M. C. E. Society's
Abeda Inamdar Senior College
Of Arts, Science and Commerce, Camp, Pune-1
(Autonomous) Affiliated to SavitribaiPhule Pune University
NAAC accredited 'A' Grade

Three Year B.Sc. Degree Program in Mathematics
(Faculty of Science & Technology)

Syllabus of

T.Y. B.Sc. Mathematics

Choice Based Credit System Syllabus
To be implemented from the academic year 2023-2024

Title of the Course: B. Sc (Mathematics)

Preamble:

Department of Mathematics, Abeda Inamdar Senior College has been implementing the first syllabus of B.Sc. under autonomy since June 2021. Taking into consideration the rapid changes in Science and Technology and new approaches in different areas of Mathematics and related subjects, the Board of studies in Mathematics has prepared the syllabus of B.Sc Semester-V and Semester-VI (w.e.f. 2023-24) Mathematics course under the Choice Based Credit System (CBCS).

The model curriculum developed by U.G.C. is used as a guideline for the present syllabus.

Aims:

Sr. No.	Aims
1.	Give the students a sufficient knowledge of fundamental principles, methods, and a clear perception of innumerous powers of mathematical ideas and tools and know-how to use them by modeling, solving, and interpreting.
2.	Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science and technology.
3.	Enhancing student's 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.
4.	Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

Objectives:

Sr. No.	Objectives
1.	A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations and terminology, recognize basic geometrical figures and graphical displays and state important facts resulting from their studies.
2.	A student should get a relational understanding of mathematical concepts and concerned structures and should be able to follow the patterns involved in mathematical reasoning.
3.	A student should get adequate exposure to global and local concerns that explore many aspects of Mathematical Sciences.
4.	A student should get adequate exposure to global and local concerns that explore many aspects of Mathematical Sciences.
5.	A student should be able to apply their skills and knowledge that is, translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques to process the information and draw the relevant conclusion.
6.	A student should be made aware of the history of mathematics and hence of its past, present, and future role as part of our culture.

Course Outcome:

Sr. No.	Outcome
1.	The mathematical maturity of students in their current and future courses shall develop.
2.	The student develops theoretical, applied, and computational skills.
3.	The student gains confidence in proving theorems and solving problems.

Evaluation Process:

Evaluation process for each paper of 2 credit comprises of Continuous Internal Evaluation (CIE) for 20 marks and End Semester Examination (ESE) for 30 marks.

For Continuous Internal Evaluation (CIE), evaluation will be done continuously. Internal assessment will be of **20** marks for a paper of 50 Marks. These 20 marks are divided as follows:

CIE for 2 Credits Theory Paper: It will be divided as follows:

Sr. No.	Components		Marks
1.	CIE I	There will be a compulsory Test on Demand MCQ Examination of **20** marks of each subject which would be converted into 5 Marks.	5
2.	CIE II	Two Class Tests 10 Marks Each. Converted to 5 Marks.	5
3.	CIE III	Mid Sem Exam of 20 Marks converted to 5 Marks.	5
4.	CIE IV	Participation in two activities at department/ college level 5 Marks	5
		In case of a student failing to score under the category, the attendance can be considered to give marks	
		Total	20

CIE for 2 Credits Practical Paper: It will be divided as follow:

Sr. No.	Components		Marks
1	CIE I	There will be a compulsory Mock Practical Examination, Viva Voce of subjects mentioned in for **20 Marks**.	20

Methods of Internal Assessment

Written exam	Quiz
Presentations	Projects
Assignments	Tutorials
Oral examination	Open Book Test and Others

Structure of the F.Y.B.Sc Mathematics Course:

	Semester-I		**Semester-II**		**Credits**
Paper-I	21SBMT111	Foundation of Mathematics	21SBMT121	Co-ordinate Geometry	2
Paper-II	21SBMT112	Calculus-I	21SBMT122	Calculus-II	2
Paper-III	21SBMT113	Operation Research and Software Maxima	21SBMT123	Abstract Algebra and Software Maxima	1.5

Structure of S. Y. B. Sc. Mathematics Course:

	Semester-III		**Semester-IV**		**Credit**
Paper-I	21SBMT231	Calculus of Several Variables	21SBMT241	Linear Algebra	2
Paper-II	21SBMT232A	Laplace Transform	21SBMT242A	Vector Calculus	2
	21SBMT232B	Computational Geometry	21SBMT242B	Combinatorics	2
Paper-III	21SBMT233	Numerical Analysis and Software Maxima	21SBMT243	Ordinary Differential Equation and Software Maxima	2

- All three courses above are compulsory.
- In semester-III, select any one from 21SBMT232A and 21SBMT232B.
- In semester-IV, select any one from 21SBMT242A and 21SBMT242B.

Structure of T. Y. B. Sc. Mathematics Course:

Semester-V		Semester-VI		Credit
21SBMT351	Metric Spaces	21SBMT361	Complex Analysis	2
21SBMT352	Real Analysis-I	21SBMT362	Real Analysis-II	2
21SBMT353	Group Theory	21SBMT363	Ring Theory	2
21SBMT354	Advanced Ordinary Differential Equations	21SBMT364	Partial Differential Equations	2
Select Any One Out Of Two Courses				
21SBMT355A	Operations Research -I	21SBMT365A	Operations Research -II	2
21SBMT355B	C- Programming	21SBMT365B	Cryptography	2
Select Any One Out Of Two Courses				
21SBMT356A	Graph Theory	21SBMT366A	Differential Geometry	2
21SBMT356B	Number Theory	21SBMT366B	Lebesgue Integration	2
Practical Courses				
21SBMT357	Practical Course Lab-I (based on 21SBMT351 and 21SBMT352)	21SBMT367	Practical Course Lab-I (based on 21SBMT361 and 21SBMT362)	2
21SBMT358	Practical Course Lab-II (based on 21SBMT353 and 21SBMT354)	21SBMT368	Practical Course Lab-II (based on 21SBMT363 and 21SBMT364)	2
21SBMT359	Practical Course Lab-III (based on 21SBMT355A or 21SBMT355B and 21SBMT356A or 21SBMT356B)	21SBMT369	Practical Course Lab-III (based on 21SBMT365A or 21SBMT365B and 21SBMT366A or 21SBMT366B)	2
Skill Enhancement Courses				
21SBMT3510	Programming in Python-I	21SBMT3610	Programming in Python-II	2

21SBMT3511	LaTeX for Scientific Writing	21SBMT3611	Mathematics into LaTeX	2

Note: 1. Skill enhancement courses are software courses and will be conducted in computer lab.

2. End semester examination of 30 marks for skill enhancement course will be practical conducted in the computer lab.

Details of Syllabus:

Semester-V

Course/ Paper Title	Metric Spaces
Course Code	21SBMT351
Semester	V
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Basic Notions**	**9**
	1.1 Definition and Examples. 1.2 Open Balls and Open Sets.	4 5
Unit II	**Convergence**	**9**
	2.1 Convergent Sequences. 2.2 Limit and Cluster Points. 2.3 Cauchy Sequences and Completeness. 2.4 Bounded Sets. 2.5 Dense Sets. 2.6 Boundary of a Set.	1 1 2 2 2 1
Unit III	**Continuity**	**8**
	3.1 Continuous Functions. 3.2 Equivalent Definitions of Continuity. 3.3 Topological Property.	1 1 1

	3.4 Uniform Continuity. 3.5 Limit of a Function. 3.6 Open and Closed maps.	2 1 2
Unit IV	**Compactness and Connectedness**	**10**
	4.1 Compact Spaces and their Properties. 4.2 Connectedness.	5 5

Text book:

1. Topology of Metric Spaces, S. Kumaresan, Narosa Publishing House, Second Edition, 2011.

Unit I: - Chapter-1: Sec. 1.1; 1.1.14(only Statement) (Except- 1.1.9 to 1.1.12, 1.1.15 to 1.1.27, 1.1.33 to 1.1.37), Sec. 1.2; 1.2.40(only Statement), 1.2.42 (only Statement) (Except - 1.2.9 to 1.2.17, 1.2.41, 1.2.49 to 1.2.55, 1.2.57 to 1.2.60, 1.2.65, 1.2.66, 1.2.70 to 1.2.73, 1.2.76, 1.2.77, 1.2.87, 1.2.88, 1.2.107).

Unit II: - Chapter -2: Sec. 2.1 (Except 2.1.7, 2.1.8, 2.1.11 to 2.1.13, 2.1.15 to 2.1.19), Sec. 2.2; 2.2.7 (on metric space), 2.2.19 (on metric space) (Except- 2.2.11, 2.2.21, 2.2.31), Sec. 2.3; 2.3.12(only statement) (Except - 2.3.4, 2.3.19, 2.3.20), Sec. 2.4 (Except 2.4.8 to 2.4.13, 2.4.16), Sec. 2.5 (Except 2.5.3, 2.5.4, 2.5.15), Sec. 2.7.

Unit III: - Chapter -3: Sec. 3.1 (Except 3.1.9, 3.1.10, 3.1.12, 3.1.14, 3.1.21to 3.1.24), Sec. 3.2; 3.2.35 (only statement), 3.2.53 (only statement), (Except- 3.2.3, 3.2.4, 3.2.6, 3.2.8, 3.2.12 to 3.2.15, 3.2.19, 3.2.29, 3.2.37 to 3.2.43, 3.2.51, 3.2.52), Sec. 3.3 (Except 3.3.5, 3.3.6, 3.3.10), Sec. 3.4 (Except 3.4.4, 3.4.5, 3.4.12 to 3.4.14, 3.4.16), Sec. 3.5, Sec. 3.6.

Unit IV: - Chapter -4: Sec. 4.1; 4.1.15(only statement) (Except - 4.1.27 to 4.1.31, 4.1.35, 4.1.36), Sec. 4.2 (Except- 4.2.2, 4.2.6, 4.2.9, 4.2.12 to 4.2.14), Sec. 4.3; 4.3.1(only statement) (Except 4.3.16. 4.3.25, 4.3.26, 4.3.27).
Chapter -5: Sec. 5.1; 5.1.6(on metric space), 5.1.7(only statement) (Except - 5.1.12, 5.1.15 to 5.1.17, 5.1.23, 5.1.24, 5.1.27, 5.1.33, 5.1.34, 5.1.36, 5.1.48).

Reference books:

1. Metric Spaces, Q.H. Ansari: Narosa Publishing House, New Delhi.
2. Metric Spaces, Satish Shirali, H. Vasudeva, Springer.
3. First Course in Metric Spaces, B. K. Tyagi, Cambridge University Press.
4. Metric spaces, M. O. Searcoid, Springer, 2007.
5. Metric Spaces, E. T. Copson, University Press, Cambridge, Second edition, Mumbai, 1978.

Website:

1. https://www.youtube.com/playlist?list=PLDzvuf9Uf4FNIIFfFlWKSBCqN3c0tkTuo

Course/ Paper Title	Real Analysis-I
Course Code	21SBMT352
Semester	V
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Logic and Set Theory**	**10**
	1.1 Introduction.	1
	1.2 “And” and “Or”.	1
	1.3 “Not” and “If - Then”.	1
	1.4 Contrapositive, Converse, and “Iff”	1
	1.5 Quantifiers.	1
	1.6 Set Theory and Venn Diagrams.	1
	1.7 Relations and Functions.	2
	1.8 Countable and Uncountable Sets.	2
Unit II	**Sequences of Real Numbers**	**7**
	2.1 Definition of Sequence and Subsequence.	1
	2.2 Limit of a Sequence.	1
	2.3 Convergent Sequences.	1
	2.4 Divergent Sequences.	1
	2.5 Bounded Sequences.	1
	2.6 Monotone Sequences.	2
Unit III	**Operations on sequences, Limit superior, Limit inferior, Cauchy sequences**	**7**
	3.1 Operations on Convergent Sequences.	1
	3.2 Operations on Divergent Sequences.	2
	3.3 Limit Superior and Limit Inferior.	2
	3.4 Cauchy Sequences.	2
Unit IV	**Series of Real Numbers**	**12**
	4.1 Convergence and Divergence.	1
	4.2 Series with Nonnegative Terms.	1
	4.3 Alternating Series.	1
	4.4 Conditional Convergence and Absolute Convergence.	1
	4.5 Rearrangements of Series.	2
	4.6 Tests for Absolute Convergence.	2
	4.7 Series whose terms form a Non-increasing Sequence.	2

	4.8 The Class l^2.	2

Text books:

1. Real Analysis and Foundations, Steven G. Krantz, Second Edition Chapman and Hall/CRC.

Unit I: Chapter 1: Sec 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8.

2. Methods of Real Analysis, Richard R. Goldberg, Second Edition, John Wiley & Sons, Inc

Unit II: Chapter 2: Sec 2.1, 2.2, 2.3, 2.4, 2.5, 2.6.

Unit III: Chapter 2: Sec 2.7, 2.8, 2.9, 2.10.

Unit IV: Chapter 3: Sec 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10.

Reference Books: -

1. Real Analysis, N.L. Carothers, Cambridge University Press
2. Introduction to Real Analysis, Robert, G. Bartle, Third edition, Donald Sherbert, John Wiley and Sons.
3. A Basic Course in Real Analysis, Ajit Kumar and S. Kumaresan, Second edition, CRC Press (Chapman and Hall).
4. A Course of Mathematical Analysis, Shanti Narayan and Mittal, S. Chand and Co. (2002).
5. Mathematical Analysis, S.C. Malik and Savita Arora, Third edition, New Age International Publications.

Website:

1. https://ocw.mit.edu/courses/18-100a-real-analysis-fall-2020/video_galleries/video-lectures

Course/ Paper Title	Group Theory
Course Code	21SBMT353
Semester	V
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Groups, Subgroups and Cyclic Groups**	**8**
	1.1 Groups. 1.2 Subgroups. 1.3 Cyclic Groups.	2 3 3

Unit II	**Permutations, Cosets, and Direct Products**	**12**
	2.1 Groups of Permutations.	2
	2.2 Orbits.	2
	2.3 Cycles.	2
	2.4 Alternating Groups.	2
	2.5 Cosets and the Theorem of Lagrange.	2
	2.6 Direct Products.	2
Unit III	**Homomorphisms and Factor Group**	**10**
	3.1 Homomorphisms.	3
	3.2 Factor Groups.	3
	3.3 Factor-Group Computations and Simple Groups.	4
Unit IV	**Group Action and G-Sets**	**6**
	4.1 Group Action on a Set.	3
	4.2 Applications of G-Sets to Counting.	3

Text book:

1. A First Course in Abstract Algebra, John B. Fraleigh, Seventh Edition, Pearson.

Unit I: Chapter 1: Sec. 4 to 6.

Unit II: Chapter 2: Sec. 8 to 11 (except finitely generated Abelian Groups).

Unit III: Chapter 3: Sec. 13 to 15.

Unit IV: Chapter 3: Sec. 16 to 17.

Reference Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press.
2. I. N. Herstien, Topics in Algebra, John Wiley and Sons.
3. N.S. Gopalakrishnan, University Algebra, Second Edition, New Age International, New Delhi, 1986.
4. Joseph. A. Gallian, Contemporary Abstract Algebra, Fourth Edition, Narosa Publishing House.

Website:

1. https://www.digimat.in/nptel/courses/video/111106113/L01.html

Course/ Paper Title	Advanced Ordinary Differential Equations
Course Code	21SBMT354
Semester	V
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Qualitative Properties And Theoretical Aspects**	**8**
	1.1 Picard's Existence and Uniqueness Theorem.	3
	1.2 Oscillations and the Sturm Separation Theorem.	2
	1.3 The Sturm Comparison Theorem.	3
Unit II	**Power Series Solutions And Special Functions**	**10**
	2.1 Second-Order Linear Equations: Ordinary Points.	2
	2.2 Regular Singular Points.	3
	2.3 More on Regular Singular Points.	3
	2.4 Gauss's Hypergeometric Equation.	2
Unit III	**Numerical Methods For Ordinary Differential Equations**	**8**
	3.1 Introductory Remarks.	1
	3.2 The Method of Euler.	2
	3.3 The Error Term.	1
	3.4 An Improved Euler Method.	2
	3.5 The Runge-Kutta Method.	2
Unit IV	**Systems Of First-Order Equations**	**10**
	4.1 Introductory Remarks.	2
	4.2 Linear Systems.	2
	4.3 Homogeneous Linear Systems with Constant Coefficients.	3
	4.4 Nonlinear Systems: Volterra's Predator-Prey Equations	3

Text book:

1. Differential Equations, Theory, Technique, and Practice, George F. Simmons and Steven G. Krantz, Mc Graw Hill.

Unit I: Chapter 3: Sec. 3.3- 3.5.

Unit II: Chapter 4: Sec. 4.3- 4.6.

Unit III: Chapter 9: Sec. 3.1- 3.3.

Unit IV: Chapter 10 Sec. 10.1 -10.4.

Reference books:

1. Differential Equations with Applications and Historical Notes, George F. Simmons, Third Edition, CRC Press.
2. Elementary Differential Equations, Rainville and Bedient, Macmillan Publication.
3. Elementary Differential Equations with Boundary Value Problems, William F. Trench

Website:

1. https://nptel.ac.in/courses/111106100

Course/ Paper Title	Operations Research-I
Course Code	21SBMT355A
Semester	V
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**The Simplex Method**	**12**
	1.1 The Simplex Method. 1.1.1 Iterative Nature of the Simplex Method. 1.1.2 Computational Details of Simplex Method. 1.1.3 Summary of the Simplex Method.	3
	1.2 Artificial Starting Solution. 1.2.1 M- Method. 1.2.2 Two Phase Method	5
	1.3 Special Cases in the Simplex Method 1.3.1 Degeneracy. 1.3.2 Alternative Optima 1.3.3 Unbounded Solution. 1.3.4 Infeasible Solution.	4
Unit II	**Duality and Dual Simplex Algorithm**	**8**

	2.1 Definition of the Dual Problem. 2.2 Primal Dual Relationships 2.2.1 Review of Simple Matrix Operations. 2.2.2 Simplex Tableau Layout. 2.2.3 Optimal Dual Solution. 2.2.4 Simplex Tableau Computations. 2.3 Economic Interpretation of Duality 2.3.1 Economic Interpretation of Dual Variables. 2.3.2 Economic Interpretation of Dual Constraints. 2.4 Dual Simplex Algorithm.	1 2 2 3
Unit III	**The Transportation Model**	**10**
	3.1 Definition of the Transportation Model 3.2 The Transportation Algorithm. 3.2.1 Determination of the Starting Solution. 3.2.2 Iterative Computations of the Transportation Algorithm. 3.2.3 Simplex Method Explanation of the Method of Multipliers.	2 3 3 2
Unit IV	**The Assignment Model**	**6**
	4.1 The Assignment Model. 4.1.1 The Hungarian Method. 4.1.2 Simplex Explanation of The Hungarian Method	6

Text book:

1. Operations Research An Introduction, Hamdy A. Taha, Tenth Edition, Global Edition, Pearson

Unit-I: Chapter-3: Sec. 3.3, 3.4, 3.5.

Unit-II: Chapter-4: Sec. 4.1, 4.2, 4.3, 4.4 (Only 4.4.1).

Unit-III: Chapter-5: Sec. 5.1, 5.3, Unit-IV: Chapter 5: 5.4.

Reference books:

1. Operations Research Theory and Applications, J K Sharma, Sixth Edition, 2016, Trinity Press.
2. Operations Research, Er. Prem Kumar Gupta, Dr. D.S. Hira, Seventh Edition, S. Chand and Company.

Website:

1. https://nptel.ac.in/courses/110106062

Course/ Paper Title	C- Programming
Course Code	21SBMT355B
Semester	V
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Fundamentals of C- Programming**	**6**
	1.1 Introduction to C, The character set, Identifier and keywords. Data types, Constants, Variables and Arrays.	2
	1.2 Declarations, Expressions, Statements, Symbolic constants, Operators and Expressions.	2
	1.3 Arithmetic Operators, Unary Operators, Relational and Logical Operators, Assignment Operators, The Conditional Operator.	2
Unit II	**Data Input Output**	**6**
	2.1 Preliminaries, single character input- the getchar() function.	1
	2.2 Single character output-the putchar() function.	1
	2.3 Entering input data- the scanf() function.	1
	2.4 Writing output data- the printf() function.	1
	2.5 The gets and puts functions.	2
Unit III	**Preparing, Running a Complete C Program and Control Statements**	**10**
	3.1 Preliminaries, the while statement, the do-while statement.	3
	3.2 The for statement, Nested loops, the if-else statement, the switch statement.	3
	3.3 The break statement, the continue statement, the comma operator, the goto statement.	4
Unit IV	**Functions and Arrays**	**14**
	4.1 Introduction to a function, defining a function, accessing a function.	4

	4.2 Passing arguments to a function. Function prototypes, recursion, defining an array. 4.3 Processing an array. Passing arrays to functions. Multidimensional arrays. Arrays and strings.	5 5

Text book:

1. Programming with C, Byron S. Gottfried, Schaum's Outline series.

   Unit-I: Chapters: 1, 2, 3.

   Unit-II: Chapter: 4.

   Unit-III: Chapters: 5, 6.

   Unit-IV: Chapters: 7, 9.

Reference books:

1. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie, Second Edition, Prentice Hall Software Series.
2. Spirit of C: An Introduction to Modern Programming, Henry Mullish and Herbert L. Cooper, Jaico Publishing House.

Website:

1. https://onlinecourses.nptel.ac.in/noc22_cs40

Course/ Paper Title	Number Theory
Course Code	21SBMT356A
Semester	V
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Divisibility**	**6**
	1.1 Introduction. 1.2 Divisibility. 1.3 Prime.	2 2 2
Unit II	**Congruences**	**8**

	2.1 Congruences. 2.2 Solution of Congruences. 2.3 The Chinese Remainder Theorem.	2 3 3
Unit III	**Quadratic Reciprocity**	**8**
	4.1 Quadratic Residues. 4.2 Quadratic Reciprocity. 4.3 The Jacobi Symbol.	2 3 3
Unit IV	**Greatest integer function**	**8**
	3.1 Greatest Integer Function. 3.2 Arithmetic Functions. 3.3 The Mobius Inversion formula.	2 3 3
Unit V	**Diophantine Equations**	**6**
	5.1 Diophantine Equation ax + by = c. 5.2 Pythagorean Triplets.	3 3

Text book:

1. An Introduction to Theory of Numbers, Niven, H. Zuckerman and H.L. Montgomery, Fifth Edition, John Wiley and Sons.

Unit I: Chapter 1 Sec. 1.1- 1.3.

Unit II: Chapter 2 Sec. 2.1- 2.3.

Unit III: Chapter 3 Sec. 3.1- 3.3.

Unit IV: Chapter 4 Sec. 4.1 -4.3.

Unit V: Chapter 5 Sec. 5.1 and 5.3.

Reference books:

1. Elementary Number Theory, David M. Burton, Second Edition, Universal Book Stall, New Delhi, 1991.

Website:

1. https://archive.nptel.ac.in/courses/111/101/111101137/

Course/ Paper Title	Graph Theory
Course Code	21SBMT356B
Semester	V
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**An Introduction to Graphs**	**14**
	1.1 The Definition of a Graph.	1
	1.2 Graphs as Models.	1
	1.3 More Definitions.	2
	1.4 Vertex Degrees.	2
	1.5 Subgraphs.	2
	1.6 Paths and Cycles.	2
	1.7 The Matrix Representation of Graphs.	2
	1.8 Fusion.	2
Unit II	**Trees**	**9**
	2.1 Definition and Simple Properties.	2
	2.2 Bridges.	3
	2.3 Spanning Trees.	4
Unit III	**Connectivity**	**9**
	3.1 Connector Problems.	3
	3.2 Shortest Path Problems	3
	3.3 Cut Vertices and Connectivity.	3
Unit IV	**Euler Tours**	**4**
	4.1 Euler Tours.	4

Text book:

1. A First Look At Graph Theory, John Clark, Derek Allan Holton, Allied Publishers Ltd., 1991.

   Unit-I: Chapter-1: Sec. 1.1- 1.8.

   Unit-II: Chapter-2: Sec. 2.1-2.3.

   Unit-III: Chapter-2: Sec. 2.4-2.6,

   Unit-IV: Chapter-3: Sec. 3.1.

Reference books:

1. Introduction to Graph Theory, R. J. Wilson, Fourth Edition, Pearson Education, 2003.

2. Graph Theory, Hararay, Narosa Publishers, New Delhi (1989).

3. Graph Theory, Narsing Deo, Prentice Hall of India Pvt. Ltd. (1987).

Website:

1. https://nptel.ac.in/courses/111106102

Course/ Paper Title	Practical Course Lab-I (based on 21SBMT351 and 21SBMT352)
Course Code	21SBMT357
Semester	V
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT351		
I	Definition and examples of Metric Spaces (Unit-I)	1
II	Open and Closed sets in metric spaces (Unit-I)	1
III	Convergence (Unit II)	1
IV	Continuity (Unit III)	1
V	Compactness (Unit IV)	1
VI	Connectedness (Unit IV)	1
Practicals based on 21SBMT352		
I	Logic, Set Theory, Functions and Cardinality (Unit-I)	1
II	Convergent and Divergent Sequences of Real Numbers (Unit-II)	1
III	Monotone Sequences and Algebra of Convergent Sequences (Unit-II)	1
IV	Limit Superior, Inferior and Cauchy Sequences (Unit-III)	1
V	Series of Real Numbers, Alternating Series and Conditional/Absolute Convergence (Unit-IV)	1
VI	Convergent and Divergent Series of Real Numbers (Unit-IV)	1

Course/ Paper Title	Practical Course Lab-II (based on 21SBMT353 and 21SBMT354)
Course Code	21SBMT358
Semester	V
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT353		
I	Isomorphic Binary Structures and Groups (Unit I)	1
II	Subgroups and Cyclic Groups (Unit II)	1
III	Groups of Permutations, Orbits and Cycles (Unit III)	1
IV	Alternating Groups, Cosets and the Theorem of Lagrange (Unit III)	1
V	Direct Products and Homomorphisms (Unit IV)	1
VI	Factor Groups, Factor Group Computations and Simple Groups (Unit IV)	1
Practicals based on 21SBMT354		
I	Qualitative Properties And Theoretical Aspects (Unit I)	1
II	Power Series Solutions And Special Functions – I (Unit II)	1
III	Power Series Solutions And Special Functions – II (Unit II)	1
IV	Numerical Methods for Ordinary Differential Equations (Unit III)	1
V	System of First Order Equations (Unit IV)	1
VI	Numerical Methods for Ordinary Differential Equations and System of First Order Equations (Unit III, Unit IV)	1

Course/ Paper Title	Practical Course Lab-III (based on 21SBMT355A or 21SBMT355B and 21SBMT356A or 21SBMT356B)
Course Code	21SBMT359
Semester	V
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT355A		
I	Simplex Method-I and Verification of solution by using Microsoft Excel (Unit I)	1
II	Simplex Method-II and Verification of solution by using Microsoft Excel (Unit II)	1
III	Duality (Unit III)	1
IV	Dual Simplex Method (Unit III)	1
V	Transportation Model (Unit IV)	1
VI	Assignment Model (Unit V)	1
Practicals based on 21SBMT355B		
I	Operators and expressions-I (Unit I)	1
II	Operators and expressions-I (Unit II)	1
III	Control statements-I (Unit III)	1
IV	Control statements-II (Unit III)	1
V	Arrays (Unit IV)	1
VI	Functions (Unit IV)	1
Practicals based on 21SBMT356A		
I	Divisibility and GCD – I (Unit I)	1
II	Divisibility and GCD – II (Unit 1)	1
III	Congruences (Unit II)	1
IV	Quadratic Reciprocity (Unit III)	1
V	Number Theoretic Functions (Unit IV)	1

VI	Linear Diophantine Equations, Pythagorean Triplets (Unit V)	1
Practicals based on 21SBMT356B		
I	Graphs and subgraphs (Unit I)	1
II	Paths and cycles (Unit I)	1
III	Properties of trees and bridges (Unit II)	1
IV	Spanning Trees (Unit II)	1
V	Connector problems and shortest path problems (Unit III)	1
VI	Cut vertices, connectivity and Euler tours (Unit IV)	1

Course/ Paper Title	Programming in Python-I
Course Code	21SBMT3510
Semester	V
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Introduction to Python**	**6**
	1.1 Installation of Python.	1
	1.2 Values and types: int, float and str, The Print Function: Print basics.	1
	1.3 Variables: assignment statements, printing variable values, types of variables.	1
	1.4 Mathematical Operators, operands and precedence: +, -, /, *, **, % PEMDAS (Rules of precedence), String operations: +: Concatenation, *: Repetition.	
	1.5 Boolean operator: 1.5.1 Comparison operators: ==, ! =, >, =, <= 1.5.2 Logical operators: and, or, not.	1
	1.6 Mathematical functions from math, cmath modules, random module, Keyboard input: input() statement	1

	1.7 Calculus: Differentiation, Integration, Limit and Series	1
Unit II	**Strings, Lists, Tuples**	**6**
	2.1 Strings: 2.1.1 Length (Len function). 2.1.2 String traversal: Using while statement, Using for statement. 2.1.3 String slice 2.1.4 Comparison operators (>, <, =) 2.2 Lists: 2.2.1 List operations. 2.2.2 Use of range function. 2.2.3 Accessing list elements. 2.2.4 List membership and for loop. 2.2.5 List operations. 2.2.6 Updating list: addition, removal or updating of elements of a list. 2.3 Tuples: 2.3.1 Defining a tuple. 2.3.2 Index operator. 2.3.3 Slice operator. 2.3.4 Tuple assignment. 2.3.5 Tuple as a return value.	2 2 2
Unit III	**Iterations and Conditional statements**	**8**
	3.1 Conditional and alternative statements, Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else. 3.2 Looping statements such as while, for etc, Tables using while. 3.3 Functions: 3.3.1 Calling functions: type, id. 3.3.2 Type conversion: int, float, str. 3.3.3 Composition of functions, Returning values from functions.	3 2 3

	3.3.4 User defined functions, Parameters and arguments.	
Unit IV	**Linear Algebra**	**6**
	4.1 Matrix construction, eye(n), zeros(n,m) matrices 4.2 Addition, Subtraction, Multiplication of matrices, powers and invers of a matrix. 4.3 Accessing Rows and Columns, Deleting and Inserting Rows and Columns 4.4 Determinant, reduced row echelon form, null space, column space, Rank. 4.5 Solving systems of linear equations (Gauss Elimination Method, Gauss Jordan Method, LU-decomposition Method). 4.6 Eigenvalues, Eigenvectors, and Diagonalization.	1 1 1 1 1 1
Unit V	**Numerical methods in Python**	**5**
	5.1 Roots of equations 5.2 Root finding method: Bisection method, Regula Falsi Method, Newton Raphson method. 5.3 Numerical integration: Trapezoidal Rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule.	1 2 2
Unit VI	**2D and 3D Graphs**	**5**
	6.1 Installation of numpy, matplotlib packages. 6.2 Graphs plotting of functions. 6.3 Different formats of graphs, PyDotPlus (Scalable Vector Graphics), PyGraph viz. Decorate Graphs with Plot Styles and Types, Polar charts: Navigation Toolbar with polar plots, Control radial and angular grids. 6.4 Three-dimensional Points and Lines. 6.5 Three-dimensional Contour Plots, Wireframes and Surface Plots.	1 1 1 1 1

Text books:

1. Think Python, How to Think Like a Computer Scientist, Allen Downey, Green Tea Press Needham, Massachusetts, 2015.

Unit-I: Chapter-1: Sec. 1.1-1.5, Chapter-2: Sec. 2.1-2.6, Chapter-3: Sec. 3.1-3.6, Chapter-5: Sec. 5.1-5.3.

Unit-II: Chapter-8: Sec. 8.1-8.5, Chapter-10: Sec. 10.12, Chapter-12: Sec.12.1.- 12.6.

Unit-III: Chapter 5: Sec. 5.4 -5.7, Chapter 7: Sec. 7.1-7-7.5.

2. Introduction to Scientific Computing in Python, Robert Johansson, 2016.

Unit-I: Chapter-6: Sec. 6.5-6.8

Unit- IV: Chapter-4: Sec. 4.6 (4.6.1 - 4.6.6), Chapter-6: Sec. 6.9-6.10,

Unit-V: Chapter-4: Sec. 4.8, Unit-VI: Chapter-5.

3. Python for Scientific Engineering, Hans-Petter Halvorsen, 2020.

Unit-V: Chapter-31

Reference books:

1. Fundamentals of Python - First Programs, Lambert K. A. Cengage Learning India, 2015.
2. Introduction to Computing and Programming in Python, Guzdial, M. J., Pearson India.
3. Introduction to Scientific Computing Using Python, Application Development Focus, Ljobomir Perkovic, Second Edition, Wiley Publication.
4. Python: Notes for Professionals, Goalkicker.com, Free Programming books.

Website:

1. https://www.math.purdue.edu/~bradfor3/ProgrammingFundamentals/Python/

Practical number	Title	No. of Practical
Practicals based on 21SBMT3510		
I	Introduction to Python, Python Data Types-I (Unit I)	1
II	Python Data Types- II (Unit II)	1
III	Control statements in Python-I (Unit III)	1
IV	Control statements in Python-II (Unit III)	1
V	Application: Matrices (Unit IV)	1
VI	Application: Determinants, System of Linear Equations (Unit IV)	1
VII	Application: System of Equations (Unit IV)	1
VIII	Application: System of Equations (Unit IV)	1
IX	Application: Eigenvalues, Eigenvectors (Unit IV)	1
X	Application: Roots of Equations (Unit V)	1

XI	Application: Numerical Integration (Unit V)	1
XII	Graph plotting (Unit VI)	1

Course/ Paper Title	LaTeX for Scientific Writing
Course Code	21SBMT3511
Semester	V
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Introduction to LaTeX**	**6**
	1.1 Definition and application of LaTeX.	1
	1.2 Preparation and Compilation of LaTeX input file.	2
	1.3 LaTeX Syntax.	2
	1.4 Keyboard Characters in LaTeX.	1
Unit II	**Formatting Words, Lines and Paragraphs**	**8**
	2.1 Text and Math mode fonts.	1
	2.2 Emphasized and colored font.	1
	2.3 Sectional unit.	1
	2.4 Labeling and referring numbered item.	1
	2.5 Text alignment and quoted text.	1
	2.6 New lines and paragraphs.	1
	2.7 Creating and filling blank spaces.	1
	2.8 Producing dashes with text.	1
Unit III	**Listing and Tabbing Text**	**8**
	3.1 Listing text.	4
	3.2 Tabbing text through the tabbing environment.	4
Unit IV	**Table Preparation**	**14**
	4.1 Table through the tabular environment.	2
	4.2 Table through the tabularx environment.	2

	4.3 Vertical positioning of tables. 4.4 Sideways (rotated) text in table. 4.5 Adjusting column width in table. 4.6 Additional provision for customizing text in table. 4.7 Merging rows and columns in table.	2 2 2 2 2

Text book:

1. LaTeX in 24 Hours, A practical guide for scientific writing, Dilip Datta, Springer International Publishing, 2017.

   Unit I: Chapter 1: Sec. 1.1 to 1.6.

   Unit II: Chapter 2: Sec. 2.1 to 2.4, Chapter 3; 3.1 to 3.7.

   Unit III: Chapter 6: Sec. 6.1, 6.2.

   Unit IV: Chapter 7: Sec. 7.1 to 7.7

Reference books:

1. LaTeX, A Document Preparation System, User's Guide and Reference Manual, Leslie Lamport, Addison-Wesley Publishing Company, Inc., 1994.
2. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing Ltd, 2011.
3. LaTeX and Friends, M.R.C. van Dongen, Springer-Verlag Berlin Heidelberg ,2012.

Website:

1. www.overleaf.com

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT3511		
I	Introduction to LaTeX (Unit I)	1
II	Syntax and Keyboard characters in LaTeX (Unit I)	1
III	Fonts in LaTeX (Unit II)	1
IV	Sections, labelling and text alignment in LaTeX (Unit II)	1
V	New lines, paragraphs, blank space and dashes in LaTeX (Unit II)	1
VI	Listing text –I (Unit III)	1
VII	Listing text –II (Unit III)	1
VIII	Tabbing text (Unit III)	1

IX	Table through tabular environment (Unit IV)	1
X	Table through the tabularx environment (Unit IV)	1
XI	Positioning text in table (Unit IV)	1
XII	Customizing text in LaTeX (Unit IV)	1

Semester-VI

Course/ Paper Title	Complex Analysis
Course Code	21SBMT361
Semester	VI
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Analytic Functions**	**9**
	1.1 Functions of a Complex Variables.	1
	1.2 Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation Formulas.	3
	1.3 Cauchy- Riemann Equations, Sufficient Conditions for Differentiability.	2
	1.4 Polar Coordinates, Analytic Functions, Harmonic Functions.	3
Unit II	**Elementary Functions**	**7**
	2.1 The Exponential Functions.	1
	2.2 The Logarithmic Function, Branches and Derivatives of Logarithms, Some Identities Involving Logarithms.	3
	2.3 Complex Exponents, Trigonometric Functions.	3
Unit III	**Integrals**	**11**
	3.1 Derivatives of Functions, Definite Integrals of Functions.	2 2
	3.2 Contours, Contour Integral, Examples.	3
	3.3 Upper Bounds for Moduli of Contour Integrals, Anti-	

	Derivatives. 3.4 Cauchy-Goursat Theorem (without proof), Simply and Multiply Connected Domains, Cauchy Integral Formula, An extension of Cauchy integral formula, Some Consequences of Extension, Liouville's Theorem and Fundamental Theorem of Algebra.	4
Unit IV	**Series**	**4**
	4.1 Convergence of Sequences and Series (Theorems without proof). 4.2 Taylor's Series (without proof), Laurent Series (without proof), examples only.	1 3
Unit V	**Residues and Poles**	**5**
	5.1 Isolated Singular Points, Residues. 5.2 Cauchy Residue Theorem, Residue at Infinity, Types of Isolated Singular Points, Residues at Poles. 5.3 Zeros of Analytic Functions, Zeros and Poles.	1 2 2

Text book:

1. Complex Variables and Applications, J. W. Brown and R.V. Churchill, International Student Edition, Eighth Edition, 2009.

Unit-I: Chapter 2: Sec.12, 15 to 26.

Unit-II: Chapter 3: Sec.29 to 34.

Unit-III: Chapter 4: Sec. 37 to 45, 46 and 48 to53.

Unit-IV: Chapter 5: Sec. 55 to 57, 59, 60, 62.

Unit -V: Chapter 6: Sec.68 to 76.

Reference books:

1. Complex Analysis, S. Ponnusamy, Second Edition, Narosa Publication.
2. Complex Analysis, S. Lang, Springer Verlag.
3. An Introduction to Complex Analysis, A.R. Shastri, MacMillan.
4. Complex Analysis, L.V. Ahlfors, Third Edition, McGraw Hill, 2000.
5. Introduction to Complex Analysis, H. A. Priestley, Second Edition (Indian), Oxford, 2006.

Website:

1. https://youtube.com/c/kumarhcu

Course/ Paper Title	Real Analysis-II
Course Code	21SBMT362
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Riemann Integration**	**12**
	1.1 Sets of Measure zero.	2
	1.2 Definition of the Riemann Integral.	2
	1.3 Existence of the Riemann Integral.	2
	1.4 Properties of the Riemann Integral.	2
	1.5 Fundamental Theorems of Calculus.	4
Unit II	**Improper Integrals**	**10**
	2.1 Improper Integrals on Closed and Bounded Intervals.	2
	2.2 Tests for Convergence of Positive Integrands.	2
	2.3 Improper Integrals on Unbounded Intervals and Tests for their Convergence.	3
	2.4 Tests for Convergence of the Integral of Product.	3
Unit III	**Sequences of Functions**	**7**
	3.1 Point wise Convergence of Sequences of Functions.	2
	3.2 Uniform Convergence of Sequences of Functions.	2
	3.3 Consequences of Uniform Convergence.	3
Unit IV	**Series of Functions**	**7**
	4.1 Convergence and Uniform Convergence of Series of Functions.	4
	4.2 Integration and Differentiation of Series of Functions.	3

Text book:

1. Methods of Real Analysis, Richard R. Goldberg, Second Edition, John Wiley & Sons,Inc

   Unit -I: Chapter -7: Sec. 7.1, 7.2, 7.3, 7.4, 7.8.

   Unit -III: Chapter - 9: Sec. 9.1, 9.2, 9.3.

   Unit -IV: Chapter - 9: Sec. 9.4, 9.5.

2. Introduction to Real Analysis, Eighth Edition, S.K. Mapa, Sarat Book House

   Unit-II: Chapter - 12: Sec. 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 12.10

Reference books:

1. Real Analysis, N.L. Carothers, Cambridge University Press.
2. Introduction to Real Analysis, Robert G. Bartle, Donald Sherbert, Third Edition, John Wiley and Sons.
3. A Basic Course in Real Analysis, Ajit Kumar and S. Kumaresan, Second Indian, CRC Press (Chapman and Hall)
4. A Course of Mathematical Analysis, Revised edition, Shanti Narayan and Mittal - S. Chand and Company (2002).
5. Mathematical Analysis, S.C. Malik and Savita Arora, Third Edition, New Age International Publications.

Website:

1. https://www.youtube.com/watch?v=F1ojdxtN__4
2. https://nptel.ac.in/courses/111106053

Course/ Paper Title	Ring Theory
Course Code	21SBMT363
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Rings and Fields**	**8**
	1.1 Rings and Fields. 1.1.1 Definitions and Basic Properties. 1.1.2 Homomorphisms and Isomorphisms. 1.1.3 Multiplicative Questions: Fields. 1.2 Integral Domains. 1.2.1 Divisors of Zeros and Cancellation. 1.2.2 Integral Domains. 1.2.3 The Characteristics of a Ring. 1.3 The Field of Quotients in an Integral Domain.	3 3 2
Unit II	**Rings of Polynomials**	**8**
	2.1 Polynomials in an Indeterminate. 2.2 The Evaluation Homomorphisms 2.3 Factorization of Polynomial over a Field; The Division Algorithm in F[X]. 2.4 Irreducible Polynomials, Uniqueness of Factorization in F[X].	2 2 2 2
Unit III	**Ideals and Factor Rings**	**8**
	3.1 Homomorphism and Factor Rings. 3.1.1 Homomorphisms. 3.1.2 Properties of Homomorphism. 3.1.3 Factor Rings. 3.1.4 Fundamental Theorem of Homomorphism. 3.2 Prime Ideals and Maximal Ideals. 3.2.1 Maximal and Prime Ideals. 3.2.2 Prime Fields. 3.2.3 Ideal Structure of F[x]. 3.2.4 Application to Unique Factorisation in F[x]. 3.3 Maximal Ideal, Prime Ideal, Ideal Structure in F[X].	3 3 2
Unit IV	**Factorization**	**12**

	4.1 Unique Factorization Domain. 4.1.1 Definitions: Associates, Irreducible, Unique Factorization Domains, Principal Ideal Domains and their examples. 4.1.2 Every PID is a UFD. 4.1.3 If D is a UFD then D[X] is a UFD. 4.2 Euclidean Domains. 4.2.1 Euclidean norm, Euclidean Domain, Every Euclidean Domain is a PID. 4.2.2 Arithmetic in Euclidean Domains, Euclidean Algorithm (Without Proof). 4.3 Gaussian Integers and Multiplicative Norm.	5 4 3

Text book:

1. A First Course in Abstract Algebra, John B. Fraleigh, Seventh Edition, Pearson.

Unit -I: Sec. 18, 19, 21.

Unit -II: Sec. 22,23.

Unit -III: Sec. 26, 27.

Unit-VI: Sec. 45, 46, 47 (except Theorem 47.10)

Reference books:

1. Contemporary Abstract Algebra, Joseph A. Gallian, Seventh Edition Pearson

2. Abstract Algebra, David S. Dummit and Richard M. Foote, Third Edition, Prentice Hall of India.

3. Abstract Algebra, I. N. Herstein, Third Edition, Prentice Hall of India.

4. Abstract Algebra, P.B. Bhattacharya, S.K. Jain, and S.R. Nagpaul, Second Edition, Cambridge University Press.

Website:

1. https://nptel.ac.in/courses/111106131

Course/ Paper Title	Partial Differential Equations
Course Code	21SBMT364
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Introduction to Ordinary and Partial Differential Equations**	**10**
	1.1 Surfaces and Curves in Three Dimensions.	2
	1.2 Simultaneous Differential Equations of the First Order and the First Degree in Three Variables.	2
	1.3 Methods of solution of $dx/P = dy/Q = dz/R$.	2
	1.4 Pfaffian Differential Forms and Equations.	2
	1.5 Solution of Pfaffian Differential Equations in Three Variables.	2
Unit II	**Partial Differential Equations**	**8**
	2.1 Introduction to Partial Differential Equations.	2
	2.2 Origin of First Order Partial Differential Equations.	2
	2.3 Linear Equations of First Order.	2
	2.4 Integral Surfaces Passing through a Given Curve.	2
Unit III	**Second Order Partial Differential Equations**	**10**
	3.1 Origin of Second Order Partial Differential Equations.	2
	3.2 Linear Partial Differential Equations with Constant Coefficients.	3
	3.3 Methods of Solving Linear Partial Differential Equations 3.3.1. Solution of Reducible Equations. 3.3.2. Solution of Irreducible Equations with Constant Coefficients. 3.3.3. Rules for Finding Complementary Functions. 3.3.4. Rule for Finding Particular Integrals.	5
Unit IV	**Classification of Partial Differential Equations**	**8**
	4.1 Classification of Second Order Partial Differential Equations. 4.1.1 Canonical forms.	2
	4.2 Solution of Laplace Equation by Separation of Variables Method.	2
	4.3 Solution of One Dimensional Heat Equation by Separation	2

	Of Variables Method. 4.4 Solution of One Dimensional Wave Equation by Separation of Variables method.	2

Text book:

1. Elements of Partial Differential Equations, Ian Sneddon, McGraw-Hill Book Company, McGraw-Hill Book Company.

   Unit-I: Chapter-1: Sec. 1, 2,3,5

   Unit-II: Chapter-2 : Sec. 1,2,4,5,

   Unit-III: Chapter-3: Sec. 1, 4, 5

2. Partial Differential Equations for Engineers and Scientists, J.N. Sharma, Kehar Singh, Second Edition, Narosa Publications.

   Unit-IV: Chapter-3: Sec. 3.3, Chapter- 4: Sec. 4.3, Chapter - 5: Sec. 5.5

Reference books:

1. An Elementary Course in Partial Differential Equations, T. Amaranath, Narosa Publishing, House, Second Edition, 2003 (Reprint, 2006).
2. Introduction to Partial Differential Equations, K. Sankara Rao, Third Edition, PHI.

Website:

1. https://archive.nptel.ac.in/courses/111/101/111101153/

Course/ Paper Title	Operations Research-II
Course Code	21SBMT365A
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Network Models**	**10**
	1.1 CPM and PERT, Network Representation, Critical Path Computations.	5
	1.2 Construction of the Time Schedule, PERT Networks.	5
Unit II	**Game Theory**	**8**
	2.1 Game Theory, Some Basic Terminologies.	2
	2.2 Optimal Solution of Two Person Zero Sum Game.	3
	2.3 Solution of Mixed Strategy Game (Graphical solution of games only).	3
Unit III	**Replacement and Maintenance Model**	**8**
	3.1 Introduction, Types of Failure.	4
	3.2 Replacement of Items Whose Efficiency Deteriorates with Time.	4
Unit IV	**Sequencing Problems**	**5**
	4.1 Introduction, Notation, Terminology and Assumption.	2
	4.2 Processing n Jobs Through Two machines, Processing n Jobs Through Three Machines.	3
Unit-V	**Classical Optimization Theory**	**5**
	5.1 Unconstrained Problems, Necessary and sufficient Conditions.	2
	5.2 Newton Raphson Method, Constrained Problems, Equality Constraints (Lagrangian Method only).	3

Text book:

1. Operations Research, Hamdy A. Taha, Eight Edition, 2009, Prentice Hall of India.
   Unit I: Chapter 6: Sec. 6.5 (6.5.1 to 6.5.3, 6.5.5).
   Unit II: Chapter 13: Sec.13.4 (13.4.1, 13.4.2, 13.4.3).
   Unit IV: Chapter 18: Sec. 18.1 (18.1.1, 18.1.2).
2. Operations Research Theory and Applications, J.K. Sharma, Second Edition, 2006.

Unit-III: Chapter 17: Sec. 17.1, 17.2, 17.3

Unit-V: Chapter 20: Sec. 20.1, 20.2, 20.3, 20.4.

Reference books:

1. Introduction to Operations Research, Fredrick S. Hiller, Gerald J. Lieberman, Eight Edition, Tata McGraw Hill.
2. Operations Research, Er. Prem Kumar Gupta, Dr. D.S. Hira, Seventh Edition, S. Chand and Company.

Website:

1. https://nptel.ac.in/courses/111105039

Course/ Paper Title	Cryptography
Course Code	21SBMT365B
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Finite Fields**	**4**
	1.1 Finite Fields.	4
Unit II	**Cryptography**	**6**
	1.1 Some Simple Cryptosystems.	3
	1.2 Enciphering Matrices.	3
Unit III	**Public Key**	**12**
	3.1 The Idea of Public Key Cryptography.	3
	3.2 RSA.	3
	3.3 Discrete Log.	3
	3.4 Knapsack.	3
Unit IV	**Primality and Factoring**	**14**
	4.1 Pseudoprimes.	3
	4.2 The Rho Method.	3
	4.3 Fermat Factorization and Factor Bases.	4
	4.4 The Continued Fraction Method.	4

Text book:

1. A Course in Number Theory and Cryptography, Neal Koblitz, Second Edition, Springer

Unit I: Chapter II: Sec. 1.

Unit II: Chapter III: Sec. 1, 2.

Unit III: Chapter IV: Sec. 1, 2, 3, 4.

Unit IV: Chapter V: Sec. 1, 2, 3, 4.

Reference books:

1. Introduction to Cryptography, Johannes A. Buchmann, Second Edition, Springer (Indian Reprint).

2. Cryptography Theory and Practice, Douglas R Stinson, Maura B. Paterson, Fourth Edition, CRC Press.

Website:

1. https://nptel.ac.in/courses/106107155

Course/ Paper Title	Differential Geometry
Course Code	21SBMT366A
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Curves in the Plane and in Space**	**4**
	1.1 What is a curve?	1
	1.2 Arc-length.	1
	1.3 Reparameterization.	1
	1.4 Level Curves vs. Parameterized Curves.	1
Unit II	**How much does a curve?**	**6**
	2.1 Curvature.	2
	2.2 Plane Curves.	2
	2.3 Space Curves.	2

Unit III	**Global Properties of Curves**	**6**
	3.1 Simple Closed Curves.	2
	3.2 The Isoperimetric Inequality.	2
	3.3 The Four Vertex Theorem.	2
Unit IV	**Surfaces in Three Dimensions**	**7**
	4.1 What is a Surface?	1
	4.2 Smooth Surfaces.	1
	4.3 Tangents, Normal and Orientability.	1
	4.4 Examples of Surfaces.	1
	4.5 Quadratic Surfaces.	1
	4.6 Triply orthogonal Systems.	1
	4.7 Applications of the Inverse Function Theorem.	1
Unit V	**The First Fundamental Form**	**5**
	5.1 Lengths of Curves on Surfaces.	1
	5.2 Isometries of Surfaces.	1
	5.3 Conformal Mappings of Surfaces.	1
	5.4 Surface Area.	1
	5.5 Equiareal Maps and Theorem of Archimedes	1
Unit VI	**Curvature of surfaces**	**8**
	6.1 The Second Fundamental Form.	2
	6.2 The Curvature of Curves on a Surface.	2
	6.3 The Normal and Principal Curvatures.	2
	6.4 Geometric Interpretation of Principal Curvatures.	2

Text book:

1. Elementary Differential Geometry, Andrew Pressley, Springer International Edition, Indian Reprint 2004.
   Unit I: Chapter 1: Sec. 1.1 to 1.4, Unit II: Chapter 2: Sec. 2.1 to 2.3,
   Unit III: Chapter 3: Sec. 3.1 to 3.3, Unit IV: Chapter 4: Section 4.1 to 4.7,
   Unit V: Chapter 5: Sec. 5.1 to 5.5, Unit VI: Chapter 6: Sec. 6.1 to 4.4.

Reference books:

1. Differential Geometry John A. Thorpe, Springer International Edition, Indian Reprint 2010.
2. Differential Geometry of Curves and surfaces, M. Do Carmo, Prentice Hall, 1976.

Website:

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/364
2. https://nptel.ac.in/courses/111104095

Course/ Paper Title	Lebesgue Integration
Course Code	21SBMT366B
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Measurable Sets**	**12**
	1.1 Length of Open Sets and Closed Sets. 1.2 Inner and Outer Measure. 1.3 Measurable Sets. 1.4 Properties of Measurable Sets.	3 3 3 3
Unit II	**Measurable Functions**	**10**
	2.1 Definition of Measurable Functions and Other Criteria for Measurability Equivalent. 2.2 Sums, Products and Limits of a Measurable Functions. 2.3 Sequences of a Measurable Functions.	3 3 4
Unit III	**The Lebesgue Integrals**	**14**
	3.1 Definition and Existence of the Lebesgue Integrals. for Bounded Functions. 3.2 Properties of Lebesgue Integrals for Bounded Measurable Functions. 3.3 The Lebesgue Integral for Unbounded Functions. 3.4 Some Fundamental Theorems.	2 4 4 4

Text Book:

1. Methods of Real Analysis, Richard R. Goldberg, Oxford and IBH Publishing Co. Pvt Ltd.

Unit I: Chapter 11: Sec. 11.1 to 11.3 (Theorem 11.1 B and Theorem 11.1C Statements only).

Unit II: Chapter 11: Sec. 11.4.

Unit III: Chapter 11: Sec. 11.5 - 11.8

Reference books:

1. Mathematical Analysis, Tom M. Apostol, Second Edition, Narosa Publishing House.
2. A First Course in Mathematical Analysis, D. Somasundaram, B. Chaoudhari, Narosa Publishing House.
3. Introduction to Real Analysis, R.G. Bartle, D.R. Sherbert, Fourth Edition, Wiley India Edition.
4. An Introduction to Measure and Integration, Inder K. Rana, Second Edition, Narosa Publishing House.
5. Measure Theory and Integration, G. de Barra, New age International (P) Limited, Publishers

Website:

1. https://nptel.ac.in/courses/111106161

Course/ Paper Title	Practical Course Lab-I (based on 21SBMT361 and 21SBMT362)
Course Code	21SBMT367
Semester	VI
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT361		
I	Analytic Functions (Unit I)	1
II	Elementary Functions (Unit II)	1
III	Integrals - I (Unit III)	1
IV	Integrals - II (Unit III)	1
V	Series (Unit IV)	1
VI	Residues and Poles (Unit IV)	1
Practicals based on 21SBMT362		
I	Definition and Existence of Riemann Integral (Unit I)	1

II	Properties of Riemann Integrals and Applications (Unit I)	1
III	Improper Integrals (Unit II)	1
IV	Pointwise Convergence of Sequences of Functions (Unit III)	1
V	Uniform Convergence of Sequences of Functions (Unit III)	1
VI	Series of Functions: Convergence and Divergence (Unit IV)	1

Course/ Paper Title	Practical Course Lab-II (based on 21SBMT363 and 21SBMT364)
Course Code	21SBMT368
Semester	VI
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT363		
I	Rings and Fields (Unit I)	1
II	Rings of Polynomials (Unit II)	1
III	Homomorphism and Factor Rings-I (Unit III)	1
IV	Ideals in a Ring (Unit III)	1
V	Unique Factorization Domain (Unit IV)	1
VI	Euclidean Domain and Gaussian Integers (Unit IV)	1
Practicals based on 21SBMT364		
I	Simultaneous Differential Equations of the First Order and the First Degree in Three Variables (Unit I)	1
II	Pfaffian Differential Equations and their Solution (Unit I)	1
III	Solution of First order Partial Differential Equations (Unit II)	1
IV	Linear Equations of First order equations and Integral surfaces passing through given curve (Unit II)	1
V	Solution of Second order Partial Differential Equations (Unit III)	1
VI	Canonical Forms and Solution of Second order Partial Differential Equations by Separation Variables Method (Unit IV)	1

Course/ Paper Title	Practical Course Lab-III (based on 21SBMT365 A or 21SBMT365B and 21SBMT366A or 21SBMT366B
Course Code	21SBMT369
Semester	VI
No. of Credits	2

Practical number	**Title**	**No. of Practical**
Practicals based on 21SBMT365A		
I	Network Models (Unit I)	1
II	Game Theory (Unit II)	1
III	Network Models and Game Theory (Unit I, Unit II)	1
IV	Replacement Theory (Unit III)	1
V	Sequencing (Unit IV)	1
VI	Classical Optimization Theory (Unit V)	1
Practicals based on 21SBMT365B		
I	Finite Fields (Unit I)	1
II	Cryptography (Unit II)	1
III	Public key (Unit III)	1
IV	Cryptography and Public key (Unit II, Unit III)	1
V	Primality and Factoring-I (Unit IV)	1
VI	Primality and Factoring-II (Unit IV)	1
Practicals based on 21SBMT366A		
I	Curves in plane and in space (Unit I)	1
II	How much does a curve? (Unit II)	1
III	Global properties of curves. (Unit III)	1
IV	Surface in three dimensions (Unit IV)	1
V	The first fundamental form (Unit V)	1
VI	Curvature of surfaces (Unit VI)	1

Practicals based on 21SBMT366B		
I	Length of Open and Closed Sets (Unit I)	1
II	Properties of Measurable Sets and Measurable Functions-I (Unit I, Unit-II)	1
III	Properties of Measurable Sets and Measurable Functions-II (Unit I, Unit-II)	1
IV	Lebesgue Integral (Unit III)	1
V	The Lebesgue Integral for Unbounded Functions (Unit-III)	1
VI	The Lebesgue Integral for Unbounded Functions and Some Fundamental Theorem (Unit-III)	1

Course/ Paper Title	Programming in Python - II
Course Code	21SBMT3610
Semester	VI
No. of Credits	2

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Graphics**	**6**
	1.1 Turtle Graphics: Overview of Turtle graphics, Turtle operations, Object instantiation and the Turtle graphics module.	1
	1.2 Drawing two-dimensional shapes.	1
	1.3 Taking a random walk.	1
	1.4 Colors and the RGB system.	1
	1.5 Drawing with random colors.	1
	1.6 Using the str function with objects.	1
Unit II	**Data Visualization with Python**	**4**
	2.1 Seaborn.	1
	2.2 Matplotlib.	1

	2.3 Plotly. 2.4 MayaVI.	1 1
Unit III	**Dictionary and Sorting, Minimum and Maximum**	**8**
	3.1 Introduction to Dictionary, Avoiding Key Error Exceptions, Iterating Over a Dictionary. 3.2 Dictionary with default values, Merging dictionaries, Accessing keys and values, Accessing values of a dictionary, Creating dictionary, Creating an ordered dictionary, Unpacking dictionaries using the ** operator. 3.3 Sorting, Minimum and Maximum: Special case: dictionaries, Using the key argument, Default argument to max, min, Getting a sorted sequence, Extracting N largest or N smallest items from an iterable, Getting the minimum or maximum of several values, Minimum and Maximum of a sequence.	2 3 3
Unit IV	**Computational Geometry**	**10**
	4.1 The distance between two points, Lists of Points – the Point List class, Integer point lists, Ordered Point sets, Extreme Points of a Point List, Random sets of Points not in general position. 4.2 Displaying Points and other geometrical objects, Lines, rays, and line segments, The geometry of line segments, Displaying lines, rays and line segments. 4.3 Representing polygons in Python, Triangles, Signed area of a triangle, Triangles and the relationships of points to lines, is Collinear, is Left, is Left On, is Right, is Right On, Between. 4.4 Two dimensional rotation and reflection. 4.5 Three dimensional rotation and reflection. 4.6 Generation of Bezier curve with given control points.	1 1 2 2 2 2
Unit V	**Study of Operations Research in Python**	**8**
	5.1 Linear Programming in Python. 5.2 Introduction to Simplex Method in Python.	4 4

Text books:

1. Fundamentals of Python: From First Programs to Data Structure, Keneth A Lambert, Martin Osborne, 2010, Course Technology, Cengage Learning.
   Unit-I: Chapter-7: Sec. 7.1.1 to 7.1.8
2. Python: Notes for Professionals, Goalkicker.com, Free Programming books.
   Unit-II: Chapter-108
   Unit-III: Chapter-19 Sec- 19.1 to 19.10 and Chapter-72: Sec. 72.1 to 72.8
3. Interactive Computational Geometry in Python, Jim Arlow,
   Unit-IV: Chapter-1: Sec.1 to 7, Chapter-2: Sec.1 to 2, Chapter-3: Sec.1, 3 to 11, Chapter-4: Sec.1
   Operations Research: Unit-V: https://pypi.org/project/PuLP

Reference books:

1. Fundamentals of Python - First Programs, Lambert K. A. Cengage Learning India, 2015.
2. Introduction to Computing and Programming in Python, Guzdial, M. J., Pearson India.
3. Introduction to Scientific Computing Using Python, Application Development Focus, Ljobomir Perkovic, second edition, Wiley Publication.
4. Jim Arlow, Interactive Computational Geometry in Python.

Website:

1. https://www.geeksforgeeks.org/geometric-algorithms/
2. https://towardsdatascience.com/using-python-and-operational-research-to-optimize-your- happiness-d96ab12bfb7b

Practical number	Title	No. of Practical
Practicals based on 21SBMT3610		
I	Turtle Graphics (Unit I)	1
II	Data Visualization (Unit II)	1
III	Dictionary, Sorting, Minimum and Maximum (Unit III)	1
IV	Application of Computational Geometry-I (Unit IV)	1
V	Application of Computational Geometry-II (Unit IV)	1
VI	Application of Computational Geometry-III (Unit IV)	1
VII	Study of graphical aspects of two dimensional transformation	1

	matrix using Matplotlib (Unit IV)	
VIII	Study of graphical aspects of three dimensional transformation matrix using Matplotlib (Unit IV)	1
IX	Study of graphical aspects of three dimensional transformation matrix using Matplotlib and Study of effect of concatenation of two dimensional and three dimensional transformations (Unit IV)	1
X	Generation of Bezier curve using given control points (Unit IV)	1
XI	Study of Operational Research in Python-I (Unit V)	1
XII	Study of Operational Research in Python-II (Unit V)	1

Course/ Paper Title	Mathematics into LaTeX
Course Code	21SBMT3611
Semester	VI
No. of Credits	2

Syllabus

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Figure Insertion**	**6**
	1.1 Commands and environment for inserting figures. 1.2 Inserting a simple figure. 1.3 Side by side figure. 1.4 Sub numbering a group of figures. 1.5 Figures in tables.	1 1 1 1 2
Unit II	**Equation Writing-I**	**12**
	2.1 Basic mathematical notations and figures 2.2 Mathematical operators. 2.3 Mathematical expressions in text-mode. 2.4 Simple equations. 2.5 Array of equations. 2.6 Left aligning an equation.	1 1 2 2 2 2

	2.7 sub- numbering a set of equations.	2
Unit III	**Equation Writing-II**	**14**
	3.1 Texts and blank space in math-mode	2
	3.2 Conditional expression.	2
	3.3 Evaluation of functional values.	2
	3.5 Vector and matrix.	2
	3.6 Over lining and underlining.	2
	3.7 Stacking terms.	2
	3.8 Side by side equation.	2
Unit IV	**User Defined Macros**	**4**
	4.1 Defining a new command.	2
	4.2 Defining a new environment.	2

Text book:

1. LaTeX in 24 Hours, A practical guide for scientific writing, Dilip Datta , Springer International Publishing, 2017.

Unit I: Chapter 9: Sec. 9.1 to 9.4, 9.8.

Unit II: Chapter 11: Sec. 11.1 to 11.7, Chapter 3: Sec. 3.1 to 3.7.

Unit III: Chapter 12: Sec. 12.1 to 12.8

Unit IV: Chapter 13: Sec. 13.1, 13.3 (13.31, 13.3.2, 13.3.3)

Reference books:

1. LaTeX, A Document Preparation System, User's Guide and Reference Manual, Leslie Lamport, Addison-Wesley Publishing Company, Inc., 1994.
2. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing Ltd, 2011.
3. LaTeX and Friends, M.R.C. van Dongen, Springer-Verlag Berlin Heidelberg ,2012.

Website:

1. www.overleaf.com

Practical number	Title	No. of Practical
Practicals based on 21SBMT3611		
I	Commands and Environment for inserting figures (Unit I)	1
II	More about figure insertion (Unit II)	1
III	Mathematical notations, Operators and Expression in LaTeX (Unit II)	1
IV	Simple equations (Unit II)	1
V	Array of equations (Unit II)	1
VI	Alignment and numbering a set of equations (Unit II)	1
VII	Texts, Blank Space and Conditional Expression in Math mode (Unit III)	1
VIII	Evaluation of functional values and splitting an equation (Unit III)	1
IX	Vector and matrix (Unit III)	1
X	More about equation writing in LaTeX (Unit III)	1
XI	New command in LaTeX (Unit IV)	1
XII	New environment in LaTeX (Unit V)	1