Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System (CBCS)

Proposal to Introduce New Academic Programme

In

T. Y. B. Sc. Mathematics

Implemented from

Academic Year 2023 - 24

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar(Autonomous)

Board of studies in Mathematics

Sr. No.	Name	Affiliation	Designation
1.	Dr. S. B. Gaikwad	Associate Professor, N.A.C.& Sc. College, Ahmednagar	Chairman
2.	Dr. S. V. Ingale	Assistant Professor, N.A.C.& Sc. College, Ahmednagar	Member
3.	Mr. S. A. Tarate	Assistant Professor N.A.C.& Sc. College, Ahmednagar	Member
4.	Dr. N. S. Darkunde	Assistant Professor School of Mathematical Sciences, Swami Ramanand Teerth Marathwada University, Nanded-43160 Hrs6	Member, Nominated by Academic council
5.	Dr. S. B. Bhalekar	Associate Professor, School of Mathematics and Statistics, University of Hyderabad, Central University Campus, Hyderabad- 500046	Member, Nominated by Academic council
6.	Dr. G. S. Kadu	Assistant Professor, Department of Mathematics, Savitribai Phule Pune University, Pune	Member, Nominated by Hon. Vice Chancellor, SPPU, Pune
7.	Mr. P. L. Pawar	Junior College Teacher, Ahmednagar College, Ahmednagar	Member, Alumina Nominated by Hon. Principal
8.	Mr. Shirish Padalkar	Principal Engineer, Medly Software System, LLP, Pune	Member, Industry/ Corporate Nominatedby Hon. Principal
9.	Dr. A. A. Kulkarni	Assistant Professor, Department of Statistics N.A.C.& Sc. College, Ahmednagar	Member (Coopted)
10.	Dr. A. V. Mancharkar	Professor and HOD Department of Physics N.A.C.& Sc. College, Ahmednagar	Member (Coopted)

Programme Structure and Course Titles: (All academic years)

Sr. No.	Class	Semester	Course Code	Course Title	Credits
1.	F.Y. B.Sc.	I	**BSC-MT101 T**	Algebra	2
2.	F.Y. B.Sc.	I	**BSC-MT102 T**	Calculus - I	2
3.	F.Y. B.Sc.	I	**BSC-MT 103 P**	Mathematics Practical using Maxima Software	1.5
4.	F.Y. B.Sc.	II	**BSC-MT 201 T**	Analytical Geometry	2
5.	F.Y. B.Sc.	II	**BSC-MT 202 T**	Calculus - II	2
6.	F.Y. B.Sc.	II	**BSC-MT 203 P**	Mathematics Practical using Maxima Software	1.5
7.	S. Y. B. Sc.	III	**BSC-MT 301 T**	Calculus of Several Variables	2
8.	S. Y. B. Sc.	III	**BSC-MT 302 T**	Numerical Methods and Differential Equations	2
9.	S. Y. B. Sc.	III	**BSC-MT 303 P**	Mathematics Practical	2
10.	S. Y. B. Sc.	IV	**BSC-MT 401 T**	Linear Algebra	2
11.	S. Y. B. Sc.	IV	**BSC-MT 402 T**	Vector Calculus	2
12.	S. Y. B. Sc.	IV	**BSC-MT 403 P**	Mathematics Practical	2
13.	T. Y. B. Sc.	V	**BSC-MT 501 T**	Metric Spaces	02
14.	T. Y. B. Sc.	V	**BSC-MT 502 T**	Real Analysis-I	02
15.	T. Y. B. Sc.	V	**BSC-MT 503 T**	Group Theory	02
16.	T. Y. B. Sc.	V	**BSC-MT 504 T**	Ordinary Differential Equations	02
17.	T. Y. B. Sc.	V	**BSC-MT 505 T (A)**	Operations Research	02
18.	T. Y. B. Sc.	V	**BSC-MT 505 T (B)**	Laplace Transform and Fourier Series	02
19.	T. Y. B. Sc.	V	**BSC-MT 506 T (A)**	Number Theory	02
20.	T. Y. B. Sc.	V	**BSC-MT 506 T (B)**	Machine Learning-I	02
21.	T. Y. B. Sc.	V	**BSC-MT 507 P**	Practical Course Lab-1	02
22.	T. Y. B. Sc.	V	**BSC-MT 508 P**	Practical Course Lab-II	02

23.	T. Y. B. Sc.	V	**BSC-MT 509 P**	Practical Course Lab-III	02
24.	T. Y. B. Sc.	V	**BSC-MT 510 P**	Programming in Python-I	02
25.	T. Y. B. Sc.	V	**BSC-MT 511 P**	LaTeX for Scientific Writing	02
26.	T. Y. B. Sc.	VI	**BSC-MT 601 T**	Complex Analysis	02
27.	T. Y. B. Sc.	VI	**BSC-MT 602 T**	Real Analysis-II	02
28.	T. Y. B. Sc.	VI	**BSC-MT 603 T**	Ring Theory	02
29.	T. Y. B. Sc.	VI	**BSC-MT 604 T**	Partial Differential Equations	02
30.	T. Y. B. Sc.	VI	**BSC-MT 605 T (A)**	Optimization Techniques	02
31.	T. Y. B. Sc.	VI	**BSC-MT 605 T (B)**	Lebesgue Integration	02
32.	T. Y. B. Sc.	VI	**BSC-MT 606 T (A)**	Computational Geometry	02
33.	T. Y. B. Sc.	VI	**BSC-MT 606 T (B)**	Machine Learning-II	02
34.	T. Y. B. Sc.	VI	**BSC-MT 607 P**	Practical Course Lab-I	02
35.	T. Y. B. Sc.	VI	**BSC-MT 608 P**	Practical Course Lab-II	02
36.	T. Y. B. Sc.	VI	**BSC-MT 609 P**	Practical Course Lab-III	02
37.	T. Y. B. Sc.	VI	**BSC-MT 610 P**	Programming in Python-II	02
38.	T. Y. B. Sc.	VI	**BSC-MT 611 P**	Introduction to Scilab	02

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar (Autonomous)
Syllabus of T. Y. B. Sc. Mathematics
under
Faculty of Science

Semester -V	**Paper -I**
Course Code: BSC-MT 501 T	**Title of the Course: Metric Spaces**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Student acquire the knowledge of notion of metric space, open sets and closed sets**.**
2. To apply the notion of metric spaces to continues functions on metric spaces.
3. To highlight the role of compactness in metric spaces and its relation to boundedness of functions.
4. To understand the basic concepts of completeness, compactness and connected sets.

Details of Syllabus:

Unit I: Introductory Concepts [09 Hrs.]

1.1 Definition and examples of metric spaces, open spheres and closed spheres

1.2 Neighborhoods, open sets, equivalent Metrics, interior points, closed sets

1.3 Limit points and isolated points, closure of a set, boundary points, distance between sets and diameter of a set

1.4 Product metric spaces

Unit II: Completeness [06 Hrs.]

2.1 Convergent sequences

2.2 Cauchy sequences

2.3 Complete spaces

2.4 Dense sets and nowhere dense sets (only definition)

Unit III: Continuous Functions [05 Hrs.]

3.1 Definition and characterizations

3.2 Extension theorem

3.3 Uniform continuity

3.4 Homeomorphism

Unit IV: Compactness and Connectedness [10 Hrs.]

4.1 Compact spaces

4.2 Sequential compactness

4.3 Continuous functions and compact spaces

4.4 Separated sets

4.5 Disconnected and connected sets.

Suggested Readings

1. Pawan K. Jain, Khalil Ahmad, Metric Spaces Narosa Publishing House, Second Edition (2009).
   Unit-I Chapter-2: 2.1 to 2.11, 2.13,
   Unit-II Chapter-3: 3.1 to 3.5,
   Unit-III Chapter-4: 4.1 to 4.2, 4.3(except 4.3.6), 4.4,
   Unit-IV Chapter-5: 5.1, 5.2, Chapter-6: 6.1, 6.2.
2. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House, Third Edition (2004)
3. B. K. Tyagi, First Course in Metric Spaces, Cambridge University Press , Seventh Edition (2002)
4. Satish Shirali, H.Vasudeva,, Metric Spaces, Springer , Narosa Publishing House, Second Edition (2007).
5. A course of Mathematical Analysis, Revised edition, Shantinarayan and Mittal - S. Chand and Co. (2002).
6. Mathematical Analysis, third Edition, S.C. Malik and Savita Arora - New Age International Publications.
7. Somasundaram D.; Choudhary, A First Course in Mathematical Analysis, Narosa Pub House.

Semester -V	**Paper -II**
Course Code: BSC-MT 502 T	**Title of the Course: Real Analysis-I**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Learn the basic facts in logic and set theory
2. Learn to define the sequence in terms of functions from N to a subset of R and to understand several properties of the real line.
3. Recognize bounded, convergent, divergent, Cauchy, and monotonic sequences and calculate their limit superior, limit inferior, and the limit of a bounded sequence.
4. Use the ratio, root, alternating series, and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Details of Syllabus:

Unit I: Logic and Set Theory [07 Hrs.]

1.1 Introduction: Logic
1.2 Set Theory and Venn Diagrams
1.3 Relations and Functions
1.4 Countable and Uncountable Sets

Unit II: Sequences of Real Numbers [08 Hrs.]

2.1 Definition of sequence and subsequence
2.2 Limit of a sequence
2.3 Convergent sequences
2.4 Divergent sequences
2.5 Bounded sequences
2.6 Monotone sequences

Unit III: Operations on convergent sequences and Limit Superior, Limit Inferior [06 Hrs.]

3.1 Operations on convergent sequences
3.2 Operations on divergent sequences
3.3 Limit superior and limit inferior
3.4 Cauchy sequences

Unit IV: Series of Real Numbers [09 Hrs.]

4.1 Convergence and divergence

4.2 Series with nonnegative terms
4.3 Alternating series
4.4 Conditional convergence and absolute convergence
4.5 Rearrangements of series
4.6 Tests for absolute convergence
4.7 Series whose terms form a non-increasing sequence
4.8 The class l_2.

Suggested Books:

1. Real Analysis and Foundations, Second Edition, Steven G. Krantz, 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, Second Edition, Richard R. Goldberg, 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
3. Real Analysis, N.L. Carothers, Cambridge University Press
4. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbert, John Wiley and Sons.
5. A Basic Course in Real Analysis, Ajit Kumar and S.Kumaresan ,CRC Press, Second Indian, CRC Press (Chapman and Hall)
6. A course of Mathematical Analysis, Revised edition, Shantinarayan and Mittal - S. Chand and Co. (2002).
7. Mathematical Analysis, third Edition, S.C. Malik and Savita Arora - New Age International Publications.
8. E-resource:
   https://math.libretexts.org/Bookshelves/Analysis/Book%3A_Introduction_to_Real_Analysis_(Trench)/04%3A_Infinite_Sequences_and_Series

   https://math.libretexts.org/Bookshelves/Analysis/Book%3A_Real_Analysis_(Boman_and_Rogers)/04%3A_Convergence_of_Sequences_and_Series

Semester- V	**Paper- III**
Course Code: BSC-MT 503 T	**Title Of the Course: Group Theory**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
2. Analyze consequences of Lagrange's theorem.
3. Learn about structure preserving maps between groups and their consequences.
4. Explain the significance of the notion of cosets, normal subgroups, and factor groups.

Details of Syllabus:

Unit I: Groups [05 Hrs]

1.1 Binary Operation- Definitions and examples

1.2 Isomorphic Binary Structures

1.3 Groups

1.4 Elementary properties of Groups

1.5 Finite Groups and Group tables

1.6 Alternating Group and Dihedral Group

Unit II: Subgroups [05 Hrs]

2.1 Subgroups

2.2 Subsets and subgroups

2.3 Cyclic subgroups

2.4 Cyclic Groups

2.5 Elementary properties of Cyclic Groups

2.6 The structure of Cyclic Groups

2.7 The subgroups of Finite Cyclic Groups

Unit III: Permutations [10 Hrs]

3.1 Groups of Permutations

3.2 Cayley's theorem

3.3 Orbits

3.4 Cycles

3.5 Alternating Groups

3.6 Cosets and the Theorem of Lagrange

3.7 Direct Products

Unit IV: Homomorphisms and Factor Group [10 Hrs]

4.1 Homomorphisms

4.2 Properties of Homomorphisms

4.3 Factor Groups

4.4 The Fundamental Homomorphism theorem

4.5 Normal subgroups and Inner Automorphisms

4.6 Factor Group Computations and Simple Groups

4.7 The Center and Commutator subgroups

Suggested Readings:

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

   Unit I: Sections 2,3,4

   Unit II: Sections 5,6

   Unit III: Sections 8,9,10,11(only direct product)

   Unit IV: Sections 13,14,15

2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (Second Ed., Foundation Books, New Delhi), 1995.
3. I. N. Herstien, Topics in Algebra (John Wiely and Sons).
4. N.S. Gopalakrishnan, University Algebra (Second Edition, New Age International, New Delhi) 1986.
5. Joseph. A. Gallian, Contemporary Abstract Algebra,(4th Edition, Narosa Publishing House).
6. Michael Artin, Algebra, Second Edition,Pearson

Semester -V	**Paper - IV**
Course Code: BSC-MT 504 T	**Title of the Course: Ordinary Differential Equations**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Understand the genesis of ordinary differential equations.
2. Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order
3. Understand methods of solving non-homogenous differential equations.
4. Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations

Details of Syllabus:

Unit I. First Order Equations [06 Hrs.]

1.1 Separable Equation
1.2 Homogeneous
1.3 Nonhomogeneous First Order Equations
1.4 Existence and Uniqueness of solutions of nonlinear equations

Unit II. Exact differential equations [08 Hrs.]

2.1 Exact differential equations
2.2 Integrating factors.
2.3 Linear Differential equations.
2.4 Bernoulli Equations

Unit III. Linear Differential Equations with constant coefficient [10 Hrs.]

3.1 Constant coefficient homogeneous equations
3.2 Characteristic equations
  3.2.1 distinct real roots
  3.2.2 repeated roots
  3.2.3 complex roots
3.3 Particular solution
3.4 Initial value problem
3.5 The operator $\frac{1}{f(D)}$ and its evaluation for the functions x^m,e^{ax} , $e^{ax}v$, xv and the Operator $\frac{1}{D^2+a^2}$ acting on sin ax and cos ax with proofs.

Unit IV. Non -Homogeneous Linear Equations [06 Hrs.]

4.1 Method of undetermined coefficients.

4.2 Method of reduction of order.

4.3 Method of variation of parameters.

Suggested Books:

1. William F Trench, Elementary Differential Equations with Boundary Value Problems, E book (Free download)
   Unit I: Chapter 2: Sec 2.2,2.3
   Unit II: Chapter 2: Sec 2.1,2.4 ,2.5, 2.6.
   Unit III: Chapter 5: Sections 2 to 3
   Unit IV: Chapter 5: Sections 4 to 7
2. Frank Ayres JR, Theory and Problems on Differential Equations, Schaum's outline Series, SI (metric) edition.
   Unit III: Chapter 16 Short methods
3. M. D. Raisinghania, Ordinary and Partial Differential Equations , S. Chand and Company LTD 2009.
4. Elementary Differential Equations seventh edition by Earl D. Rainville and Philip E Bedient.
5. George F. Simmons and Stevan G. Krantz , Differential Equations, Tata McGraw-Hill.

Semester -V	**Paper -V**
Course Code: BSC-MT 505 T (A)	**Title of the Course: Operations Research**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Analyze and solve linear programming models of real-life situations.
2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
3. The relationships between the primal and dual problems and their solutions with applications to transportation, assignment
4. Understand the Hungarian Method.

Details of Syllabus:

Unit I. Modeling with Linear Programming [08 Hrs]

1.1 Two variable LP Model
1.2 Solution of LP Model by Graphical Method
1.3 Selected LP Model Applications
1.4 Graphical Sensitivity Analysis.

Unit II. The Simplex Method and Duality [08 Hrs]

2.1 LP Model in equation form
2.2 Transition from graphical to algebraic solutions
2.3 The Simplex method.
2.4 Definition of the dual problem
2.5 Primal dual relationship
2.6 Economic interpretation of Duality.

Unit III. Transportation Model [08 Hrs]

3.1 Definition of the Transportation model
3.2 North west Corner Method
3.3 Matrix Minima Method
3.4 Vogel's Approximation Method
3.2 The Transportation algorithm.

Unit IV. The Assignment Model [06 Hrs]

4.1 The Hungarian method
4.2 Simplex explanation of the Hungarian method.

Suggested Books:

1. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
   Unit I: Chapter-2: 2.1,2.2,2.3(2.3.4, 2.3.5, 2.3.6).
   Unit II: Chapter-3: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 (3.6.1), Chapter-4: 4.2, 4.3
   Unit III: Chapter -5: 5.1,5.3 (5.3.1, 5.3.2, 5.3.3),
   Unit IV: Chapter-5: 5.4(5.4.1, 5.4.2).

2. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operation Research (Eighth Edition) Tata McGraw Hill.
3. J K Sharma, Operations Research (Theory and Applications, second edition, 2006), Macmillan India Ltd.
4. Hira and Gupta, Operation Research.

Semester -V	**Paper -V**
Course Code: BSC-MT 505 T (B)	**Title of the Course: Laplace Transform and Fourier Series**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Students will be able to know the use of Laplace transform in system modeling, digital signal processing, process control.
2. Solve an initial value problem for nth order ordinary differential equation using the Laplace transform.
3. Find the Fourier series representation of a function of one variable
4. To find the solution for simultaneous Ordinary Differential Equations.

Details of Syllabus:

Unit I: The Laplace Transform [10 Hrs]

1.1 Definition, Laplace Transform of some elementary functions.
1.2 Sufficient condition for existence of Laplace Transform
1.3 Some important properties of Laplace Transform.
1.4 Methods of finding Laplace Transform: Direct Method, Series Method
1.5 Evaluation of Integration
1.6 Some Special Functions

Unit II: The Inverse Laplace Transform [10 Hrs]

2.1 Definition, Some inverse Laplace Transform.
2.2 Some important properties of Inverse Laplace Transform.
2.3 Methods of finding inverse Laplace Transforms: Partial Fraction Method and Series Method.
2.4 The Heaviside's Expansion formula.
2.5 Beta function, Evaluation of Integration.

Unit III: Applications to Differential Equations [05 Hrs]

3.1 Ordinary Differential Equations with constant coefficients.
3.2 Ordinary Differential Equations with variable coefficients.
3.3 Simultaneous Ordinary Differential Equations.

Unit IV: Fourier series [05 Hrs]

4.1 Even and Odd functions, Its properties.

4.2 Fourier series and its Examples.

Suggested Books:

1. Schaum's Outline Series-Theory and Problems of Laplace Transform by Murray R. Spiegel.
   Unit I:Chapter-1,
   Unit II:Chapter-2,
   Unit III:Chapter-3 (Excluding Applications to Mechanics, Electrical circuits, Beam and PDE).
2. Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co.Pvt..Ltd.(1970).
   Unit4: Chapter-12(only12.1)
3. Phil Dyke, An Introduction to Laplace Transforms and Fourier Series, Second Edition, Indian Reprint 2014.
4. Joel L. Schiff, The Laplace Transforms- Theory and Applications, Springer Verlag New York 1999.
5. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, Third Edition, CRC Press.

Semester- V	**Paper- VI**
Course Code: BSC-MT 506 (A) T	**Title Of the Course: Number Theory**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Some of the open problems related to prime numbers.
2. About number theoretic functions and modular arithmetic.
3. The Law of Quadratic Reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.
4. The Diophantine equations and Pythagorean triplets.

Details of Syllabus:

Unit I: Divisibility [05 Hrs]

1.1 Introduction

1.2 Divisibility

1.3 Prime

1.4 Fundamental theorem of Arithmetic

Unit II: Congruences [06 Hrs]

2.1 Properties of Congruences

2.2 Residue classes

2.3 Fermat's theorem, Euler's theorem, Wilson's theorem

2.4 Solution of Congruences

2.5 The Chinese Remainder Theorem

Unit III: Greatest integer function [08 Hrs]

3.1 Greatest integer function

3.2 Arithmetic functions

3.3 The number of divisors d(n)

3.4 $\sigma(n)$, $\omega(n)$ and $\Omega(n)$

3.5 The Mobius Inversion formula

Unit IV: Quadratic Reciprocity and Diophantine equations [11 Hrs]

4.1 Quadratic residues

4.2 Legendre's symbol and its properties

4.3 Quadratic reciprocity

4.4 The Jacobi Symbol

4.5 Diophantine equations ax + by = c

4.6 Pythagorean triplets

Suggested Books:

1. I. Niven, H. Zuckerman and H.L. Montgomery, An Introduction to Theory of Numbers, 5th Edition, John Wiley and Sons.

   Unit I: Chapter 1 Section 1.1- 1.3,

   Unit II: Chapter 2 Section 2.1- 2.3,

   Unit III: Chapter 3 Section 3.1- 3.3,

   Unit IV: Chapter 4 Section 4.1 -4.3, Chapter 5 Section 5.1 and 5.3

2. David M. Burton, Elementary Number Theory (Second Ed.), Universal Book Stall, New Delhi, 1991.
3. T. M. Apostol, An Introduction to Analytical Number Theory (Springer International Student's Edition), 1998.
4. S. G. Telang, Number Theory (Tata Mc Graw Hill), 1996.

Semester- V	**Paper-VI**
Course Code: BSC-MT 506 (B) T	**Title Of the Course: Machine Learning-I**
Credits: 2	**Total Lectures: 30 hours**

Course Outcomes:

1. Gain knowledge about basic concepts of Machine Learning.
2. Identify machine learning techniques suitable for a given problem.
3. Solve the problems using various machine learning techniques.
4. Understand the End to End Machine Learning Project.

Details of Syllabus:

Unit I: Introduction to Machine Learning [06 Hrs]

1.1 What & why behind machine learning

1.2 Types of Machine Learning - Supervised vs Unsupervised

1.3 Model Based Training

1.4 Main challenges of Machine Learning

1.5 Testing and Validating

Unit II: Introduction to Python [06 Hrs]

2.1 The Way Of The Program

2.2 Variables, Expressions and Statements

2.3 Functions

2.4 Conditionals and Recursion

2.5 Strings

2.6 Lists

Unit III: Understanding ML related Python Packages [09 Hrs]

3.1 Numpy Basics: Arrays and Vectorized Computation

3.2 The NumPy ndarray: A Multidimensional Array Object

3.3 Universal Functions: Fast Element-wise Array Functions

3.4 Data Processing Using Arrays

3.5 Linear Algebra

3.6 Getting Started with Pandas

3.7 Introduction to pandas Data Structures

3.8 Essential Functionality

3.9 Summarizing and Computing Descriptive Statistics

3.10 Handling Missing Data

3.11 Hierarchical Indexing

3.12 Plotting and Visualization

3.13 A Brief matplotlib API Primer

3.14 Plotting Functions in Pandas

Unit IV: End to End Machine Learning Project [09 Hrs]

4.1 Get the data

4.2 Discover & Visualize the data to gain insights

4.3 Preparing the data for machine learning - Cleaning, Handling categorical values, Feature scaling

4.4 Select and Train a model - Training and Evaluating on the Training Set

4.5 Fine-tuning the model- Grid and Randomized Search

Suggested Books:-

1. Keras and Tensorflow, Hands-on Machine Learning with Scikit-Learn – Aurelien Heron,
   Unit I: Chapter1
   Unit IV: Chapter 2
2. Wes McKinney Python for Data Analysis (O' Reilly publication)
   Unit-III: Chapter 4: 4.1,4.2, 4.3, 4.5, Chapter -5: 5.1, 5.2, 5.3, 5.4, 5.5,
   Chapter-8: 8.1, 8.2, 8.3
3. Allen Downey, Think Python, How to Think Like a Computer Scientist, Green Tea Press Needham, Massachusetts, 2015,
   Unit II: Chapter -1, 2, 3, 5, 8, 10
4. Andreas C. Muller & Sarah Guide Introduction to Machine Learning With Python
5. Paul Barry Head first Python (O Reilly publication)
6. Jason Brownlee - Basics of Linear Algebra for Machine Learning, 2018
7. M. P. Deisenroth, A. A. Faisal, C. S. Ong - Mathematics for Machine Learning, Cambridge University Press, 2019
8. Dipanjan Sarkar, Raghav Bali, Tushar Sharma - Practical Machine Learning with

Python, 2018.

Some Extra References:-

https://developers.google.com/machine-learning/crash-course

https://learn.microsoft.com/en-us/training/modules/introduction-to-machine-learning/

Semester -V	**Paper - VII**
Course Code: BSC-MT 507 P	**Title of the Course: Practical Course Lab-1**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 501 T and BSC-MT 502 T)

Semester -V	**Paper – VIII**
Course Code: BSC-MT 508 P	**Title of the Course: Practical Course Lab-II**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 503 T and BSC-MT 504 T)

Semester –V	**Paper - IX**
Course Code: BSC-MT 509 P	**Title of the Course: Practical Course Lab-III**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 505 T (A) or BSC-MT 505 T (B) and BSC-MT 506 T (A) or BSC-MT 506 T (B))

Semester -V	**Paper - X**
Course Code: BSC-MT 510 P	**Title of the Course: Programming in Python–I**
Credits: 2	**Total Lectures: 60 Hrs.**

Course Outcomes:

1. To understand why Python is a useful scripting language for developers.
2. To learn how to use lists, tuples, and dictionaries in Python programs.
3. To learn and understand python looping, control statements and string manipulations.
4. To acquire programming skills in core Python.

Details of Syllabus:

Unit I. Introduction to Python [06 Hrs.]

1.1 Installation of Python.
1.2 Values and types: int, float and str.
1.3 The Print Function: Print basics.
1.4 Variables: assignment statements, printing variable values, types of variables.
1.5 Mathematical Operators, operands and precedence: +, -, /, *, **, % PEMDAS.
1.6 String operations: +: Concatenation, * : Repetition.
1.7 Boolean operator:
    1.7.1 Comparison operators: ==, !=, >, =, <=
    1.7.2 Logical operators: and, or, not
1.8 Mathematical functions from math, cmath modules, random module.
1.9 Keyboard input: input() statement.
1.10 Calculus: Differentiation, Integration, Limit and Series.

Unit II. String, List, Tuple [06 Hrs.]

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.

Unit III. Iterations and Conditional statements [06 Hrs.]

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.
3.3.4 User defined functions, Parameters and arguments.

Unit IV. Linear Algebra in Python [04 Hrs.]

4.1 Matrix construct, 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.

Unit V. Numerical methods in Python [04 Hrs.]

5.1 Roots of Equations.
5.2 Newton-Raphson Method.
5.3 False Position (RegulaFalsi) Method.
5.4 Numerical Integration:
5.4.1 Trapezoidal Rule.
5.4.2 Simpson's 1/3rd Rule.
5.4.3 Simpson's 3/8th Rule.

Unit VI. 2D and 3D Graphs [04 Hrs.]

6.1 Installation of numpy, matplotlib packages
6.2 Graphs plotting of functions
6.3 Different formats of graphs, PyDotPlus (Scalable Vector Graphics), PyGraphviz. Decorate Graphs with Plot Styles and Types: Markers and line styles, Control colors, Specifying styles in multiline plots, Control line styles, Control marker styles. 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.

Practicals: [30 Hrs.]

Practical 1: Introduction to Python, Python Data Types-I (Unit 1)
Practical 2: Python Data Types- II (Unit 2)
Practical 3: Control statements in Python-I (Unit 3- 3.1, 3.2)
Practical 4: Control statements in Python-II (Unit 3- 3.3)
Practical 5: Application: Matrices (Unit 4 – 4.1-4.3)
Practical 6: Application: Determinants, system of Linear Equations (Unit 4- 4.4, 4.5)
Practical 7: Application: System of equations (Unit 4- 4.5)
Practical 8: Application: Eigenvalues, Eigenvectors (Unit 4 – 4.6)
Practical 9: Application: Eigenvalues, Eigenvectors (Unit 4 – 4.6)
Practical 10: Application: Roots of equations (Unit 5 – 5.1)
Practical 11: Application: Numerical integration (Unit 5 – 5.2, 5.3,5.4)
Practical 12: Graph Plotting (Unit 6)

Suggested Books:

1. Allen Downey, Think Python, How to Think Like a Computer Scientist, Green Tea Press Needham, Massachusetts, 2015,
   Unit-I: Chapter-1:1.1-1.5, Capter-2: 2.1-2.6, Chapter-3: 3.1-3.6, Chapter-5: 5.1-5.3
   Unit-II: Chapter-8: 8.1-1.5, Capter-10: 10.12, Chapter-12: 12.1.- 12.6
   Unit-III: Chapter 5:5.4 -5.7, Chapter 7: 7.1-7-7.5
2. Robert Johansson, Introduction to Scientific Computing in Python, 2016
   Unit-I: 6.5-6.8
   Unit- IV: Chapter-4: 4.6 (4.6.1 - 4.6.6), Chapter-6: 6.9-6.10, Unit-5: Chapter-4: 4.8,
   Unit-VI: Chapter-5
3. Hans-PetterHalvorsen,Python for Scientific engineering, 2020 Unit-5: Chapter-31
4. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015.
5. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
6. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle and Assiciatesn Inc.
7. SandroTosi, Matplotlib for Python Developers, Packet Publishing Ltd. (2009) BIRMINGHAM – MUMBAI. (Use for 2D and 3D plots and also use Lambert K. A book).
8. Python: Notes for Professionals, Goalkicker.com, Free Programming books.
9. Luciano Ramalho, Fluent Python, August 2015, O'Reilly Media, Inc.
10. Readings available on Python official website:
    https://docs.python.org/3/tutorial/index.html

Semester -V	**Paper -XI**
Course Code: BSC-MT 511 P	**Title of the Course: LaTeX for Scientific Writing**
Credits: 2	**Total Lectures: 60 Hrs.**

Course Outcomes:

1. Write a simple LaTeX input document based on the article class.
2. Turn the input document into pdf with the pdflatex program.
3. Format Words, Lines, and Paragraphs.
4. Understand how to present data using tables.

Details of Syllabus:

Unit I. Introduction to LaTeX [05 Hrs.]

1.1 Definition and application of LaTeX
1.2 Preparation and Compilation of LaTeX input file
1.3 LaTeX Syntax
1.4 Keyboard Characters in LaTeX

Unit II. Formatting Words, Lines, and Paragraphs [08 Hrs.]

2.1 Text and Math Mode Fonts.
2.2 Emphasized and Colored Fonts
2.3 Sectional Units
2.4 Labeling and Referring Numbered Items
2.5 Texts Alignment and Quoted text
2.6 New Lines and Paragraphs
2.7 Creating and Filling Blank Space
2.8 Producing Dashes Within Texts

Unit III. Listing, Tabbing Texts and Table Preparation [08 Hrs.]

3.1 Listing Texts
3.2 Tabbing Texts Through the tabbing Environment
3.3 Table Through the tabular Environment
3.4 Table Through the tabularx Environment
3.5 Vertical Positioning of Tables
3.6 Sideways (Rotated) Texts in Tables
3.7 Adjusting Column Width in Tables
3.8 Additional Provisions for Customizing Columns of Tables
3.9 Merging Rows and Columns of Tables.

Unit IV. Equation Writing in LaTeX [10 Hrs.]

4.1 Basic Mathematical Notations and Delimiters., Mathematical Operators.

4.2 Mathematical Expressions in Text-Mode.
4.3 Simple Equations.
4.4 Array of Equations.
4.5 Left Aligning an Equation.
4.6 Sub-numbering a Set of Equations.
4.7 Texts and Blank Space in Math-Mode.
4.8 Conditional Expression.
4.9 Evaluation of Functional Values.
4.10 Splitting an Equation into Multiple Lines.
4.11 Vector and Matrix.
4.12 Over lining and Underlining.
4.13 Stacking Terms.
4.14 Side-by-Side Equations.

Suggested Books:

1. LaTeX in 24 Hours, A Practical Guide for Scientific Writing, Dilip Datta, Springer International Publishing AG, 2017.
   Unit I: Chapter 1; 1.1 to 1.6,
   Unit II: Chapter 2; 2.1 to 2.4, Chapter 3; 3.1 to 3.7
   Unit III: Chapter 6; 6.1, 6.2,
   Unit IV: Chapter 7; 7.1 to 7.7
2. LaTeX, A Document Preparation System, User's Guide and Reference Manual, Leslie Lamport, Addison-Wesley Publishing Company, Inc., 1994.
3. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing Ltd, 2011.
4. LaTeX and Friends, M.R.C. van Dongen, Springer-Verlag Berlin Heidelberg , 2012.
5. Math into LaTeX, George Gratzer, Springer Science Business Media New York, 1996.

Semester- VI	**Paper- I**
Course Code: BSC-MT 601 T	**Title Of the Course: Complex Analysis**
Credits: 2	**Total Lectures: 30 Hrs**

Course Outcomes:

1. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
2. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
3. Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.
4. Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

Details of Syllabus:

Unit I. Analytic functions [09 Hrs]

1.1 Functions of a Complex Variables

1.2 Limits, Theorems on limits (Without Proof), Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulas (Without Proof)

1.3 Cauchy- Riemann Equations, Sufficient Conditions for differentiability

1.4 Polar coordinates

1.5 Analytic functions

1.6 Harmonic functions

1.7 Elementary Functions

Unit II . Integrals [11 Hrs]

2.1 Derivatives of functions, Definite integrals of functions

2.2 Contours, Contour integral, Examples

2.3 Upper bounds for Moduli of contour integrals, Anti-derivatives (Only Examples)

2.4 Cauchy-Goursat Thorem (without proof)

2.5 Simply and multiply Connected domains

2.6 Cauchy integral formula

2.7 Derivatives of analytic functions

2.8 Liouville's Theorem and Fundamental Theorem of Algebra (Without Proof)

Unit III. Series [06 Hrs]

3.1 Convergence of sequences (Theorems without proof)

3.2 Convergence of series (Theorems without proof)

3.3 Taylor's series

3.4 Laurent series

Unit IV: Residues and Poles [04 Hrs]

4.1 Isolated singular points

4.2 Residues

4.3 Cauchy residue theorem

4.4 Residue at infinity, types of isolated singular points, residues at poles

4.5 Zeros of analytic functions, zeros and poles

Suggested Books:

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

Unit -I: Chapter 1: Sec.11, 12, 15 to 26.

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

Unit -III: Chapter 4: Sec. 37 to 44, 46 and 48 to 53.

Unit -IV: Chapter 5: Sec. 55 to 60 and 62.

2. S. Ponnusamy, Complex Analysis, (Second Edition Narosa).

3. L.V.Ahlfors, Complex Analysis, (3rd edition, McGraw Hill), 2000.

4. H.A.Priestley, Introduction to Complex Analysis,(2nd edition (Indian), Oxford), 2006

Semester -VI	**Paper -II**
Course Code: BSC-MT 602 T	**Title of the Course: Real Analysis-II**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
2. Recognize the difference between pointwise and uniform convergence of a sequence of functions.
3. Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.
4. Understand the different tests of convergence of improper integrals.

Details of Syllabus:

Unit I. Riemann Integration [10 Hrs.]

1.1 Sets of Measure zero
1.2 Definition of the Riemann Integral
1.3 Existence of the Riemann Integral
1.4 Properties of the Riemann Integral
1.5 Fundamental Theorems of Calculus

Unit II. Improper Integrals [08 Hrs.]

2.1 Improper Integrals on Closed and Bounded Intervals
2.2 Tests for Convergence of Positive Integrands
2.3 Improper Integrals on Unbounded Intervals and Tests for their Convergence
2.4 Tests for Convergence of the Integral of Product

Unit III: Sequences of Functions [06 Hrs.]

3.1 Pointwise convergence of sequences of functions
3.2 Uniform convergence of sequences of functions
3.3 Consequences of uniform convergence

Unit IV: Series of Functions [06 Hrs.]

4.1 Convergence and uniform convergence of series of functions
4.2 Integration and differentiation of series of functions

Suggested Books:

1. Methods of Real Analysis, Second Edition, Richard R. Goldberg, John Wiley and amp; Sons, Inc.
   Unit -I: Sec.: 7.1,7.2,7.3,7.4,7.8,
   Unit -III: Sec: 9.1 to 9.3,
   Unit-IV: Sec.9.4, 9.5
2. Introduction to Real Analysis, Eighth Edition, S.K. Mapa, Sarat Book House
   Unit-II: Sections: 12.1, 12.2, 12.3, 12.4,12.5, 12.6, 12.7, 12.8, 12.9, 12.10
3. Real Analysis, N.L. Carothers, Cambridge University Press
4. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbert, John Wiley and Sons.
5. A Basic Course in Real Analysis, Ajit Kumar and S.Kumaresan, CRC Press, Second Indian, CRC Press (Chapman and Hall)
6. A course of Mathematical Analysis, Revised edition, Shanti Narayan and Mittal - S.Chand and Co.(2002).
7. Mathematical Analysis, third Editions'. Malik and Savita Arora - New Age International Publications
8. E-resource:
   https://math.libretexts.org/Bookshelves/Analysis/Introduction_to_Real_Analysis_(Lebl)/06%3A_The_Riemann_Integral

   https://math.libretexts.org/Bookshelves/Analysis/Book%3A_Functions_Defined_by_Improper_Integrals_(Trench)/01%3A_Chapters/1.03%3A_Uniform_convergence_of_improper_integrals

Semester -VI	**Paper -III**
Course Code: BSC-MT 603 T	**Title of the Course: Ring Theory**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. To introduce the terms Ring, Fields and subring.
2. Learn to define Integral Domain, Ideals, Prime and Maximal Ideals.
3. To understand homomorphism, Isomorphism, Rings of polynomials and Principle Ideal Domain.
4. To study about Gauss's lemma, Euclidean norm, Euclidean domain, Gaussian Integers and Multiplicative Norm.

Details of Syllabus:

Unit I. Introduction to Ring and Fields. [05 Hrs.]

1.1 Definition of Ring and Field
1.2 Uniqueness of unit and inverse.
1.3 Subring, Subring test
1.4 Examples

Unit II. Integral Domain. [06 Hrs.]

2.1 Definition of integral domain, Zero divisors.
2.2 Characteristic of a ring with unity.
2.3 Ideals, Factor rings, Fundamental Homomorphism Theorem.
2.4 Prime ideal, Maximal ideal.

Unit III. Homomorphism of Ring. [07 Hrs.]

3.1 Homomorphism, Isomorphism, Properties of Ring homomorphism.
3.2 Ring of polynomials over R.
3.3 Polynomials indeterminate.
3.4 Division Algorithm.
3.5 Principle Ideal Domain.

Unit IV. Factorization of polynomials. [12 Hrs.]

4.1 Associates, Irreducible and Prime, Reducibility and Irreducibility tests.
4.2 Gauss's lemma.
4.3 Eisenstein's Criterion.

4.4 Unique Factorization Domains.
4.5 Euclidean Norm, Euclidean Domain.
4.6 Gaussian Integers, Multiplicative Norm.

Suggested Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, Seventh Edition, Pearson.
   Unit-I: Section 18 ,19,21.
   Unit-II: Section 22, 23.
   Unit-III: Section 26 and 27.
   Unit-IV: Section 45,46 and 47.
2. Joseph A. Gallian, Contemporary Abstract Algebra, (4th Edition), Narosa Publishing House.
3. I. N. Herstein. Abstract Algebra, (3rd Edition), Prentice Hall of India, 1996.
4. N. S. Gopalkrishnan, University of Algebra, Wiley Eastern, 1986.
5. C. Musili, Rings and Modules, Narosa Publishing House, 1992.
6. Michael Artin, Algebra, Second Edition, Pearson

Semester -VI	**Paper -IV**
Course Code: BSC-MT 604 T	**Title of the Course: : Partial Differential Equations**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Understand the genesis of Partial differential equations.
2. Formulate, classify and transform partial differential equations into canonical form
3. Solve linear partial differential equations using various method apply these methods in solving some physical problem
4. Understanding the difference between Complementary solution and particular solutions

Details of Syllabus:

Unit I. Introduction to Ordinary and Partial Differential Equations [10 Hrs.]

1.1 Surfaces and Curves in Three Dimensions

1.2 Simultaneous Differential Equations of the First Order and the First Degree in Three Variables.

1.3 Methods of solution of $dx/P = dy/Q = dz/R$

1.4 Pfaffian Differential Forms and Equations.

1.5 Solution of Pfaffian Differential Equations in Three Variables

Unit II. Partial Differential Equations [08 Hrs.]

2.1 Introduction to Partial Differential Equations

2.2 Origin of first order Partial Differential Equations

2.3 Linear Equations of First order equations

2.4Integral surface passing through given curve

2.5 Compatible systems

Unit III. Second Order Partial Differential Equations [04 Hrs.]

3.1The Origin of Second Order Partial Differential Equations.

3.2 Linear Partial Differential Equations with constant coefficients.

3.3 Classification of second order partial differential equations, Heat Equation and Wave Equation

Unit IV. Methods of solving Linear Partial Differential Equations [08 Hrs.]

4.1 Solution of reducible equations

4.2 Solution of irreducible equations with constant coefficients

4.3 Rules of finding complementary functions

4.5 Rule of finding particular integrals

Suggested Books:

1. Ian Sneddon, Element of Partial Differential Equations, McGraw-Hill Book Company, McGraw-Hill Book Company.
   Unit-I: Chapter-1: 1,2,3,5
   Unit-II: Chapter-2 :1,2,4,5,9
   Unit-III: Chapter-3: 1,4
   Unit IV: Chapter -3: 4,5
2. T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Publishing, House 2nd Edition, 2003 (Reprint, 2006).
   Unit -3.3: Chapter -2 -2.2
3. K. Sankara Rao, Introduction to Partial Differential Equations, Third Edition, PHI.
4. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand and Company LTD 2009

Semester- VI	**Paper- V**
Course Code: BSC-MT 605 T (A)	**Title Of the Course: Optimization Techniques**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Understands fundamentals of Network Analysis using CPM and PERT.
2. Solves a sequencing Problem for various jobs and machines.
3. Knows Lagrange multipliers methods for solving problems on finding extremum.
4. Understands some special types of Games.

Details of Syllabus:

Unit I. Network Models [08 Hrs]

1.1 Network logic

1.2 Numbering the events (Fulkerson's rule)

1.3 Network representation

1.4 Critical Path Computations

1.5 PERT computations

Unit II. Game Theory [09 Hrs]

2.1 The theory of games

2.2 Characteristics of games

2.3 Game model

2.4 Definitions

2.5 Rules for a game theory

2.6 Mixed strategies (2×2, $2\times n$ or $m\times2$ game)

Unit III. Replacement and Maintenance Models [04 Hrs]

3.1 Introduction

3.2 Types of failure

3.3 Replacement of items whose efficiency deteriorates with time

Unit IV. Sequencing Problems [04 Hrs]

4.1 Sequencing problem

4.2 Assumptions in sequencing problem

4.3 Processing n jobs through two machines

4.4 Processing n jobs through three machines

Unit V. Classical Optimization Theory [05 Hrs]

5.1 Local and global optimum

5.2 Concave and convex function

5.3 Constrained problem with one equality constraints (Lagrangian Method Only)

5.4 Constrained problem (Necessary and sufficient condition for general NLPP)

Suggested Books:

1. Hira and Gupta, Operation Research (Seventh Edition, S. Chand Publication), Reprint 2016.

Unit I: Chapter 14, Sec.14.8, 14.9, 14.12, 14.13

Unit II: Chapter 9, Sec. 9.10, 9.11,9.12, 9.13, 9.14, 9.15, 9.16, 9.17, 9.18, 9.19

Unit III: Chapter 11, Sec. 11.1, 11.2(11.2-1 Only)

Unit IV: Chapter 5, Sec 5.1, 5.2, 5.4, 5.5

Unit V: Chapter 16, Sec. 16.4, 16.5, 16.7

2. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.
3. J K Sharma, Operations Research (Theory and Applications, second edition), 2006
4. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operation Research (Eighth Edition), Tata McGraw Hill.

Semester -VI	**Paper -V**
Course Code: BSC-MT 605 (B) T	**Title of the Course: Lebesgue Integration**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. To understand the concept of measure and properties of Lebesgue measure.
2. To understand the properties and concept of measurable sets
3. To study the properties of Lebesgue integral and compare it with Riemann integral.
4. To understand the properties of Lebesgue integrals for unbounded functions

Details of Syllabus:

Unit I. Measurable Sets: [06 Hrs]

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.

Unit II. Measurable Functions: [08 Hrs]

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 function

Unit III. The Lebesgue integral for bounded function [08 Hrs]

3.1 Measurable partition, lower sum, upper sum,
3.2 Lebesgue integral for bounded measurable function
3.3 Properties of Lebesgue integrals for bounded measurable functions

Unit IV. The Lebesgue integral for unbounded function [08 Hrs]

4.1 The Lebesgue integral for non-negative valued function
4.2 The Lebesgue integral for real valued function
4.3 Properties of Lebesgue integrals for unbounded functions
4.4 Some fundamental theorems

Suggested Books:

1. Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. (1970).
Unit I: Chapter 11: Sec 11.1 to 11.3. (Theorem No. 11.1B and 11.1C Statements only).

Unit II: Chapter 11: Sec 11.4.
Unit III: Chapter 11: Sec 11.5 to 11.4.
Unit IV: Chapter 11: Sec. 11.5 to 11.8 (Theorem 11.8 D statement only)

2. Tom M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House.
3. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis,Narosa Publishing House.
4. R.G. Bartle and D.R. Scherbert, Introduction to real analysis Fourth Edition, Wiley India Edition.
5. Inder K. Rana, An Introduction to Measure and Integration Second Edition, NarosaPublishing House.
6. G. de Barra, Measure Theory and Integration, New Age International (P) Limited, Publishers.

Semester -VI	**Paper -VI**
Course Code: BSC-MT 606 (A) T	**Title of the Course: Computational Geometry**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Construct algorithms for simple geometrical problems.
2. Characterize invariance properties of Euclidean geometry by groups of transformations.
3. Describe and construct basic geometric shapes and concepts by computational means.
4. Understand the concept of Bezier Curves.

Details of Syllabus:

Unit 1. Two Dimensional Transformations [08 Hrs]

1.1 Introduction.
1.2 Representation of points.
1.3 Transformations and matrices.
1.4 Transformation of – points, straight lines.
1.5 Midpoint Transformation.
1.6 Transformation of – parallel lines, intersecting lines.
1.7 Transformation: rotations, reflections, scaling.
1.8 Combined transformations.
1.9 Transformation of a unit square.
1.10 Solid body transformations.
1.11 Translations and homogeneous coordinates.
1.12 Rotation about an arbitrary point.
1.13 Reflection through an arbitrary line.
1.14 Projection – A Geometric Interpretation of Homogeneous Coordinates.
1.15 Overall Scaling.
1.16 Points at Infinity.

Unit 2. Three Dimensional Transformations [08 Hrs]

2.1 Introduction.
2.2 Three dimensional – Scaling, shearing, rotation, reflection, translation.
2.3 Multiple transformations.
2.4 Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space.
2.5 Reflection through an arbitrary plane.

Unit 3. Projection [08 Hrs]

3.1 Orthographic projections.
3.2 Axonometric projections.
3.3 Oblique projections.

3.4 Perspective Transformations.

Unit 4. Plane and Space Curves [06 Hrs]

4.1 Introduction.
4.2 Curve representation.
4.3 Parametric curves.
4.4 Parametric representation of a circle.
4.5 Bezier Curves – Introduction, definition, properties (without proof),
Curve fitting (up to n = 3), equation of the curve in matrix form (up to n = 3).

Suggested Book:

1. D. F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill, Second Edition.
Unit I: Chapter 2: Sec. 2.1 to 2.20,
Unit II: Chapter 3: Sec. 3.1 to 3.10.
Unit III: Chapter 3: Sec. 3.12 to 3.15,
Unit IV: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5, Chapter 5: Sec. 5.1, 5.8.

2. Computer Graphics with OpenGL, Donald Hearn, M. Pauline Baker, Warren Carithers, Pearson (4th Edition).
3. Schaum Series, Computer Graphics by Zhigang Xiang and Roy A. Plastock.

Semester- VI	**Paper- VI**
Course Code: BSC-MT 606 (B) T	**Title Of the Course: Machine Learning-II**
Credits: 2	**Total Lectures: 30 Hrs.**

Course Outcomes:

1. Students learn, understand and practice machine learning approaches which include the study of modern computing big data technologies.
2. Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.
3. Students are able to scaling up machine learning technologies focusing on industry applications.
4. Understand the Supervised Algorithms.

Details of Syllabus:

Unit I: Classification of MNIST dataset [06 Hrs]

1.1 MNIST (Modified National Institute of Standards and Technology Database)

1.2 Training a Binary Classifier

1.3 Performance Measures- Measuring accuracy using Cross Validation, Confusion Matrix, Precision and recall

1.4 Multiclass Classification

1.5 Multilabel Classification

Unit II: Linear Regression [09 Hrs]

2.1 Linear Regression

2.2 The Normal Equation

2.3 Batch Gradient Descent

2.4 Stochastic Gradient Descent

2.5 Mini-batch Gradient Descent

2.6 Polynomail Regression

Unit III: Logistic Regression [06 Hrs]

3.1 Estimating Probabilities

3.2 Training and Cost Function

3.3 Decision Boundary

3.4 Softmax Regression

Unit IV: Other Supervised Algorithms [09 Hrs]

4.1 K Nearest Neighbors – K-neighbors classification,
K-neighbors regression, Parameters, strength, weakness

4.2 Decision Trees – Building Decision Tress

4.3 Ensembles of Decision Trees - Random Forest

4.4 Support Vector Machines – Linear Model on Non-Linear Features,
Kernel Trick, Understanding SVM's, Tuning SVM parameters,
Parameters, Strength, Weakness

Suggested Books:-

1. Aurelien Geron , Hands-on Machine Learning with Scikit-Learn, Keras and Tensorflow
Unit I: Chapter-3: 3.1, 3.2, 3.3, 3.4, 3.6,
Unit II: Chapter-4: 4.1, 4.2
Unit III: Chapter-4: 4.3, 4.6
2. Andreas C. Muller & Sarah Guido, Introduction to Machine Learning with Python
Unit IV: Chapter-2: 2.2.2, 2.2.5, 2.2.6, 2.2.7
3. Jason Brownlee - Basics of Linear Algebra for Machine Learning, 2018.
4. M. P. Deisenroth, A. A. Faisal, C. S. Ong - Mathematics for Machine Learning, Cambridge University Press, 2019.
5. Dipanjan Sarkar, Raghav Bali, Tushar Sharma - Practical Machine Learning with Python, 2018.

Some Extra References:-

https://developers.google.com/machine-learning/crash-course

https://learn.microsoft.com/en-us/training/modules/introduction-to-machine-learning/

Semester -VI	**Paper - VII**
Course Code: BSC-MT 607 P	**Title of the Course: Practical Course Lab-1**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 601 T and BSC-MT 602 T)

Semester -VI	**Paper – VIII**
Course Code: BSC-MT 608 P	**Title of the Course: Practical Course Lab-II**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 603 T and BSC-MT 604 T)

Semester –VI	**Paper - IX**
Course Code: BSC-MT 609 P	**Title of the Course: Practical Course Lab-III**
Credits: 2	**Total Lectures: 60 Hrs.**

(Based on BSC-MT 605 T (A) or BSC-MT 605 T (B) and BSC-MT 606 T (A) or BSC-MT 606 T (B))

Semester -VI	**Paper -X**
Course Code: BSC-MT 610 P	**Title of the Course: Programming in Python–II**
Credits: 2	**Total Lectures: 60 Hrs.**

Course Outcomes:

1. To acquire Object Oriented Skills in Python.
2. To develop the skill of designing Graphical User Interfaces in Python.
3. To learn and understand Python programming basics and paradigm.
4. To learn the concepts of visualization of data and database connectivity.

Details of Syllabus:

Unit I. Graphics [06 Hrs.]

1.1 Turtle Graphics: Overview of Turtle Graphics, Turtle Operations, Object Instantiation and the turtle graphics Module.
1.2 Drawing Two-Dimensional Shapes.
1.3 Taking a Random Walk.
1.4 Colors and the RGB System.
1.5 Drawing with Random Colors.
1.6 Using the str Function with Objects.

Unit II. Data Visualization with Python [04 Hrs.]

2.1 Seaborn
2.2 Matplotlib
2.3 Plotly
2.4 MayaVI

Unit III. Dictionary and Sorting, Minimum and Maximum [08 Hrs.]

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.

Unit IV. Computational Geometry [08 Hrs.]

4.1 Points: 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 Points: Displaying Points and other geometrical objects, Lines, rays and line segments, the geometry of line segments, Displaying lines, rays and line segments.

4.3 Polygon: 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.

Unit V. Study of Operational Research in Python [04 Hrs.]

5.1 Linear Programming in Python.

5.2 Introduction to Simplex Method in Python.

Practicals: [30 Hrs]

Practical 1: Turtle Graphics (Unit 1)
Practical 2: Data Visualization (Unit 2)
Practical 3: Dictionary and Sorting, Minimum and Maximum (Unit 3)
Practical 4: Application to Computational Geometry-I (Unit 4)
Practical 5: Application to Computational Geometry-II (Unit 4)
Practical 6: Application to Computational Geometry-II (Unit 4)
Practical 7: Study of Graphical aspects of 2-D transformation matrix using Matplotlib (Unit 4)
Practical 8: Study of Graphical aspects of 3-D transformation matrix using Matplotlib (Unit 4)
Practical 9: Study of Graphical aspects of 3-D transformation matrix using Matplotlib and Study of effect of concatenation of 2-D and 3-D transformations (Unit 4).
Practical 10: Generation of Bezier curve using given control points (Unit 4)
Practical 11: Study of Operational Research in Python (Unit 5-5.1)
Practical 12: Study of Operational Research in Python (Unit 5-5.2)

Suggested Books:

1. Kenneth A. Lambert, Fundamentals of Python:From First Programs to DataStructure, 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 Section:19.1 to 19.10
and Chapter-72, Section:72.1 to 72.8
3. Jim Arlow, Interactive Computational Geometry in Python.
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 to 3, Ch-5: Sec.- 3 to 7.

4. Operations Research:
Unit-V: https://pypi.org/project/PuLP/
5. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
6. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015.
7. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin,Beedle and Associates Inc.
8. Jim Arlow, Interactive Computational Geometry in Python.
9. Robert Johansson, Introduction to Scientific Computing in Python.
10. Jason Brownlee, Basics of Linear Algebra for Machine Learning, Discover the Mathematical Language of Data in Python.

E-resource:

1. Introduction to Python, NPTEL-NOC IITM:
https://youtu.be/c235EsGFcZs
2.Readings available on Python official website:
https://docs.python.org/3/tutorial/index.html

Semester - VI	**Paper -XI**
Course Code: BSC-MT 611 P	**Title of the Course: Introduction to Scilab**
Credits: 2	**Total Lectures: 60 Hrs.**

Course Outcomes:

1. To understand the fundamentals of Scilab and Utilization.
2. Understand basics of complex numbers, vectors and matrix in Scilab.
3. Use of Scilab to plot 2D, 3D graphs and data plotting
4. To learn application of Scilab in Numerical Linear Algebra.

Details of Syllabus:

Unit I. Introduction to Scilab [04 Hrs.]

1.1 Installation of the software Scilab.
1.2 Basic syntax.
1.3 Mathematical Operators.
1.4 Predefined constants.
1.5 Built in functions.

Unit II. Mathematics and Programming in Scilab [08 Hrs.]

2.1 Complex numbers.
2.2 Polynomials
2.3 Vectors,
2.4 Matrix operations
2.5 Use of ‘deff’ command
2.5 Functions, Loops, Conditional statements.

Unit III. 2D, 3D Graphs in Scilab [08 Hrs.]

3.1 Installation of additional packages like optimization
3.2 2D graphs
3.3 3D graphs
3.4 Use of deff command and fplot command
3.5 Coloured graphs

Unit IV. Numerical Linear Algebra in Scilab [09 Hrs.]

4.1 Numerical Linear Algebra
4.2 Solving linear equations, eigen values.
4.3 Numerical Analysis – iterative methods
4.4 ODE – Blotting solution curves

Suggested Books:

1. Micha¨el Baudin, Programming in Scilab, The Scilab Consortium-Digiteo, September 2011.
2. Ranjan Goyal and Mansi Dhingra, Programming in SCILAB, Alpha Science International Ltd, September 2018.
3. Sandeep Nagar, Introduction to Scilab: For Engineers and Scientists, Apress Publication, 2017.
4. Anil Kumar Verma, SCILAB: A Begineer's Approach, Cengage Learning India Pvt. Ltd., First Edition, 2018

E-resources:

1. Video Lectures conducted by Spoken Tutorial and IIT Bombay (You tube): https://youtu.be/mSjuyl7HZLQ
2. Introduction to Scilab by Studio IIT Bombay: https://youtu.be/cd9XEymIUFY