# 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 (Computer Science)

**Choice Based Credit System Syllabus**

**To be implemented from Academic Year 2019-2020**

# Title of the Course : B.Sc. Mathematics (Computer Science)

## Structure of the course:-

|  | Semester - I |  | Semester -II |  |
|---|---|---|---|---|
| Paper I | MTC-111 | Matrix Algebra | MTC-121 | Linear Algebra |
| Paper II | MTC-112 | Discrete Mathematics | MTC-122 | Graph Theory |
| Paper III | MTC-113 | Mathematics Practical | MTC-123 | Mathematics Practical |

## Proposed Structure of S. Y. B. Sc. Mathematics (Computer Science) Courses:

|  | Semester - III |  | Semester -IV |  |
|---|---|---|---|---|
| Paper I | MT-231 | Group Theory | MT-241 | Calculus |
| Paper II | MT-232 | Numerical Analysis | MT-242 | Operations Research |
| Paper III | MT-233 | Mathematics Practical | MT-243 | Mathematics Practical |

All three above courses are compulsory.

## Equivalence of Previous syllabus along with new syllabus:

|  | Old course | New Course |
|---|---|---|
| Paper I | MTC-101 : Discrete Mathematics | MTC-111: Matrix Algebra and MTC-121 : Linear Algebra |
| Paper II | MTC-102 : Algebra and Calculus | MTC-112 : Discrete Mathematics and MTC-122 : Graph Theory |
| Paper III | MTC-103 : Mathematics Practical | MTC – 113 : Mathematics Practical and MTC – 113 : Mathematics Practical |

## Detailed Syllabus:

## Semester - I

### MTC-111: Matrix Algebra

**Unit 1 : Introduction**                         **(4 lectures)**

1.1     Matrix Operations
1.2     The Inverse of a Matrix
1.3     Characterization of invertible matrices

**Unit 2 : Linear Equations in Linear Algebra-I**     **(12 lectures)**

2.1     System of Linear equations
2.2     Row  reduction and echelon forms
2.3     Vector equations
2.4     The matrix equation $Ax=b$
2.5     Solution sets of linear systems

**Unit 3 : Linear Equations in Linear Algebra  -II**     **(12 lectures)**

3.1     Partitioned Matrices
3.2     Matrix factorization [Lu decomposition]
3.3     Linear Independence
3.4     Introduction to linear transformation
3.5     The matrix of linear transformation
3.6     Subspaces of $R^n$
3.7     Dimension and Rank

**Unit 4 : Determinants**                         **(8 lectures)**

4.1     Introduction to determinants
4.2     Properties of determinants
4.3     Cramer's rule, Volume and linear transformations

**Text Book : Linear Algebra and its Applications,  David C Lay, Steven R. Lay, Judi J. MacDonald Pearson Publication,2016, Fifth Edition.**

Unit 1: Chapter 2: Sec. 2.1, 2.2, 2.3
Unit 2: Chapter 1: Sec. 1.1, 1.2, 1.3, 1.4, 1.5
Unit 3: Chapter 2: Sec. 2.4, 2.5,2.8, 2.9, Chapter 1: 1.7, 1.8, 1.9
Unit 4: Chapter 3: Sec. 3.1, 3.2, 3.3

**Reference Books :**

1.     Elementary Linear Algebra with supplemental Applications,Howard Anton and others ,Wiley Student Edition.

2.      Matrix and Linear Algebra (aided with MATLAB),KantiBhushanDatta, Eastern Economic Edition.

## MTC 112: Discrete Mathematics

### UNIT 1 : LOGIC            (7 Lectures)

1.1 Revision : Propositional Logic, Propositional Equivalences.
1.2 Rules of Inference : Argument in propositional Logic, Validity Argument(Direct and Indirect methods) Rules of Inference for Propositional Logic, Building Arguments.
1.3 Predicates and Quantifiers : Predicate, n-Place Predicate or ,n-ary Predicate, Quantification and Quantifiers, Universal Quantifier, Existential Quantifier, Quantifiers with restricted domains, Logical Equivalences involving Quantifiers.

### Unit 2 : Lattices and Boolean Algebra     (13 Lectures)

2.1  Relations, types  of relations, equivalence relations, Partial ordering relations
2.2  Digraphs of relations, matrix representation and composition of relations.
2.3  Transitive closure and Warshall's Algorithm
2.3  Poset, Hasse diagram.
2.4  Lattices, Complemented lattice, Bounded lattice and Distributive lattice.
2.5  Boolean Functions : Introduction, Boolean variable, Boolean Function of  degree n, Boolean identities, Definition of Boolean Algebra.
2.6  Representation of Boolean Functions : Minterm, Maxterm Disjunctive normal  form, Conjunctive normal Form.

### Unit 3 : Counting Principles           (7 Lectures)

3.1  Cardinality of Set : Cardinality of a finite set.
3.2  Basics of Counting : The Product Rule, The Sum Rule, The Inclusion- Exclusion Principle.
3.3  The Pigeonhole Principle: Statement, the Generalized Pigeonhole Principle, Its Applications.
3.4  Generalized Permutations and Combinations : Permutation and
3.5  Combination with Repetitions, Permutations with Indistinguishable Objects

### Unit 4: Recurrence Relations          (9 Lectures)

4.1 Recurrence Relations: Introduction, Formation.
4.2  Linear Recurrence Relations with constant coefficients.
4.3  Homogeneous Solutions.
4.4  Particular Solutions.
4.5 Total Solutions.

### TextBooks:
1. Discrete Mathematics and its applications, by Kenneth Rosen, Tata McGraw Hill, Seventh Edition.

2. Discrete Mathematical Structures, by Kolman, Busby, Ross, Rehman, Prentice Hall,
 3. Elements of Discrete Mathematics, by C. L. Liu, Tata McGraw Hill,

Unit 1: Text Book 1: Chapter 1: Sec. 1.1, 1.2, 1.3, 1.4, 1.5
Unit 2: Text Book 2: Chapter 6: Sec.  6.1, 6.2, 6.3, 6.4, 6.5
Unit 3: Text Book 1: Chapter 2: Sec. 2.1, Chapter 5: Sec.5.1, 5.2, 5.3
Unit 4: Text Book 3: Chapter 10: Sec. 10.1, 10.2, 10.3, 10.4, 10.5, 10.6


## MTC 113: Mathematics Practical

(Practical based on the applications of articles in MTC-111 and MTC - 112)

In Semester-I, we should conduct 3 written practical and 3 practical on maxima software for each paper MTC -111 and MTC -112.

**List of Practical**

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

### MTC-121: Linear Algebra

**Unit 1: Vector Spaces**                          **(10 lectures)**

1.1      Vector spaces and subspaces
1.2      Null spaces, column spaces and linear tranformations.
1.3      Linearly independent sets : Bases
1.4      Coordinate systems
1.5      The dimension of a vector space
1.6      Rank

**Unit 2: Eigen values and Eigen vectors**            **(10 lectures)**

2.1      Eigen values and Eigen vectors
2.2      The characteristic equation
2.3      Diagonalization
2.4      Eigen vectors and Linear transformations

**Unit 3:Orthogonality and Symmetric Matrices**      **(10 lectures)**

3.1      Inner product, length and orthogonality
3.2      Orthogonal sets
3.3      Orthogonal Projections
3.4      Diagonalization of Symmetric Matrices
3.5      Quadratic forms

**Unit 4: The Geometry of vector spaces**            **(6lectures)**

4.1      Affine combinations
4.2      Affine independence
4.3      Convex combinations

**Text Book :**

**Linear Algebra and its Applications (5$^{th}$ Edition) David C Lay, Steven R. Lay, Judi J. MacDonaldPearson Publication, Fifth Edition, 2016.**

Unit 1:Chapter 4: Sec.4.1, 4.2, 4.3,4.4, 4.5, 4.6
Unit 2: Chapter 5: Sec. 5.1, 5.2, 5.3, 5.4
Unit 3: Chapter 6: Sec. 6.1, 6.2, 6.3, Chapter 7: 7.1,7.2
Unit 4: Chapter 8:Sec. 8.1, 8.2*,8.3
*From section 8.2 omit Barycentric coordinates.

**Reference Books:**

1.    Elementary Linear Algebra with supplemental Applications, by Howard Anton and others,Wiley Student Edition, Fourth edition.

2.    Matrix and Linear Algebra (aided with MATLAB), byKantiBhushanDatta, Eastern Economic Edition, Fourth edition.


## MTC-122:  Graph Theory

### Unit 1: An Introduction to graph                         (10 lectures)

1.1.    Definitions, Basic terminologies and properties of graph, Graph models.
1.2.    Special types of graphs,  basic terminologies, properties and examples of directed graphs .Types of diagraphs.
1.3.     Some applications of special types of graph.
1.4.    Matrix representation and elementary results, Isomorphism of graphs.

### Unit 2: Connected graph                                  (8 lectures)

2.1.    Walk, trail, path, cycle, elementary properties of connectedness. Counting paths between vertices (by Warshall's algorithm).
2.2.    Cut edge (Bridge), Cut vertex, cut set, vertex connectivity, edge connectivity, and Properties.
2.3.    Shortest path problem, Dijkstra's algorithm.

### Unit 3.  Euler and Hamilton path.                         (8 lectures)

3.1.    The Konigsberg bridge problem, Euler trail, path, circuit and tour, elementary properties and Fleury's algorithm.
3.2.    Hamilton path, circuit, elementary properties and examples.
3.3.    Introduction of Travelling salesman problem, Chinese postman problem.


### Unit  4.  Trees                                           (10 lectures)

4.1. Definitions, basic terminologies, properties and applications of trees.
4.2. Weighted graph, definition and properties of spanning tree, shortest spanning tree, Kruskal's algorithm, Prim's algorithm.
4.3. M-ary tree, binary tree, definitions and properties, tree traversal: preorder, inorder, postorder, infix, prefix, postfix notations and examples.


**Text Book:**

**Kenneth Rosen, Discrete Mathematics and its applications, Tata McGraw Hill, Seventh Edition.**

Unit 1: Chapter 8: Sec. 8.1, 8.2, 8.3
Unit 2: Chapter 8: Sec. 8.4
Unit 3: Chapter 8: Sec. 8.5, 8.6
Unit 4: Chapter 9: Sec. 9.1,9.2,9.3,9.4,9.5.

**Reference Books:**
1. John Clark and Derek Holton, A first look at Graph theory, Allied Publishers.
2. NarsinghDeo, Graph Theory with applications to computer science and engineering, Prentice Hall.
3. C.L.Liu, Elements of Discrete Mathematics, Tata McGraw Hill, Fourth edition
4. Douglas B. West, Introduction to Graph Theory, Pearson Education, second edition.

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## MTC 123: Mathematics Practical

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

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

**List of Practical**

Practical 1 : Problems on Unit 1 (Written) from MTC-121.
Practical 2 : Problems on Unit 2 (Written) from MTC-121.
Practical 3 : Problems on Unit 3(Written)  from MTC-121.
Practical 4 :Problems on Unit 4(Written)  from MTC-121.
Practical 5 : Problems on unit 1 and unit 2  from MTC-121using maxima software.
Practical 6 : Problems on Unit 3 and Unit 4  from MTC-121using maxima software.
Practical 7: Problems on Unit 1 (Written) from MTC-122.
Practical 8 : Problems on Unit 2 (Written) from MTC-122.
Practical 9 : Problems on Unit 3 (Written)  from MTC-122.
Practical 10 :Problems on Unit 4 (Written)  from MTC-122.
Practical 11 : Problems on unit 1 and Unit 2  from MTC-122 using maxima software.
Practical 12: Problems on Unit 3 and Unit 4 from MTC-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. Practical 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**.**