Progressive Education Society's

Modern college of Arts, Science and Commerce,

Ganeshkhind,Pune-16

Autonomous

Three year B.Sc.(Regular)

(Under Faculty of Science and Technology)

S.Y.B.Sc.(Regular) : Mathematics

Choice Based Credit System Syllabus

To be implemented from Academic Year 2023-2024

S.Y.B.Sc. [General] (Autonomous)

MATHEMATICS

Introduction: 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 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 modelling ,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 modelling 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.

S.Y.B.Sc. [General] (Autonomous)

MATHEMATICS

	Semester - III		**Semester -IV**		Credits
Paper I	**23-MT-231**	**Calculus of Several Variables**	**23-MT-241**	**Linear Algebra-I**	**2**
Paper II	**23-MT-232 (A)**	**Numerical Methods and its applications**	**23-MT-242(A)**	**Vector Calculus**	**2**
	23-MT-232 (B)	**Graph Theory**	**23-MT-242(B)**	**Discrete Mathematics**	
Paper III	**23-MT-233**	**Mathematics Practical based on 23-MT-231 and 23-MT-232**	**23-MT-243**	**Mathematics Practical based on 23-MT-241 and 23-MT-242**	**2**

• All three above courses are compulsory.

• In Semester-III, select any one from 23-MT-232(A) and 23-MT-232(B).

• In Semester-IV, select any one from 23-MT-242(A) and 23-MT-242(B).

Medium of Instruction: English.

Examination:

A) Pattern of Examination: Semester

B) Each course is of 50 marks (35 marks theory end semester examination & 15 marks internal examination).

C) Standard of passing : 20 marks out of 50 marks for each paper. Student should obtain minimum 14 marks out of 35 in the theory examination and 6 marks for internal examination out of 15.

D) Pattern of Question Papers for papers 23- MT-231, 23- MT-232(A), 23- MT-232(B), 23- MT-241, 23- MT-242(A), 23- MT-242(B).

Q.1 Attempt any 5 out of 7 each of 2 marks [10 marks]

Q.2 Attempt any 3 out of 5 each of 5 marks [15 marks].

Q.3 Attempt any 1 out of 2 each of 10 marks [10 marks].

E) External students: Not Allowed

Detailed Syllabus

Semester – III
23-MT-231: Calculus of Several Variables
(2 Credits)

Course Learning Outcomes

CO1: Student will learn functions of several variables.

CO2: Student will learn the notion of Continuity and Differentiability of multivariate functions.

CO3: Student will be able to find extreme values of multivariable functions using derivatives.

CO4: Student will learn evaluation of double and triple integration and its application to area and volume

CO5: Student will be able to use change of variables effectively for evaluation of integrals.

Course Contents

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 DifferentialEquations, 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, SpringerVerlag (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).

23-MT-232 (A): Numerical Methods and its applications (2 Credits)

Course Learning Outcomes

CO1: Problem solving skills of students are enhanced.

CO2: Students learn how to apply mathematical concepts to practical and real life problems.

CO3: The problems which cannot be solved by usual formulae and methods can be solved approximately by using numerical techniques.

CO4: Student will be able to solve the integration problems which cannot be solved by usual formulae and methods using numerical techniques.

CO5: Student will learn curve fitting to the data using 3 different methods of interpolation

Course Contents

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, Backwarddifference 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 ofndia.

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).

Course Contents

23-MT-232 (B): Graph Theory
(2 Credits)

Course Learning Outcomes

CO1: Student will earn basic concepts in Graph theory.

CO2: Student will develop the skill of converting mathematical problem graphically and vice versa

CO3: Student will learn suitable techniques of analysis of problems

CO4: Student will learn various tools for solving real life problems

CO5: Student will develop a positive attitude towards mathematics as an interesting and valuable subject to study.

Course Contents

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.

23-MT-233: Mathematics Practical
(Practical based on the applications of 23-MT231 and 23-MT-232)
List Of Practicals

Practical 1: Problems on Unit 1 (Written) from 23-MT231
Practical 2: Problems on Unit 2 (Written) from 23-MT231
Practical 3: Problems on Unit 3 (Written) from 23-MT231
Practical 4: Problems on Unit 4 (Written) from 23-MT231
Practical 5: Miscellaneous
Practical 6: Applications using Mathematical software

Practical 7: Problems on Unit 1 (Written) from 23-MT232
Practical 8: Problems on Unit 2 (Written) from 23-MT232
Practical 9: Problems on Unit 3 (Written) from 23-MT232
Practical 10: Problems on Unit 4 (Written) from 23-MT232
Practical 11: Miscellaneous
Practical 12: Applications using Mathematical software

Semester IV
23-MT-241: Linear Algebra
(2 Credits)

Course Learning Outcomes

CO1: Student will be able to formulate , solve and interpret properties of linear systems .

CO2: Student gets introduced to the concepts of vector space which is used in other pure mathematical subjects and engineering

CO3: Student will be able to identify the subspaces of a given vector space.

CO4: Student will learn the importance and applications of linear transformation.

CO5: To get well equipped with Mathematical Modelling abilities.

Course Contents

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, definitionof row equivalent matrices.
1.4 Consistency of homogeneous and non-homogeneous system of linear equationsusing rank, condition for consistency.
1.5 Solution of System of Equations: Gauss elimination and Gauss-Jordan eliminationmethod, 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, NinthEdition, 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, NewDelhi

(2) Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall ofIndia. New Delhi
(3) Vivek Sahai, Vikas Bist, Linear Algebra, 4th Reprint 2017, Narosa Publishing House, NewDelhi
(4) Promode Kumar Saikia, Linear Algebra, 2009, Pearson, Delhi
(5) S. Lang, Introduction to Linear Algebra, 2nd edition,1986, Springer-Verlag, New York,Inc.

23-MT-242 (A): Vector Calculus
(2 Credits)

Course Learning Outcomes

CO1: Student will learn how to compute the derivatives of vector functions

CO2: Student will learn to evaluate the line integrals of vector functions

CO3: Student gets the knowledge of central concepts in multivariable analysis such as space curves, directional derivative, gradient etc.

CO4: Student will be able to evaluate surface integrals.

CO5: Student will be able to apply techniques from multivariable analysis to set up and solve Mathematical models, to deduce simple mathematical results and to calculate integrals.

Course Contents

Unit 1: **Vector-Valued Functions** **[08 lectures]**

1.1 Curves in Space, Limits and Continuity, Derivatives and Motion, DifferentiationRules 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 TangentVector.
1.4 Curvature of a Plane Curve, Circle of Curvature for Plane Curves, Curvature andNormal 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 withrespect to dx, dy, dz .
2.3 Work done by a Force over a Curve in Space, Flow Integrals and Circulation forVelocity 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 andStokes' 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 ServicesPvt. 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).

23-MT-242 (B): Discrete Mathematics
(2 Credits)

Course Learning Outcomes

CO1: The student develops theoretical, applied and computational skills.
CO2: The student gains confidence in proving theorems and solving problems.
CO3: Student will learn fundamental and advanced tools of counting
CO4: Student will be able to solve recurrence relations

Course Contents

Unit 1: Logic and Proofs **[12 Lectures]**

1.1 Propositional Logic
1.2 Propositional Equivalences
1.3 Predicate and Quantifiers
1.4 Nested Quantifiers
1.5 Rules of Inference
1.6 Introduction to Proofs

Unit 2: Counting **[14 Lectures]**

2.1 The Basics of Counting
2.2 Permutations and Combinations
2.3 Binomial Coefficients
2.4 Generalized Permutations and Combinations
2.5 The Pigeonhole Principle

Unit 3: Advanced Counting Techniques **[10 Lectures]**

3.1 Inclusion Exclusion
3.2 Recurrence Relations
3.3 Solving Linear Recurrence Relations

Textbooks :

Discrete Mathematics and Its Applications : Kenneth Rosen, Seventh Edition

Unit 1: Chapter 1 : Section - 1.1 to 1.6.
Unit 2: Chapter 5 : Section, 5.1 to 5.5.
Unit 3: Chapter 6 : Section 6.1,6.2,6.5.

Reference Books :

1. Applied Combinatories By Alan Tucker.
2. Discrete Mathematical Structures By Kolman, Busby and Ross

23-MT-243: Mathematics Practical
(Practical based on the applications of 23-MT241 and 23-MT-242)
List Of Practicals

Practical 1: Problems on Unit 1 (Written) from 23-MT241
Practical 2: Problems on Unit 2 (Written) from 23-MT241
Practical 3: Problems on Unit 3 (Written) from 23-MT241
Practical 4: Problems on Unit 4 (Written) from 23-MT241
Practical 5: Miscellaneous
Practical 6: Applications using Mathematical software
Practical 7: Problems on Unit 1 (Written) from 23-MT242
Practical 8: Problems on Unit 2 (Written) from 23-MT242
Practical 9: Problems on Unit 3 (Written) from 23-MT242
Practical 10: Problems on Unit 4 (Written) from 23-MT242
Practical 11: Miscellaneous
Practical 12: Applications using Mathematical software

Modalities for conducting practicals and practical Examination :

1. There will be one 4 hours & 20 minutes (260 marks) practical session for each of batch of 15 students per week for each practical course.
2. External examiner shall be appointed by the college for Mathematics Practical Examination.
3. The duration of practical examination is 3 hours.

4. The practical examination is of 35 marks which consist of written examination of 25 marks & 10 marks on maxima software. The slips for the questions on programming and problem solving shall be prepared by the examiner.
5. The internal 15 marks will be given on the basis of journal prepared by student and the cumulative performance of student at practical .
6. Study tours may be arranged at place having important mathematical institutes or historical places.

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