credits 4		**VSC Credits 2**	
	Course 1 Cr. 2: Algebra-I	2L	Course 1 Cr. 2: Calculus-I	2L
	Course 2 Cr. 2: Practical based on course 1	(2P)4L	Course 2 Cr. 2: Practical based on course 1	(2P)4L
	MINOR Credits 4 (2+2)		AEC,VEC,IKS	
	Course 1 Cr. 2: Algebra-I	2L	AEC - 2 Credit	**2L**
	Course 2 Cr. 2: Practical based on Algebra-I	(2P)4L	VEC-2 Credit	**2L**
			OJT/FP/CEP/CC/RP	
			CC Credits 4	
			Course 1 Cr. 2: Practical	2L
			OJT/FP/CEP/CC/RP	
Total Cumulative credits = **06 + 06 + 06 + 06 + 06 + 04 + 02 = 36 Credits**				
Exit option: *Award of UG Degree in Major and Minor with 132 credits OR continue with Major & Minor*				

B. Sc. Program in Mathematics: Cumulative Credit Structure

Level	Sem.	MAJOR Mandatory*	MINOR	VSC	AEC/VEC/IKS/CC	Cum. Credits	Degree
5.5	**Sem-I**	For Mathematics **Credits 4 (2+2)** Course 1 Cr. 2: Algebra I Course 2 Cr. 2: practical (based on Algebra I)	**Credits 4 (2+2)** Course 1 Cr. 2: Algebra I Course 2 Cr. 2: practical (based on Algebra I)	**Credits 4 (2+2)** Course 1 Cr. 2: Calculus 1 & Course 2 Cr. 2: Practical (Based on Calculus I)	**Credits 6** Course 1 Cr. 2: AEC Course 1 Cr. 2: VEC Course 1 Cr. 2: IKS	**18**	**UG Degree** After 3-Yr UG
	Sem-II	For Mathematics					
		Credits 4 (2+2) Course 1 Cr. 2: Algebra II Course 2 Cr. 2: practical (based on Algebra II)	**Credits 4 (2+2)** Course 1 Cr. 2: Algebra II Course 2 Cr. 2: practical (based on Algebra II)	**Credits 4 (2+2)** Course 1 Cr. 2: Calculus II & Course 2 Cr. 2: Practical (Based on Calculus II)	**Credits 6** Course 1 Cr. 2: AEC Course 1 Cr. 2: VEC Course 1 Cr. 2: CC	**18**	
Total Credits		**08**	**08**	**08**	**12**	**36**	

Programme Educational Objectives

PEO1	Mathematical Foundation – Develop strong problem-solving and analytical skills in core mathematical concepts.
PEO2	Real-World Application – Apply mathematical methods in science, engineering, and other fields.
PEO3	Critical Thinking – Enhance logical reasoning and problem-solving abilities.
PEO4	Technology Integration – Utilize modern mathematical software and computational tools.
PEO5	Communication & Teamwork – Effectively communicate mathematical ideas and collaborate in teams.
PEO6	Lifelong Learning – Engage in continuous learning and research in mathematics.
PEO7	Ethical Responsibility – Apply mathematics responsibly in professional and societal contexts.

Programme Outcomes

Upon successful completion of the B.Sc. (Mathematics) course from Vaze College affiliated to Mumbai University, graduates can expect the following outcomes:

PO1	Mathematical Knowledge – Demonstrate a strong understanding of fundamental mathematical concepts and theories.
PO2	Problem-Solving Skills – Apply mathematical techniques to solve real-world problems efficiently.
PO3	Logical and Analytical Thinking – Develop critical thinking, reasoning, and analytical abilities.
PO4	Computational Proficiency – Use mathematical software, programming, and computational tools effectively.
PO5	Data Analysis and Modeling – Interpret and analyze data using mathematical and statistical methods.
PO6	Effective Communication – Convey mathematical ideas clearly through written and verbal communication.
PO7	Interdisciplinary Approach – Apply mathematical knowledge across various fields like physics, economics, and computer science.

Programme Specific Outcomes

PSO1	**Core Mathematical Proficiency** – Demonstrate expertise in algebra, calculus, differential equations, and other fundamental areas of mathematics.
PSO2	Computational and Analytical Skills – Apply mathematical and computational techniques to solve theoretical and practical problems.
PSO3	Mathematical Modeling – Develop and analyze mathematical models for real-world applications in science, engineering, and economics.
PSO4	**Data Interpretation and Statistics** – Use statistical and probabilistic methods to analyze and interpret data effectively.
PSO5	Software and Programming Proficiency – Utilize mathematical software (such as MATLAB, Maxima, or Python) for problem-solving and research.
PSO6	**Research and Higher Studies Readiness** – Build a strong foundation for advanced studies and research in mathematics and related fields.

The Detailed Semester and Course Wise Syllabus as follows:

The total minimum credits required for completing the B.Sc. in Mathematics is **132**

SEMESTER - I					
Code	**Course of Study – Major**	**L**	**T**	**P**	**Cr.**
VSMA100	Course 1 Cr. 2: Algebra I	2	-	4	4
	VSC **Credits 2**		-		
VSMA102	Course 3 Cr. 2: Calculus I	2	-	4	4
	MINOR **Credits 4 (2+2)**		-		
VSMA104	Course 2 Cr. 2: Algebra I	2	-	4	4
Total		6	-	12	**12**

***** **Note:** Students are allowed to select one elective out of two electives given in curriculum

SEMESTER - II					
Code	**Course of Study – Major**	**L**	**T**	**P**	**Cr.**
VSMA150	Course 1 Cr. 2: Algebra II	2	-	4	4
	VSC **Credits 2**		-		
VSMA152	Course 3 Cr. 2: Calculus II	2	-	4	4
	MINOR **Credits 4 (2+2)**		-		
VSMA154	Course 2 Cr. 2: Algebra II	2	-	4	4
Total		6	-	12	**12**

***** **Note:** Students are allowed to select one elective out of two electives given in curriculum

Proposed Draft Syllabus for TY. B. Sc. Mathematics Semester I and II

(Mathematics Specialization)

Choice Based Credit System (NEP 2020)

(To be implemented from the academic year, 2023-2024)

Semester – I

Paper I

Course Code: VSMA100

Credits: 2

FYBSC MAJOR (ALGEBRA I)

Course Learning Objectives

Upon completion of the course the student will be able to understand

1.	To learn how to solve system of homogeneous and non-homogeneous equations with different methods.
2.	To learn the concept of eigenvalues and eigenvectors and their importance in linear algebra.
3.	To explore applications of eigen values in various fields such as physics, engineering and data analysis.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Develop the ability to solve systems of linear equations using various methods.
CO2	Differentiate between the types of matrices.
CO3	Solve the problems of finding inverse of matrix using Cayley's Hamilton theorem.

COURSE CONTENT

Unit	Contents	No. of lectures
I	**Unit – I (Matrices)**	
	Definition of a Matrix, types of matrices, transpose of matrix and its properties, Orthogonal matrix (Definition), properties of orthogonal matrix, its determinant. Determinant and its properties, row echelon form of a matrix, elementary row operations, elementary matrices, rank of a matrix, System of linear equations in matrix form, System of m homogeneous linear equations in n unknowns has a non-trivial solution if $m < n$.	**10**
II	**Unit-II (Eigen Values and Eigen Vectors)**	
	Characteristic polynomial, characteristics equation, minimal polynomial. standard formula to calculate characteristic polynomial of 2x2 and 3x3 matrices. characteristic and minimal polynomial of orthogonal matrix. Definition of eigen value, examples, Theorems on properties of eigen value. Algebraic multiplicity and	**10**

	Geometric multiplicity, Eigen vector, examples (for distinct roots and for repeated roots)	
III	**Unit -III (Application of eigen values and eigen vector)**	
	Cayley Hamilton theorem, application of Cayley Hamilton theorem to find inverse of a matrix. Diagonalization of matrices, Derogatory Matrix, Finding n^{th} power of a matrix.	**10**

List of suggested Practicals:

F. Y.B.SC (Major)		
Title of the course and course code :VSMA101	**ALGEBRA-I (PRACTICAL)**	**No. of Credits : 02**
Practical /Lab work to be performed in Computer Lab **List of Practicals to be done using SageMath/Scilab/Maxima/Python:**		
Sr. No	**Topics**	
1	Identification of types of Matrices	
2	Compute transpose, determinant and rank of a matrix	
3	Orthogonal matrix and its characteristic polynomial	
4	Elementary Matrices and row echelon form	
5	Solving System of linear equations using rank of matrix	
6	Eigen values for higher order matrix	
7	Minimal polynomial of a various types of matrices	
8	Computation of eigen values using formula	
9	Eigen vector (for both repeated and non-repeated roots)	
10	Problems on properties of eigen values	
11	Finding inverse of matrix	
12	Finding inverse of matrix using Cayley Hamilton Theorem	
13	Problems on Diagonalization of matrices	
14	Computation of derogatory matrix	
15	Computation of nth power of a matrix	

Reference Books:

1. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi,2000.
2. A Text Book of Matrices, by Shanti Narayan, S. Chand Limited, 2010.
3. Schaum's Outline of Theory and Problems of MATRICES, by Richord Bronson, McGraw- Hill, New York, 1989.
4. "Linear Algebra" by J.N. Sharma
5. "Matrix Algebra" by Abhay Bhattacharya and S.K. Jain

Paper I
Course Code:VSMA104
Credits: 2

FYBSC MINOR (ALGEBRA I)

Course Learning Objectives

Upon completion of the course the student will be able to understand

4.	To learn how to solve system of homogeneous and non-homogeneous equations with different methods.
5.	To learn the concept of eigenvalues and eigenvectors and their importance in linear algebra.
6.	To explore applications of eigen values in various fields such as physics, engineering and data analysis.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Develop the ability to solve systems of linear equations using various methods.
CO2	Differentiate between the types of matrices.
CO3	Solve the problems of finding inverse of matrix using Cayley's Hamilton theorem.

COURSE CONTENT

Unit	Contents	No. of lectures
I	**Unit – I (Matrices)**	
	Definition of a Matrix, types of matrices, transpose of matrix and its properties, Orthogonal matrix (Definition), properties of orthogonal matrix, its determinant. Determinant and its properties, row echelon form of a matrix, elementary row operations, elementary matrices, rank of a matrix, System of linear equations in matrix form, System of m homogeneous linear equations in n unknowns has a non-trivial solution if $m < n$.	**10**
II	**Unit-II (Eigen Values and Eigen Vectors)**	
	Characteristic polynomial, characteristics equation, minimal polynomial. standard formula to calculate characteristic polynomial of 2x2 and 3x3 matrices. characteristic and minimal polynomial of orthogonal matrix. Definition of eigen value, examples, Theorems on properties of eigen value. Algebraic multiplicity and Geometric multiplicity, Eigen vector, examples (for distinct roots and for repeated roots)	**10**
III	**Unit -III (Application of eigen values and eigen vector)**	
	Cayley Hamilton theorem, application of Cayley Hamilton theorem to find inverse of a matrix. Diagonalization of matrices, Derogatory Matrix, Finding n^{th} power of a matrix.	**10**

List of suggested Practicals:

F. Y.B.SC (Minor)		
Title of the course and course code: VSMA105	**ALGEBRA-I (PRACTICAL)**	**No. of Credits : 02**
Practical /Lab work to be performed in Computer Lab **List of Practicals to be done using SageMath/Scilab/Maxima/Python:**		
Sr.No	**Topics**	
1	Identification of types of Matrices	
2	Compute transpose, determinant and rank of a matrix	
3	Orthogonal matrix and its characteristic polynomial	
4	Elementary Matrices and row echelon form	
5	Solving System of linear equations using rank of matrix	
6	Eigen values for higher order matrix	
7	Minimal polynomial of a various types of matrices	
8	Computation of eigen values using formula	
9	Eigen vector (for both repeated and non-repeated roots)	
10	Problems on properties of eigen values	
11	Finding inverse of matrix	
12	Finding inverse of matrix using Cayley Hamilton Theorem	
13	Problems on Diagonalization of matrices	
14	Computation of derogatory matrix	
15	Computation of nth power of a matrix	

Reference Books:

6. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi,2000.
7. A Text Book of Matrices, by Shanti Narayan, S. Chand Limited, 2010.
8. Schaum's Outline of Theory and Problems of MATRICES, by Richord Bronson, McGraw- Hill, New York, 1989.
9. "Linear Algebra" by J.N. Sharma
10. "Matrix Algebra" by Abhay Bhattacharya and S.K. Jain

Paper II
Course Code: VSMA102
Credits: 2

CALCULUS I

Course Learning Objectives

Upon completion of the course the student will be able to understand

1.	Understand the relationships between natural numbers, integers, rational numbers, and irrational numbers as subsets of the real numbers.
2.	Understand the domain and range of a sequence.
3.	Classify a sequence as finite or infinite.
4.	To understand the behavior of a function as its independent variable approaches a specific value.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.
CO2	Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
CO3	Calculate the limit and examine the continuity of a function at a point & Sketch curves in Cartesian and polar coordinate systems.

COURSE CONTENT

Unit	**Contents**	No. of lectures
I	**Real Number System**	**I**
	Real number system R and order properties of R, Absolute value and its properties, AM-GM inequality, Cauchy Schwarz inequality, Intervals and neighbourhoods, Hausdroff property, Bounded sets, supremum, infimum and their properties, statement of L.U.B. axiom, Archimedean property and its applications, Density of rationals in R, Existence of nth root of positive real numbers.	**10**
II	**Sequences**	
	Definition of a sequence and examples, convergence and divergence of sequences, Boundedness of convergent sequence, Uniqueness of limit of a convergent sequence, Algebra of convergent sequences, Sandwich theorem, Monotone sequences, monotone convergence theorems and consequences. Subsequence, Cauchy sequence and examples. Every convergent sequence is a Cauchy sequence. Boundedness of a Cauchy sequence. Cauchy Completeness property.	**10**
III	**Limits and Continuity**	

	Graphs of some standard functions such as $\|x\|, e^x, sinx, cosx, tanx, lnx, \frac{1}{x}$ over suitable intervals of R. limit of a function, $(\varepsilon - \delta)$ definition of limit of a function, Evaluation of limit of simple functions using $(\varepsilon - \delta)$ definition, uniqueness of limit when it exists, Algebra of limits, Sandwich theorem for limits, one sided limit, non-existence of limits, limit at infinity and infinite limits. Continuous functions: 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.	**10**

List of suggested Practicals:

F.Y.B.SC(Vocational Skill Course(VSC)		
Title of the course and course code	**CALCULUS-I (PRACTICAL) VSMA103**	**No.of credits:02**
Practical /lab work to be performed in computer lab. **List of practicals to be done using SageMath/Scilab/Maxima/Python.**		
1	Order properties, absolute value	
2	AM-GM inequality	
3	Hausdorff property.	
4	Bounded sets	
5	Supremum and Infimum	
6	Archimedian property	
7	Convergent sequences .	
8	Divergent sequences .	
9	Sandwich theorem.	
10	Monotone sequences	
11	Cauchy sequences	
12	Subsequences	
13	Drawing graphs of functions.	
14	Limits and Continuity of functions.	
15	Non-existence of limits.	

Reference Books:

1. Robert G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, third edition, John Wiley & Sons, Inc.
2. R. R. Goldberg, Methods of real analysis, Indian Edition, Oxford and IBH publishing, New Delhi.
3. Tom M. Apostol, Calculus Vol.1, Second edition, John Wiley & Sons.
4. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press.

Semester – II

Paper I

Course Code: VSMA150

Credits: 2

F.Y.B.Sc (Major) ALGEBRA II

Course Learning Objectives

Upon completion of the course the student will be able to understand

1.	To learn the number theoretic functions and their application in various contexts such as cryptography.
2.	Learn techniques of complex analysis that make practical problems easy (e.g. graphical rotation and scaling as an example of complex multiplication).
3.	To study functions to learn how to study graphs and analyze their properties such as intercepts and symmetry.
4.	To Understand polynomial in finding roots, solving equations, and simplifying complex expressions.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Apply relations and functions in business.
CO2	Provide a framework for analyzing number sequences, patterns other number sequences using concepts like divisibility and congruences.
CO3	Differentiate between the types of functions & Learn the algebraic properties of polynomial.

COURSE CONTENT

Unit	**Contents**	No. of lectures
I	**Number theoretic functions and Divisibility of integers**	
	Number theoretic functions: Euler's ϕ function, statements of Euler's theorem, tau function, sigma function. 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 & b and that the g.c.d. can be expressed as $ma + nb$ for some $m, n \in \mathbb{Z}$, Euclidean algorithm. Euclid's lemma, Primes, Fundamental theorem of arithmetic, the set of primes is infinite. Congruences, Fermat's theorem, Gauss theorem and Wilson's theorem and their applications.	**10**
II	**Equivalence Relations and Functions**	
	Binary operation, 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	**10**

	and vice versa.Definition of a function, domain, co-domain and range of a function, composite functions, examples, injective, surjective, bijective functions, Composite of injective, surjective, bijective functions when defined, invertible functions, bijective functions are invertible and conversely. Types of functions such as constant, identity, projection, inclusion.	
III	**Polynomials**	
	Definition of polynomials over $\mathbb{Z}$, $\mathbb{Q}$, $\mathbb{R}$ *or* $\mathbb{C}$, Algebra of polynomials, degree of polynomial, basic properties. Division algorithm in F[x], g.c.d. of two polynomials and its basic properties, Euclidean algorithm, applications, Roots of a polynomial, relation between roots and coefficients, multiplicity of a root, Remainder theorem, Factor theorem.	**10**

List of suggested practicals:

F.Y.B.SC (Major)		
Title of the course and course code:VSMA151	**ALGEBRA-II (PRACTICAL)**	**No. of Credits : 02**
Practical /Lab work to be performed in Computer Lab **List of Practicals to be done using SageMath/Scilab/Maxima/Python:**		
Sr.No	**Topics**	
1	Finding divisors and number of divisors using tau and sigma function.	
2	Finding GCD of two integers	
3	Problems on Fermat's theorem and Gauss theorem	
4	Problems on Wilson theorem	
5	Finding last digit and remainder using Fermat's and Wilson theorem.	
6	Problems on binary operation and its property	
7	Equivalence relation and partition	
8	Identification of types of functions	
9	Problems on injection, surjection and bijection of function	
10	Composition of function	
11	Algebra of polynomials	
12	Computation of GCD of polynomials.	
13	Relation between roots and coefficients	
14	Problems on Remainder theorem	
15	Problems on Factor theorem	

Reference Books:

1. Robert G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, third edition, John Wiley & Sons, Inc.
2. R. R. Goldberg, Methods of real analysis, Indian Edition, Oxford and IBH publishing, New Delhi.
3. Tom M. Apostol, Calculus Vol.1, Second edition, John Wiley & Sons
4. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press.

Paper I
Course Code:VSMA154
Credits: 2

F.Y.B.Sc (Minor) ALGEBRA II

Course Learning Objectives

Upon completion of the course the student will be able to understand

5.	To learn the number theoretic functions and their application in various contexts such as cryptography.
6.	Learn techniques of complex analysis that make practical problems easy (e.g. graphical rotation and scaling as an example of complex multiplication).
7.	To study functions to learn how to study graphs and analyze their properties such as intercepts and symmetry.
8.	To Understand polynomial in finding roots, solving equations, and simplifying complex expressions.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Apply relations and functions in business.
CO2	Provide a framework for analyzing number sequences, patterns other number sequences using concepts like divisibility and congruences.
CO3	Differentiate between the types of functions & Learn the algebraic properties of polynomial.

COURSE CONTENT

Unit	**Contents**	No. of lectures
I	**Number theoretic functions and Divisibility of integers**	
	Number theoretic functions: Euler's ϕ function, statements of Euler's theorem, tau function, sigma function. 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 & b and that the g.c.d. can be expressed as $ma + nb$ for some $m, n \in \mathbb{Z}$, Euclidean algorithm. Euclid's lemma, Primes, Fundamental theorem of arithmetic, the set of primes is infinite. Congruences, Fermat's theorem, Gauss theorem and Wilson's theorem and their applications.	**10**
II	**Equivalence Relations and Functions**	
	Binary operation, 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.Definition of a function, domain, co-domain and range of a	**10**

	function, composite functions, examples, injective, surjective, bijective functions, Composite of injective, surjective, bijective functions when defined, invertible functions, bijective functions are invertible and conversely. Types of functions such as constant, identity, projection, inclusion.	
III	**Polynomials**	
	Definition of polynomials over $\mathbb{Z}$, $\mathbb{Q}$, $\mathbb{R}$ *or* $\mathbb{C}$, Algebra of polynomials, degree of polynomial, basic properties. Division algorithm in F[x], g.c.d. of two polynomials and its basic properties, Euclidean algorithm, applications, Roots of a polynomial, relation between roots and coefficients, multiplicity of a root, Remainder theorem, Factor theorem.	**10**

List of suggested practicals:

F.Y.B.SC (Minor)		
Title of the course and course code :VSMA155	**ALGEBRA-II (PRACTICAL)**	**No. of Credits : 02**
Practical /Lab work to be performed in Computer Lab **List of Practicals to be done using SageMath/Scilab/Maxima/Python:**		
Sr.No	**Topics**	
1	Finding divisors and number of divisors using tau and sigma function.	
2	Finding GCD of two integers	
3	Problems on Fermat's theorem and Gauss theorem	
4	Problems on Wilson theorem	
5	Finding last digit and remainder using Fermat's and Wilson theorem.	
6	Problems on binary operation and its property	
7	Equivalence relation and partition	
8	Identification of types of functions	
9	Problems on injection, surjection and bijection of function	
10	Composition of function	
11	Algebra of polynomials	
12	Computation of GCD of polynomials.	
13	Relation between roots and coefficients	
14	Problems on Remainder theorem	
15	Problems on Factor theorem	

Reference Books:

5. Robert G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, third edition, John Wiley & Sons, Inc.
6. R. R. Goldberg, Methods of real analysis, Indian Edition, Oxford and IBH publishing, New Delhi.
7. Tom M. Apostol, Calculus Vol.1, Second edition, John Wiley & Sons
8. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press.

Paper II
Course Code: VSMA152
Credits: 2

CALCULUS II

Course Learning Objectives

Upon completion of the course the student will be able to understand

1.	Defining continuity on an interval.
2.	Understanding, and investigating uses of the Intermediate Value Theorem.
3.	Understanding the types of functions that are always continuous over their entire domain.
4.	The learning objectives of differentiability and its application include understanding the concepts like continuity at a point, continuity on an interval, derivative of functions and many more.
5.	Differentiability has many applications in real life. For example, it can be used to find the maximum or minimum value of a function. It can also be used to find the rate of change of a function.

Course Outcome

Upon completing the course, the student will be able to understand

CO1	Convergence and divergence of Series & Absolute and conditional convergence.
CO2	Continuity & Sequential continuity & Intermediate value theorem and Bolzano Weierstrass Theorem
CO3	Differentiability with geometrical and physical interpretation & Mean value theorem & its applications

COURSE CONTENT

Unit	**Contents**	No. of lectures
I	**Series**	
	Infinite series of real numbers, convergent series, divergent series. Necessary condition for convergence of series. Algebra of convergent series, harmonic series, p-harmonic series, Comparison test, Limit comparison test, ratio test (without proof), root test (without proof) and examples, alternating series,Leibnitz test for alternating series, absolute convergence, conditional convergence.	**10**
II	**Continuity and Its Applications**	
	Continuity of real valued functions with domain as intervals in R, examples, continuity of functions at end points of interval, Sequential continuity, Sign preserving property of continuous function. Intermediate value theorem and its applications. Bolzano Weierstrass Theorem	**10**

III	**Differentiability and Its Applications**	
	Notion of differentiability with geometrical and physical interpretation, non-differentiable functions, necessary condition for differentiability of real valued function, algebra of differentiable functions, derivative of inverse functions, chain rule. Higher order derivatives, Leibnitz rule, implicit differentiation, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, increasing and decreasing functions, extreme values, stationary points, first derivative test, second derivative test, point of inflection, convex and concave functions	**10**

List of Suggested Practicals

F.Y.B.SC [Vocational Skill Course(VSC)]		
Title of the course and course code	**CALCULUS-II (PRACTICAL) VSMA153**	**No.of credits:02**
Practical /lab work to be performed in computer lab. List of practicals to be done using SageMath/Scilab/Maxima/Python.		
1)Learning series of real numbers.		
2) Check behavior of series using sequence of partial sums.		
3) Some tests for convergence.		
4) Alternating series.		
5) Continuous functions ε -δ definition.		
6) Sequential continuity.		
7) Applications of continuous functions.		
8) Leibnitz theorem,		
9) Mean value theorems.		
10) Increasing and decreasing functions.		
11) Extreme values.		
11) Stationary points.		
13) point of inflection.		
14) Convex and Concave functions.		
15) Taylor's Theorem.		

Reference Books:

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2. R. R. Goldberg, Methods of real analysis, Indian Edition, Oxford and IBH publishing, New

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3. Tom M. Apostol, Calculus Vol.1, Second edition, John Wiley & Sons
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