Savitribai Phule Pune University, Pune

(Formerly University of Pune)

Second Year B.Sc in Mathematics

(Faculty of Science & Technology)

Revised Syllabi for

S.Y.B.Sc. - Mathematics

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System Syllabus

To be implemented from the Academic Year 2020-2021

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
Board of Studies in Mathematics Syllabus for S. Y. B. Sc
Subject: MATHEMATICS
(With effect from June 2020)

Introduction:

Savitribai Phule Pune University, Pune has decided to change the syllabi of various faculties from June 2020. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects Board of studies in Mathematics with concern of teachers of Mathematics from different colleges affiliated to Savitribai Phule Pune University, Pune has prepared the syllabus of S.Y.B.Sc. Mathematics. To develop the syllabus the U.G.C. Model curriculum is followed.

Aims:

- Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling ,solving and interpreting.
- Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
- Enhancing students overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment .
- Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

Objectives:

- A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations, terminology and recognize basic geometrical figures and graphical displays ,state important facts resulting from their studies.
- A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.
- A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.
- A student 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 in order to process the information and draw the relevant conclusion.
- A student should be made aware of history of mathematics and hence of its past, present and future role as part of our culture.

Eligibility: F. Y. B. Sc., as per University rules.

Structure of the course:

	Semester - III		Semester -IV	
Paper I	MT-231	**Calculus of Several Variables**	MT-241	**Linear Algebra**
Paper II	MT-232(A)	**Numerical Methods and Its Applications**	MT-242(A)	**Vector Calculus**
	MT-232(B)	**Graph Theory**	MT-242(B)	**Dynamical Systems**
Paper III	MT-233	**Mathematics Practical based on MT - 231 and MT - 232**	MT-243	**Mathematics Practical based on MT - 241 and MT-242**

- All three above courses are compulsory.
- In Semester-III, select any one from **MT-232(A) and MT-232(B).**
- In Semester-IV, select any one from **MT-242(A) and MT-242(B).**

Medium of Instruction: English.

Examination:

A) Pattern of examination: Semester.

B) Standard of passing: 20 marks out of 50 marks for each papers.
But for MT- 231, MT -232(A), MT -232(B), MT -241, MT -242(A), MT -242(B), MT -233 and MT-243 for passing a student should obtain minimum 14 marks out of 35 in the theory examination and overall total marks for theory and internal should be minimum 20.

C) Pattern of question papers: For MT- 231, MT -232(A), MT -232(B), MT -241, MT -242(A), MT -242(B).

Q1. Attempt any 05 out of 07 questions each of 01 marks. [05 Marks]

Q2. Attempt any 02 out of 04 questions each of 05 marks. [10 Marks].

Q.3. Attempt any 02 out of 04 questions each of 05 marks. [10 Marks].

Q4. Attempt any 02 out of 04 questions each of 10 marks. [10 Marks].

D) External Students: Not allowed.

E) Verification /Revaluation: Allowed for MT- 231, MT -232(A), MT -232(B), MT - 241, MT -242(A), MT -242(B).

The pattern of question paper for MT -233, MT-243 is given in the detailed syllabus.

Equivalence of Previous syllabus along with new syllabus:

	Semester-III		Semester-IV	
	New Course	**Old Course**	**New Course**	**Old Course**
Paper I	**MT-231: Calculus of Several Variables**	**MT-211 : Multivariable Calculus-I**	**MT-241:Linear Algebra**	**MT-221: Linear Algebra**
Paper II	**MT-232(A): Numerical Methods and Its Applications** **MT-232(B): Graph Theory**	**MT-212(A): Discrete Mathematics** **MT- 212(B): Laplace Transform and Fourier Series**	**MT-242(A): Vector Calculus** **MT-242(B): Dynamical Systems**	**MT-222(A): Multivariable Calculus - II** **MT-212(B): Numerical Analysis**
Paper III	**MT-233: Mathematics Practical based on MT-231 and MT-232**	**MT-213 : Mathematics Practical based on MT-211 and MT-212**	**MT-243: Mathematics Practical based on MT-241 and MT-242**	**MT–223: Mathematics Practical based on MT-221 and MT-222**

Qualifications for Teacher: M.Sc. Mathematics (with NET /SET as per existing rules).

Semester – III

MT-231: Calculus of Several Variables

Unit-1 Limits and Continuity   **[06 lectures]**

   1.1 Functions of Several Variables :- Functions of two variables, Domain and Range,

      Graphs, Level Curves, Functions of Three or More Variables

   1.2 Limits and Continuity.

Unit-2 Partial Derivatives and Differentiability   **[10 lectures]**

   2.1 Definition and examples.

   2.2 Higher Derivatives, Clairaut's Theorem (Statement Only) , Partial Differential

      Equations, Wave equation.

2.3 Differentiable function, Differentials

2.4 Chain Rule, Homogeneous Functions, Euler's theorem

Unit-3 Extreme Values [08 lectures]

3.1 Extreme values of functions of two variables.

3.2 Necessary conditions for extreme values.

3.3 Second Derivative Test (without proof).

3.4 Lagrange Multipliers (with one constraints)

Unit-4 Multiple Integrals [12 lectures]

4.1 Iterated Integrals, Fubini's Theorem (Statement only)

4.2 Double integral over general regions, Change of order of integration for two variables.

4.3 Double integral in Polar coordinates.

4.4 Triple integrals , Evaluation of triple integrals. Triple integrals in spherical coordinates

4.5 Jacobians , Change of variables in multiple integrals .(Results without proofs)

Text book: Multivariable Calculus 7th Edition By James Stewart, Brooks/Cole, Cengage Learning, 2012, 2008.
 Unit 1:- Chapter 14: Sec- 14.1, 14.2
 Unit 2:- Chapter 14: Sec- 14.3(except the Cobb-Douglas production function), 4.4
            (except Tangent Planes and Linear Approximations), Sec-14.5
 Unit 3:- Chapter 14: Sec 14.7, 14.8 (except two constraints)
 Unit 4:- Chapter 15: Sec 15.2, 15.3, 15.4, 15.7 (without Riemann sum and
            Application), 15.9, 15.10

Reference Books:

1. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A. Weinstein, Springer

Verlag (Indian Edition).

2. Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company.

3. D.V. Widder, Advanced Calculus (2nd Edition), Prentice Hall of India ,NewDelhi,(1944).

4. T.M. Apostol , Calculus Vol. II (2nd Edition), John Wiley, New York, (1967).

MT-232(A): Numerical Methods and It's Applications

Unit1: Solution of Algebraic and Transcendental Equations [10 Lectures]
1.1 Errors and their computations
1.2 Bisection method.
1.3 The method of False position
1.4   Newton- Raphson method
Unit 2: Interpolation [12 Lectures]

2.1 Finite Difference Operators and their relations (Forward, Backward
  difference and Shift operator).
2.2 Differences of a polynomial
2.3 Newton's Interpolation Formulae (Forward and Backward)
2.4 Lagrange's Interpolation Formula

Unit 3: Numerical Differentiation and Integration   **[06 Lectures]**
  3.1 Numerical Differentiation (Derivatives using Newton's forward difference formula)
  3.2 Numerical Integration, General quadrature formula.
  3.3 Trapezoidal rule.
  3.4 Simpsons's 1/3rd rule.
  3.5 Simpsons's 3/8th rule.

Unit 4: Numerical solution of first order ordinary differential equations [08 Lectures]
  4.1 Taylor's Series method
  4.2 Picard's method of successive approximations
  4.3 Euler's method.
  4.4 Modified Euler's methods.
  4.5 Runge - Kutta Methods.

Text book:
**1. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th edition, Prentice Hall of
ndia.**
  Unit 1: Chapter 1: section 1.3, Chapter 2: section 2.2, 2.3, 2.5
  Unit 2: Chapter 3: section 3.3, 3.5, 3.6, 3.9(3.9.1 only)
  Unit 3: Chapter 4: section 6.2 (excluding 6.2.1 to 6.2.3), 6.4
  Unit 4: Chapter 5: section 8.2, 8.3, 8.4 (excluding 8.4.1).

Reference Books:
1. C.F. Gerald and O.P. Wheatley, Applied Numerical Analysis, Addison Wesley;

  7thedition (2003).

2. K.E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.

3. T. Sauer, Numerical analysis, 3rd edition, Pearson.

4. M. K. Jain, SRK Iyengar and R.K. Jain, Numerical Methods For Scientific & Engg 5e,

  New Age International (P) Ltd (2008).

MT-232(B) : Graph Theory

Unit 1. Introduction   **[04 Lectures]**
  1.1 What is a Graph?
  1.2 Application of Graphs
  1.3 Finite and Infinite Graphs
  1.4 Incidence and Degree
  1.5 Isolated Vertex, Pendant Vertex and Null Graph
Unit 2. Paths and Circuits   **[12 Lectures]**

2.1 Isomorphism
2.2 Subgraphs
2.4 Walks, Paths, and Circuits
2.5 Connected Graphs, Disconnected Graphs, and Components
2.6 Euler Graphs
2.7 Operations on Graphs
2.8 More on Euler Graphs
2.9 Hamiltonian Paths and Circuits
2.10 The Traveling Salesman Problem

Unit 3. Trees and Fundamental Circuits   [14 Lectures]
3.1 Trees
3.2 Some Properties of Trees
3.3 Pendant Vertices in a Tree
3.4 Distance and Centers in a Tree
3.5 Rooted and Binary Trees
3.6 On Counting Trees
3.7 Spanning Trees
3.8 Fundamental Circuits
3.10 Spanning Trees in a Weighted Graph

Unit 4. Cut-Sets and Cut-Vertices   [06 Lectures]
4.1 Cut-Sets
4.2 Some Properties of a Cut-Set
4.3 All Cut-Sets in a Graph
4.4 Fundamental Circuits and Cut-Sets
4.5 Connectivity and Separability

Recommended Book :

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science"
   Printice-Hall, of India Pvt. Lt. New Delhi.
        Unit 1 : Chapter 1: Sec.1.1 to 1.5
        Unit 2: Chapter 2: Sec. 2.1 to 2.10 (Excluding 2.3)
        Unit 3: Chapter 3: Sec. 3.1 to 3.10 (Excluding 3.9)
        Unit 4: Chapter 4 : Sec. 4.1 to 4.5

Reference books:
        1. John Clark and Derek Holton, A First Look at Graph Theory (Allied Publishers)
        2. Robin J. Wilson, Introduction to Graph Theory, Fourth Edition (low price edition)
        3. Introduction to Graph Theory, Douglas West 2nd edition.
       4. A Textbook of Graph Theory, Balakrishnan, R., Ranganathan, K.

Outcomes of Course:
 Upon completion of the course, the students will achieve the following.
       **(i) The mathematical maturity of students in their current and future courses
          shall develop.**

(ii) The student develops theoretical, applied and computational skills.

(iii) The student gains confidence in proving theorems and solving problems.

MT 233: Mathematics Practical
(Practicals based on the applications of articles in MT - 231 and MT - 232)

In Semester-III, we should conduct 4 written practical and 2 practical on maxima software for each paper MT-231 and MT-232.

List of Practical

Practical 1 : Problems on Unit 1(Written) from MT-231.

Practical 2 : Problems on Unit 2 (Written) from MT-231.

Practical 3 : Problems on Unit 3 (Written) from MT-231.

Practical 4 : IProblems on Unit 4 (Written) from MT-231.

Practical 5 : Problems on unit 1 and unit 2 from MT-231using maxima software.

Practical 6 : Problems on Unit 3 and Unit 4 from MT-231using maxima software.

Practical 7 : Problems on Unit 1 (Written) from MT-232.

Practical 8 :Problems on Unit 2 (Written) from MT-232.

Practical 9 : Problems on Unit 3 (Written) from MT-232.

Practical 10 : IProblems on Unit 4 (Written) from MT-232.

Practical 11 : Problems on unit 1 and unit 2 from MT-232 using maxima software.

Practical 12 : Problems on Unit 3 and Unit 4 from MT-2322 using maxima software.

Note:

1. The soft copy of practicals on maxima software will be prepared and provided by the Board of Studies in mathematics.

2. Practicals on maxima software can be performed on computer only.

3. Practical examination of 25 marks on written problems, 10 marks for problems on maxima software (5 marks for writing syntax and 5 marks to perform the same on computer).

MT-241: Linear Algebra

Unit-1: Matrices and System of Linear Equations   **[06 lectures]**

  1.1 Row echelon form of a matrix, reduced row echelon form of a matrix.

  1.2 Definition of rank of a matrix using row echelon or row reduced echelon form.

  1.3 System of linear equations- Introduction, matrix form of linear system, definition of row equivalent matrices.

  1.4 Consistency of homogeneous and non-homogeneous system of linear equations using rank, condition for consistency.

  1.5 Solution of System of Equations: Gauss elimination and Gauss-Jordan elimination method, examples.

Unit-2: Vector Spaces-I   **[10 lectures]**

  2.1 Definition and Examples.

  2.2 Subspaces.

  2.3 Linear Dependence and Independence.

  2.4 Basis of Vector Space

Unit-3: Vector Spaces-II   **[08 lectures]**

  3.1 Dimension of a Vector Space.

  3.2 Row, Column and Null Space of a matrix.

  3.3 Rank and nullity.

Unit-4: Linear Transformations   **[12 lectures]**

  4.1 Definition and Examples, Properties, Equality.

  4.2 Kernel and range of a linear Transformation

  4.3 Rank-Nullity theorem.

  4.4 Composite and Inverse Transformation.

  4.5 Matrices and Linear Transformation.

  4.6 Basic Matrix Transformations in R^2 and R^3

  4.7 Linear Isomorphism.

Text Book::

Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Ninth Edition, Wiley, 11th edition.

    Unit-1: Chapter-1: Sec. 1.1, 1.2.

    Unit-2: Chapter- Sec. 4: 4.1 to 4.4.

    Unit-3: Chapter- Sec. 4: 4.5, 4.7, 4.8

Unit- 4: Chapter- Sec.8: 8.1 to 8.4, 1.8, 4.9.

Reference Books:

(1) K. Hoffman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India, New Delhi

(2) Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall of India. New Delhi

(3) Vivek Sahai, Vikas Bist, Linear Algebra, 4th Reprint 2017, Narosa Publishing House, New Delhi

(4) Promode Kumar Saikia, Linear Algebra, 2009, Pearson, Delhi

(5) S. Lang, Introduction to Linear Algebra, 2nd edition,1986, Springer-Verlag, New York, Inc.

MT 242(A): Vector Calculus

Unit 1: **Vector-Valued Functions**   [08 lectures]
   1.1 Curves in Space, Limits and Continuity, Derivatives and Motion, Differentiation
      Rules for Vector Function, Vector Functions of Constant Length.
   1.2 Integrals of Vector Functions.
   1.3 Arc Length along a Space Curve, Speed on a Smooth Curve, Unit Tangent
      Vector.
   1.4 Curvature of a Plane Curve, Circle of Curvature for Plane Curves, Curvature and
      Normal Vectors for a Space Curve.

Unit 2: **Integrals**   [12 Lectures]
   2.1 Line Integral of Scalar Functions, Additivity, Line integral in the Plane.
   2.2 Vector Fields, Gradient Fields, Line Integral of Vector Fields, Line Integrals with
      respect to dx, dy, dz .
   2.3 Work done by a Force over a Curve in Space, Flow Integrals and Circulation for
      Velocity Fields, Flow across the Simple Closed Plane Curve.
   2.4 Path Independence, Conservative and Potential Functions.
   2.5 Divergence, Two forms for Green's Theorem, Green's Theorem in the Plane
      (Proof for special regions),

Unit 3: **Surface Integrals**   [08 Lectures]
   3.1 Parameterizations of Surfaces, Implicit surfaces.
   3.2 Surface integrals, Orientation of Surfaces.
   3.3 Surface Integrals of Vector Fields.

Unit 4: Applications of Integrals   [08 Lectures]
   4.1 The Curl Vector Field, Stokes' Theorem(without proof), Conservative Fields and
      Stokes' Theorem.

4.2 Divergence in three Dimensions, Divergence Theorem (without proof).

4.3 Unifying the Integral Theorems.

Text Book:
- Thomas' Calculus (14th Edition) by Hass, Heil, Weir, Pearson Indian Education Services Pvt. Ltd.
  Unit 1: Chapter 13: Sec- 13.1, 13.2, 13.3, 13.4
  Unit 2: Chapter 16: Sec-16.1, 16.2, 16.3, 16.4
  Unit 3: Chapter 16: Sec- 16.5, 16.6
  Unit 4: Chapter 16: Sec- 16.7, 16.8

Reference books:

(1) Basic Multivariable Calculus byJ.E.Mardson, A.J.Tromba, A. Weinstein, Sppriger Verlag (Indian Edition)

(2) Advanced Calculus by M.R. Spiegel, Schaum Series.

(3) Advanced Calculus (IInd Edition) byD.V. Widder, Prentice Hall of India, New Delhi(1944).

(4) Advanced Calculus by John M. H. Olmsted, Eurasia Publishing House, New Delhi(1970)

(5) Calculus Vol. II (IInd Edition) by T.M. Apostol, John Wiley, New York (1967).

MT-242(B): Dynamical Systems

Unit 1: Eigenvalues and Eigenvectors [08 Lectures]
 1.1 Eigenvalues and Eigenvectors
 1.2 Diagonalisation(matrices with real and distinct eigenvalues)

Unit 2: First-Order Equations and Planar Linear Systems [12 Lectures]
 2.1 The Simplest Example
 2.2 The Logistic Population Model
 2.3 Second-Order Differential Equations
 2.4 Planar Systems
 2.5 Preliminaries from Algebra
 2.6 Planar Linear Systems
 2.7 Eigenvalues and Eigenvectors
 2.8 Solving Linear Systems
 2.9 The Linearity Principle.

Unit 3: Phase Portraits for Planar Systems [08 Lectures]
 3.1 Real Distinct Eigenvalues
 3.2 Complex Eigenvalues
 3.3 Repeated Eigenvalues
 3.4 Changing Coordinates

Unit 4: Classification of Planar Systems and Exponential of a matrix [08 Lectures]

4.1 The Trace-Determinant Plane

4.2 Exponential of a matrix.

Textbooks :

1) Elementary Linear Algebra by Howard Anton and Chris Rorres (9thedition), Applications Version.

Unit 1: Chapter 7 : Section 7.1 (Examples, Theorems with Statements only) , Section 7.2 (2 x 2 and 3 x 3 matrices with real and distinct eigenvalues, Theorems with Statements only)

2) Differential Equations, Dynamical Systems and An Introduction to Chaos (2nd edition) by Morris Hirsch, Stephen Smale and Robert Devaney, Academic Press.

Unit 2: Chapter 1 : Section - 1.1 to 1.2, Chapter 2 : Section - 2.1 to 2.7.
Unit 3: Chapter 3 : Section, 3.1 to 3.4,
Unit 4: Chapter 4 :Section 4.1, Chapter 6 : Section 6.4 (2 x 2 matrices with distinct
       real, repeated real and complex eigenvalues, 3 x 3 matrices with distinct real
       eigenvalues).

Reference Books :

1. K.B.Datta, Matrix and Linear Algebra, Prentice hall of India Pvt.Ltd, New Delhi 2000.

2. Differential Equations and Dynamical Systems (Third Edition) by Lawrence Perko, Texts in Applied Mathematics 7, Springer.

Outcomes of Course:
Upon completion of the course, the students will achive the following.
        (i) The mathematical maturity of students in their current and future courses
           shall develop.
        (ii) The student develops theoretical, applied and computational skills.
        (iii) The student gains confidence in proving theorems and solving problems.

<div align="center">

MT 243: Mathematics Practical
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(Practical based on the applications of articles in MT- 241 and MT -242)
In Semester-IV, we should conduct 4 written practical and 2 practical on maxima software for each paper MT-241 and MT-242.

List of Practical

Practical 1 : Problems on Unit 1 (Written) from MT-241.

Practical 2 : Problems on Unit 2 (Written) from MT-241.

Practical 3 : Problems on Unit 3(Written) from MT-241

Practical 4 : Problems on Unit 4(Written) from MT-241.

Practical 5 : Problems on unit 1 and unit 2 from MT-241using maxima software.

Practical 6 : Problems on Unit 3 and Unit 4 from MT-241 using maxima software.

Practical 7 : Problems on Unit 1 (Written) from MT-242.

Practical 8 : Problems on Unit 2 (Written) from MT-242.

Practical 9 : Problems on Unit 3(Written) from MT-242.

Practical 10 : Problems on Unit 4(Written) from MT-242.

Practical 11 : Problems on unit 1 and Unit 2 from MT-242 using maxima software.

Practical 12 : Problems on Unit 3 and Unit 4 from MT-242 using maxima software.

Note:

1 The soft copy of practical on maxima software will be prepared and provided by the Board of Studies in mathematics.

2. Practicals on maxima software shall be performed on computer only..

3.Practical examination 25 marks on written problems, 10 marks for problems on maxima software (5 marks for writing syntax and 5 marks to perform the same on computer only).

Modalities For Conducting The Practical and The Practical Examination:

1) There will be one 4 hour 10 minutes (250 minutes) practical session for each batch of 15
 students per week.
2) The College will conduct the Practical Examination at least 15 days before the
commencement of the Main Theory Examination. The practical examination will consist of written examination of 20 marks, 10 marks on maxima software and oral examination of 05 marks.
3) There will be external examiner; the practical exam will be of the duration of 3hours.
4) The teacher will set a question paper at the time of paper setting meeting conducted by Savitribai Phule Pune University, Pune based on pattern as follows
      Q1. Any 2 out of 4 each question of   5 marks on paper - I.
      Q2. Any 2 out of 4 each question of   5 marks on paper - II.
      Q3. (a) Any 1 out of 2 each question of 5 marks on maxima software from paper – I.
          (b) Any 1 out of 2 each question of 5 marks on maxima software from paper – II.

5) Each student will maintain a journal to be provided by the college.

7) The internal 15 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical.

8) It is recommended that concept may be illustrated using computer software maxima and graphing calculators wherever possible.

9) Study tours may be arranged at places having important mathematical institutes or historical places.

10) **Special Instruction:**
   a) There should be well equipped mathematics practical laboratory of size 20x20 sq. fts containing at least 20 computers.
   b) Examiners should set separate question papers, solutions and scheme of marking for each batch and claim the remuneration as per rule.
   c) Before starting each practical necessary introduction, basic definitions, intuitive inspiring ideas and prerequisites must be discussed**.**