Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Mathematics

(Faculty of Science & Technology)

F.Y.B.Sc. (Mathematics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: B. Sc (Mathematics)

Preamble:

SavitribaiPhule Pune University has decided to change the syllabi of   various faculties from June,2019. 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 SavitribaiPhule Pune University has prepared the syllabus of F. Y. B.Sc. Mathematics. To develop the syllabus the U.G.C. Model curriculum is followed.

Aims:

(i) Give the students a sufficient knowledge of fundamental principles,methods and a clearperception of innumerous power of mathematical ideas and tools and know how to usethem by modeling ,solving and interpreting.
(ii) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science and technology.
(iii) 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 .
(iv) Enabling students to develop a positive attitude towards mathematics as an interestingand valuable subject of study.

Objectives:

(i) 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.
(ii) A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.
(iii) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.
(iv) 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.
(v) A student should be made aware of history of mathematics and hence of its past, present and future role as part of our culture.

Course Outcome:

Upon successful completion of this course, the student will be able to:
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.

Structure of the course:

	Semester - I		Semester -II		Credit
Paper I	MT-111	Algebra	MT-121	Analytical Geometry	2
Paper II	MT-112	Calculus - I	MT-122	Calculus - II	2
Paper III	MT-113	Mathematics Practical	MT-123	Mathematics Practical	1.5

Proposed Structure of S. Y. B. Sc. Mathematics Courses:

	Semester - III		Semester -IV		
Paper I	MT-231	Calculus of Several Variables	MT-241	Linear Algebra-I	2
Paper II	MT-232 (A)	Laplace Transform and Fourier Series	MT-242(A)	Vector Calculus	2
	MT-232 (B)	Computational Geometry	MT-242(B)	Numerical Analysis	2
Paper III	MT-233	Mathematics Practical	MT-243	Mathematics Practical	2

Proposed Structure of T. Y. B. Sc. Mathematics Courses:

Semester- V		Semester- VI		Credit
MT 351	Matric Spaces	MT 361	Complex Analysis	2
MT 352	Real Analysis-I	MT 362	Real Analysis-II	2
MT 353	Problem Course on MT 351 and MT 352	MT 363	Problem Course on MT 361 and MT 362	2
MT 354	Group Theory-I	MT 364	Ring Theory-I	2
MT 355	OrdinaryDifferential Equations–I	MT 365	Partial Differential Equations-I	2
MT 356	Problem Course on MT 354 and MT 355	MT 366	Problem Course on MT 364 and MT 365	2

Select Any Two out of six courses				
MT357:A	**Operations Research**	**MT367: A**	**Optimization Techniques**	**2**
MT357:B	**Number Theory**	**MT367: B**	**Graph theory**	**2**
MT357:C	**C- Programming**	**MT367: C**	**Lebesgue Integration**	**2**
MT357:D	**Lattice Theory**	**MT367: D**	**Financial Mathematics**	**2**
MT357:E	**Python Course -I**	**MT367: E**	**Python Course-II**	**2**
MT357:F	**Machine Learning Course- I**	**MT367: F**	**Machine Learning Course- II**	**2**
MT 338	**Practical based on papers selected from 357 A to 357 F**	**MT 348**	**Practical based on papers selected from 367 A to 367 F**	**2**
MT-3510	**Skill Enhancement course in maths**	**MT-3511**	**Skill Enhancement course in maths**	**2**
MT-3610	**Skill Enhancement course in maths**	**MT-3611**	**Skill Enhancement course in maths**	**2**

All three above courses are compulsory.

1. **Equivalence of Previous syllabus along with new syllabus:**

	Old course	New Course
Paper I	**MT-101 : Algebra and Geometry**	**MT-111: Algebra and MT-121 : Analytical Geometry**
Paper II	**MT-102 : Calculus and Differential Equations**	**MT-112 : Calculus - I and MT-122 : Calculus – II**
Paper III	**MT-103 : Mathematics Practical**	**MT – 113 : Mathematics Practical and MT – 113 : Mathematics Practical**

Details of Syllabus:

Semester – I

MT 111- Algebra

Unit 1:   Sets Relations and Functions   (8 Lectures)
1.1   Sets, Relations, Equivalence relations, Equivalence classes and partitions of a set
1.2   Functions, Basic terminology, Types of Functions, Inverse of a Function, Composition of Functions (Excluding theorems only examples).

Unit2:   Divisibility Theory in the Integers(10 Lectures)
2.1   Mathematical Induction:Well-Ordering Principle.
2.2   The Division Algorithm, The Greatest Common Divisor, Euclid's Lemma, The Least Common Multiple, The Euclidean Algorithm.

Unit 3:   Primes and the theory of Congruence   (8 Lectures)
3.1   The Fundamental Number of Arithmetic: Prime Numbers, Euclid's Lemma.
3.2   The theory of Congruence: Basic Properties of congruence.
3.3   Fermat's Theorem

Unit 4:   Complex Numbers   (10 Lectures)
4.1   Sums and Products, Basic Algebraic Properties, Moduli, Complex Conjugates, Exponential form, Products and Quotients, De-Moivre's theorem.
4.2   Roots of Complex Numbers: The nth roots of unity.
4.3   Regions in Complex Plane.

Text Books:
1.   **A Foundation Course in Mathematics, Ajit Kumar, S. Kumeresan and Bhaba Kumar Sarma, Narosa Publication House.**
      Unit 1: Chapter 2: Sec. 2.1 to 2.5, Chapter 3: Sec. 3.1 to 3.6, Chapter 4: Sec. 4.1 to 4.4.
2.   **Elementary Number Theory, David M. Burton, Tata McGraw Hill, Sixth Edition.**
      Unit 2: Textbook 2: Chapter 1: Sec. 1.1, Chapter 2: Sec. 2.2 to 2.4
      Unit 3: Textbook 2: Chapter 3: Sec. 3.1, Chapter 4: Sec. 4.1, 4.2, Chapter 5: Sec. 5.2.
3.   **Complex Variables and Applications, James Ward Brown and Ruel V. Churchill, Mc-Graw Hill, Seventh Edition.**

Unit 4: Textbook 3: Chapter 1: Sec 1 to 10.

Reference Books:
1. Textbook of Algebra, S. K. Shah and S. C. Garg, Vikas Publishing House Pvt. Ltd. Edition 2017.
2. Introduction to Real Analysis by R.G. Bartle and D.R. Sherbert, John Wiley and Sons Inc, Fourth Edition.

MT 112: CALCULUS - I

Unit 1:   **Real Numbers**   **(06 Lectures)**
1.1 The Algebriac and Order Properties of R:
Algebraic properties of R, Order properties of R, Well-Ordering Property of N. Arithmetic mean-Geometric mean inequality, Bernoulli's inequality.
(Revision: essential properties should be revised with illustrative examples)
1.2 Absolute Value and the Real Line:
Absolute value function and its properties, triangle inequality and its consequences, neighborhood of a point on real line.
1.3 The Completeness Property of R:
Definitions of Upper bound, Lower bound, supremum, infimum of subsets of R, completeness property of R.
1.4 Applications of the Supremum Property:
Archimedean property and its consequences, The density theorem (without proof).

Unit 2.   **Sequences**   **(10 Lectures)**
2.1 Sequences and Their Limits:
Definition and examples of sequences of real numbers, Definition of limit of sequence and uniqueness of limit, Examples on limit of sequence.
2.2 Limits Theorems:
Definition of bounded sequence, Every convergent sequence is bounded, Algebra of limits.
2.3 Monotone Sequences:
Definition and examples of monotone sequences, Monotone convergence theorem and examples.
2.4 Subsequences and Bolzano -Wierstrass Theorem:
Definition of subsequence and examples, Divergence criteria, Monotone Subsequence theorem (without proof), Bolzano -Wierstrass theorem (first proof).

Unit 3.   **Limits**   **(08 lectures)**
3.1 Functions and their Graphs:

Functions, domain and range, graphs of functions, representing a function numerically, Vertical line test, Piecewise defined functions, increasing and decreasing functions, even and odd functions symmetry, common functions

3.2   Limits of Functions:
       Definition of cluster point and examples, definition of limit of a function, sequential criterion for limits, divergence criteria.

3.3   Limit Theorems:
       Algebra of limits (proofs using sequential criterion) ,Squeeze theoerem.

3.4   Some extension of limit concepts:
       one-sided limits, infinite limits (without   proof) .

Unit 4:   Continuity   (12 lectures)

4.1   Continuous Functions:
       Definition of continuous function at a point , sequential criterion for continuity, Divergence criterion, combination of continuous functions.

4.2   Continuous Functions on Intervals:
       Properties of continuous functions on an interval, Boundedness theorem (without proof), The minimum -maximum theorem(without proof), Location of root theorem (Without proof), Bolzano's   intermediate value theorem. Continuous function maps closed bounded interval to closed bounded interval, Preservation of interval theorem.

Textbook Books:
1.   Introduction to Real Analysis by R.G. Bartle and D.R. Sherbert, John Wiley and Sons Inc, Fourth Edition.
       Unit 1: Chapter 2: Sec 2.1 (2.1.1 to 2.1.13), Sec. 2.2(2.2.1 to 2.2.9), 2.3, 2.4(2.4.1, 2.4.3 to 2.4.6, 2.4.8, 2.4.9).
       Unit 2:   Chapter 3: Sec. 3.1(3.1.1 to 3.1.7, 3.1.10, 3.1.11), Sec. 3.2(3.2.1 to 3.2.11), Sec. 3.3(3.3.1, 3.3.4), Sec. 3.4 (3.4.1 to 3.4.3, 3.4.5 to 3.4.8).
       Unit 3: Chapter 4: Sec. 4.1(4.1.1, 4.1.3 to 4.1.9), Sec. 4.2(4.2.1 to 4.2.8), Sec. 4.3 (4.3.1 to 4.3.9).
        Unit 4:   Chapter 5: Sec. 5.1, Sec. 5.2, Sec 5.3 (5.3.1 to 5.3.5, 5.3.7 to 5.3.10).

2.   Thomas Calculus, Thirteenth edition, Pearson Publication.
Unit 3: Text book-2: Chapter 1: Sec. 1.1.

Reference books:
       1   Introduction to Real analysis, William F.Trench, Free edition, 2010.
       2   Calculus of a single variable Ron Larson , Bruce Edwards, tenth edition.
       3   Elementary Analysis, The Theory of Calculus, Kenneth A. Ross, Springer Publication, second edition.
       4   Calculus and its Applications, Marvin L. Bittinger, David J. Ellenbogen and Scott A. Surgent, Addison Wesley, tenth edition.

MT 113: Mathematics Practical

(Practicals based on the applications of articles in MT 111 and MT 112)
 In Semester-I, we should conduct 3 written practical and 3 practical on maxima software for each paper MT-111 and MT-112.

List of Practical

Practical 1 : Problems on Unit 1 and Unit 2(Written) from MT-111.
Practical 2 : Problems on Unit 3 (Written) from MT-111.
Practical 3 : Problems on Unit 4(Written) from MT-111.
Practical 4 :Introduction to maxima software forMT-111.
Practical 5 : Problems on unit 1 and unit 2 from MT-111using maxima software.
Practical 6 : Problems on Unit 3 and Unit 4 from MT-111using maxima software.
Practical 7: Problems on Unit 1 and Unit 2(Written) from MT-112.
Practical 8 : Problems on Unit 3 (Written) from MT-112.
Practical 9 : Problems on Unit 4(Written) from MT-112.
Practical 10 :Introduction to maxima software for MT-112.
Practical 11 : Problems on unit 1 and unit 2 from MT-112using maxima software.
Practical 12 : Problems on Unit 3 and Unit 4 from MT-112 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 and android mobiles.

3. Android mobiles are allowed for practical examination on maxima software .

4.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 android mobile or computer).

Semester - II

MT 121-Analytical Geometry

Unit 1:   Analytical Geometry of Two Dimension   (10 Lectures)
1.1.   Change of axes: translation and rotation.
1.2.   Conic Sections: General equation of second degree in two variables
1.3.   Reductionto standard form, center of conic, nature of conic.

Unit 2:   Planes   (10 Lectures)
2.1.   Direction cosines and direction ratios,Equation of plane, Normal form, Transform
        to the normal form, Plane passing through three non-collinear points, Intercept
        form, Angle between   two   planes.
2.2.   Distance of a point from a plane, Distance between parallel planes, Systems of
        planes, two sides of planes, Bisector planes.

Unit 3:   Lines in three dimension   (8 lectures)
3.1.   Equations of a line in Symmetric and unsymmetrical forms, Line passing through
        two points, Angle between a line and a plane.
3.2.   Perpendicular distance of a point from a plane, Condition for two lines to be
        coplanar (without proof).

Unit 4:   Sphere   (8 Lectures)
4.1.   Equation of a sphere in different forms, plane section of a sphere.
4.2.   Equation of a circle, sphere through a given circle
4.3.   Intersection of a sphere and a line, Equation of tangent plane to sphere.

Text Books:
1.   Analytic Geometry in Two and Three Dimensions : Von Steuben
Unit1: Sec, 8.4
2.   Analytical Solid Geometry: Shantinarayan; S. Chand and Company
        Ltd, New Delhi, 1998.
        Unit2: Sec. 1.6,1.7, Sec. 2.1 to 2.7
            Unit3: Sec. 3.1 to 3.4, 3.7
            Unit4: Sec. 6.1 to 6.6.

Reference Book:
1.   P.K.Jain and Khalil Ahmad,A Text Book of Analytical Geometry of Three
        Dimensions, Wiley Estern Ltd. 1999.

MT 122: Calculus-II

Unit 1:   **Differentiation**   **(10 lectures)**
1.1.   The Derivatives:
       Definition of the derivative of a function at a point, every differentiable function is continuous, Rules of differentiation, Caratheodary'stheorem(without proof), The chain rule, Derivative of inverse function (without proof , only examples).
1.2   The Mean Value Theorems:
       Interior extremum theorem, Mean Value theorems and their Consequences, Intervals of increasing and decreasing of a function,first derivative test for extrema.

Unit 2:   **L' Hospital Ruleand Successive Differentiation(10 lectures)**
2.1   L'Hospital Rule:
       Indeterminate forms, L'Hospital Rules(without proof)
2.2   Taylor's theorem: Taylor's theorem and Maclaurin'stheorem with Lagrange's form of remainder(Without proof).
2.3   Successive Differentiation: The nth derivative and Leibnitz theorem for successive differentiation.

Unit 3:   **Ordinary Differential Equations**   **(08 lectures)**
3.1   Linear first order equations.
3.2   Separable equations.
3.3   Existence and Uniqueness of solutions of nonlinear equations.

Unit 4:   **Exact Differential Equations**   **(08 lectures)**
4.1   Transformation of nonlinear equations to separable equations.
4.2   Exact differential equations.
4.3   Integrating factors.

Textbooks:
1.   **Introduction to Real Analysis by R.G. Bartle and D.R. Sherbert, John Wiley and Sons, Inc., Fourth Edition.**
     Unit 1: Chapter 6: Sec. 6.1(6.1.1 to 6.1.8), Sec 6.2(6.2.1 to 6.2.8).
      Unit 2: Chapter 6: Sec 6.3(6.3.1 to 6.3.7), Sec 6.4(6.4.1 to 6.4.3).
2.   **Differential Calculus by Shanti Narayan, Tenth Revised Edition.**
     Units 2: Chapter 5: Sec. 5.1 to 5.6.
3.   **Elementary Differential equations, William F. Trench, E-book (Free download)**
Unit 3: Chapter 2: Sec 2.1 to 2.3.
     Unit 4: Chapter 2: Sec 2.4 to 2.6.

Reference books:

1.   Introduction to Real analysis, William F.Trench, Free edition, 2010.
2.   Calculus of a single variable Ron Larson , Bruce Edwards, tenth edition.
3.   Elementary Analysis, The Theory of Calculus, Kenneth A. Ross, Springer Publication, second edition.
4.   Calculus and its Applications, Marvin L. Bittinger, David J. Ellenbogen and Scott A. Surgent, Addison Wesley, tenth edition.
5.   Ordinary and partial Differential equations,M.D. Raisingania, S. Chand andCompany,2009.

MT 123: Mathematics Practical

(Practical based on the applications of articles in MT 121 and MT 122)

In Semester-II, we should conduct 4 written practical and 2 practical on maxima software for each paper MT-121 and MT-122.

List of Practical

Practical 1 : Problems on Unit 1 (Written) from MT-121.
Practical 2 : Problems on Unit 2 (Written) from MT-121.
Practical 3 : Problems on Unit 3(Written) from MT-121.
Practical 4 :Problems on Unit 4(Written) from MT-121.
Practical 5 : Problems on unit 1 and unit 2 from MT-121using maxima software.
Practical 6 : Problems on Unit 3 and Unit 4 from MT-121using maxima software.
Practical 7: Problems on Unit 1 (Written) from MT-122.
Practical 8 : Problems on Unit 2 (Written) from MT-122.
Practical 9 : Problems on Unit 3(Written) from MT-122.
Practical 10 :Problems on Unit 4(Written) from MT-122.
Practical 11 : Problems on unit 1 and Unit 2 from MT-122using maxima software.
Practical 12: Problems on Unit 3 and Unit 4from MT-122 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 can be performed on computer and android mobiles.
3. Android mobiles are allowed for practical examination on maxima software .
4.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 android mobile or computer).

Modalities For Conducting The Practical and The Practical Examination:

1) There will be one 3 hour 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 no external examiner, the practical exam will be of the duration of 3 hours.

4) The subject teacher will set a question paper 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 andgraphing 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 20 X 20 sq. fts containing at least 10 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**.**