SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A++' Grade

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Bachelor of Science (Mathematics) Part I (Level-4.5)

Semester I and II

under the

Faculty of Science and Technology

(To Be Implemented from Academic Year 2024-25)

PROGRAM STRUCTURE:

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
B.Sc. (Mathematics) Part – I (Level-4.5)

Level	Semester	1-Major		2-Minor	3-OE	4-SEC	5-AEC, VEC, IKS			6-OJT, FP, CEP, CC, RP			Total Credits
		Major		Minor	IDC/MDC/ OE/GE	SEC	AEC (Language)	Value Education Courses (VEC)	IKS	CC	Summer Internship/Field Project/OJT	Research Project / Dissertation	
		DSC	DSE	MIN	OE								
4.5	I	**DSC-I (2)** Basic Algebra **DSC-II (2)** Calculus **DSC Pract. -I(2)** Mathematics Practical-I	---	**MINOR-I (2)** Basic Algebra **MINOR-II (2)** Calculus **MINOR Pract - I (2)** Mathematics Practical-I	**IDC/MDC/OE-I (2)** Foundations of Mathematics **IDC/MDC/OE-II (T/P) (2)** Quantitative Aptitude for Competitive Examinations	**SEC-I (2)** Mathematics using Scilab **SEC-Pract.-I(2)** Computing Mathematics using Scilab			**IKS-I (2)** Introduction to IKS Vedic Mathematics			-	
	Credits	**4+2=6**		**4+2=6**	**2+2=4**	**2+2=4**			**2**			**-**	**22**
	II	**DSC-III (2)** Differential Equations - I **DSC-IV (2)** Discrete Mathematics **DSC Pract.-II(2)** Mathematics Practical-II	---	**MINOR-III (2)** Differential Equations - I **MINOR-IV (2)** Discrete Mathematics **MINOR Pract -II (2)** Mathematics Practical-II	**IDC/MDC/OE-III(2)** Logical Reasoning for Competitive Examinations **IDC/MDC/OE-IV (T/P) (2)** Business Mathematics	**SEC-II (2)** Mathematics in Data Science **SEC-Pract. -II (2)** Applications of Mathematics in Data Science		**VEC- I (2)** Democracy				-	
	Credits	**4+2=6**		**4+2=6**	**2+2=4**	**2+2=4**		**2**				**-**	**22**
1st Year Cum. Credits		**12**		**12**	**8**	**8**		**2**	**2**				**44**

Exit option: Award of UG Certificate in MATHEMATICS as Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
B.Sc. (Mathematics) Part – II (Level-5.0)

Level	Semester	1-Major		2-Minor	3-OE	4-SEC	5-AEC, VEC, IKS			6-OJT, FP, CEP, CC, RP			Total Credits
		Major		Minor	IDC/MDC/ OE/GE	SEC	AEC (Language)	Value Education Courses (VEC)	IKS	CC	Summer Internship/Field Project/OJT	Research Project / Dissertation	
		DSC	DSE	MIN	OE								
5.0	III	**DSC-V (2)** Differential Equations - II **DSC-VI (2)** Numerical Methods **DSC Pract. -III (4)** Mathematics Practical-III	---	**MINOR-V (2)** Differential Equations - II **MINOR-VI (2)** Numerical Methods **MINOR Pract - III (2)** Mathematics Practical-III	---	**SEC-III (2)** Numerical Recipes in Mathematics using Python **SEC-Pract. -III (2)** Computing Mathematics using Python	**AEC-I (2)** English		**IKS-II (2)** Major Specific ???			-	
	Credits	**4+4=8**		**4+2=6**		**2+2=4**	**2**		**2**			**-**	**22**
	IV	**DSC-VII (2)** Differential Calculus **DSC-VIII (2)** Integral Calculus **DSC Pract.-IV (4)** Mathematics Practical-IV	---	**MINOR-VII (2)** Differential Calculus **MINOR-VIII (2)** Integral Calculus **MINOR Pract - IV (2)** Mathematics Practical-IV	---	**SEC-Pract.-IV (2)** Mathematics Typesetting using Latex	**AEC-II (2)** English	**VEC-II (2)** Environmental Studies		**CC (2)** ???		-	
	Credits	**4+4=8**		**4+2=6**		**0+2=2**	**2**	**2**		**2**		**-**	**22**
	2nd Year Cum. Credits	**16**		**12**		**6**	**4**	**2**	**2**	**2**			**44**

Exit option: Award of UG Diploma in MATHEMATICS as Major with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
B.Sc. (Mathematics) Part – III (Level-5.5)

Level	Semester	1-Major		2-Minor	3-OE	4-SEC	5-AEC, VEC, IKS			6-OJT, FP, CEP, CC, RP			Total Credits
		Major		Minor	IDC/MDC/ OE/GE	SEC	AEC (Language)	Value Education Courses (VEC)	IKS	CC	Summer Internship/Field Project/OJT	Research Project / Dissertation	
		DSC	DSE	MIN	OE								
5.5	V	**DSC-IX (2)** Real Analysis **DSC-X (2)** Modern Algebra **DSC-XI (2)** Partial Differential Equations **DSC-XII (2)** Integral Transform **DSC Pract. -V(8)** Mathematics Practical-V	**DSE- I(2)** Vector Calculus / Special Functions/ Fuzzy Set theory / Mathematics for Data science I/ Optimization Techniques-I/ Coding Theory/ Theory of Module	---	---	---	**AEC-III (2)** English	---	---	---	**OJT (2)**	-	
	Credits	**8+8=16**	**2+0=2**				**2**				**2**	**-**	**22**
	VI	**DSC- XIII (2)** Metric Spaces **DSC- XIV (2)** Linear Algebra **DSC- XV (2)** Complex Analysis **DSC-XVI (2)** Operations Research **DSC Pract. VI(8)** Mathematics Practical-VI	**DSE-II(2)** Introduction to Lattice Theory / Number Theory / Differential Geometry / Analytical Geometry / Tensor Calculus/ Mathematics for Data Science II/ Optimization Techniques -II/ Dynamical Systems/ Classical Mechanics	---	---	---	**AEC-IV (2)** English	---	---	---	**FP (2)**	-	
	Credits	**8+8=16**	**2+0=2**				**2**				**2**	**-**	**22**
3rd Year Cum. Credits		**32**	**4**				**4**				**4**		**44**
Three Years Cumulative Credits		**60 DSC**	**4 DSE**	**24 Minor**	**8 IDC/MDC/ OE/GE**	**14 SEC**	**8 AEC**	**4 VEC**	**4 IKS**	**2 CC**	**4 FP+OJT**	**-**	**132**

Exit option: Exit option: Award of UG Degree in MATHEMTSCS as Major with 132 credits OR Continue with Major and Minor

B. Sc. (Honors / Research) – First Year (Level – 4.5), SEMESTER – I											
Course Type	**Course**	**Course Code**	**Course Title**	**Credits**	**Teaching Hours/ Week**			**Marks (Total 100)**			
					T	**P**	**Total**	**Internal (CA)**		**External (UA)**	
								T	**P**	**T**	**P**
MAJOR	DSC-I		Basic Algebra	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MAJOR	DSC-II		Calculus	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MAJOR	DSC Pr. I		Mathematics Practical - I	**2**	**---**	**4**	**4**	**---**	**---**	**---**	**50**
MINOR	MIN – I		Basic Algebra	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MINOR	MIN – II		Calculus	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MINOR	MIN Pr. I		Mathematics Practical - I	**2**	**---**	**4**	**4**	**---**	**---**	**---**	**50**
OE	OE-1		Foundations of Mathematics	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
OE	OE-II		Quantitative Aptitude for Competitive Examinations	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
SEC	SEC-1		Mathematics using Scilab	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
SEC	SEC Pr. I		Computing Mathematics using Scilab	**2**	**--**	**4**	**4**	**--**	**--**	**--**	**50**
IKS	IKS		Vedic Mathematics	**2**	**2**	**--**	**2**	**10**	**--**	**40**	**--**
B. Sc. (Honors / Research) – First Year (Level – 4.5), SEMESTER – II											
MAJOR	DSC-III		Differential Equations - I	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MAJOR	DSC-IV		Discrete Mathematics	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MAJOR	DSC Pr. II		Mathematics Practical - II	**2**	**---**	**4**	**4**	**---**	**---**	**---**	**50**
MINOR	MIN – III		Differential Equations - I	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MINOR	MIN – IV		Discrete Mathematics	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
MINOR	MIN Pr. II		Mathematics Practical - II	**2**	**---**	**4**	**4**	**---**	**---**	**---**	**50**
OE	OE-II		Logical Reasoning for Competitive Examinations	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
OE	OE-IV		Business Mathematics	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
SEC	SEC-II		Mathematics in Data Science	**2**	**2**	**---**	**2**	**10**	**---**	**40**	**---**
SEC	SEC Pr. II		Applications of Mathematics in Data Science	**2**	**--**	**4**	**4**	**--**	**--**	**--**	**50**
VEC	VEC-I		Democracy	**2**	**2**	**--**	**2**	**--**	**--**	**50**	**--**

Abbreviations:

AEC	Ability Enhancement Course
CC	Co-curricular Courses
CEP	Community Engagement and Service
DSC	Department Specific Core
DSE	Department Specific Elective
FP	Field Project
GE	Generic Elective
IDC	Inter-Disciplinary Course
IKS	Indian Knowledge System
MDC	Multi-Disciplinary Course
MIN	Minor
OE	Open Elective
OEC	Open Elective Course
OJT	On Job Training
P	Practical
RP	Research Project
SEC	Skill Enhancement Course
T	Theory
VEC	Value Education Course
VSC	Vocational Skill Course

Semester I

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Major (DSC – I)
Title of course : Basic Algebra
Credit : 02

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. apply De-Moivre's theorem.
CO 2. find rank, eigen values, eigen vectors of the matrix.
CO 3. solve system of linear homogeneous and non-homogeneous equations.
CO 4. understand Hermitian and Skew Hermitian matrices.

UNIT – 1: ALGEBRA OF COMPLEX NUMBERS (15 hrs.)

1.1. Sums and Products, Moduli, Polar form, Geometrical representation of Complex Numbers, Exponential form, arguments of Products and Quotients.
1.2. De-Moivre's Theorem and examples
1.3 Applications of De-Moivre's Theorem
1.3.1 n^{th} roots of unity.
1.3.2 Expansion of $\cos n\theta$, $\sin n\theta$
1.3.3 Circular functions and hyperbolic functions.
1.3.4 Relations between circular and hyperbolic functions.
1.3.5 Inverse circular and hyperbolic functions.

UNIT – 2: MATRICES (15 hrs.)

2.1. Introduction
2.2 Definitions of Hermitian and Skew Hermitian matrices.
2.3. Properties of Hermitian and Skew Hermitian matrices.
2.4. Rank of a Matrix, Row-echelon form and reduced row echelon form, normal form.
2.5. System of linear homogeneous and non-homogeneous equations.
2.5.1. Condition for consistency.
2.5.2. Nature of the general solution.
2.5.3. Gaussian elimination and Gauss Jordon method
(Using row-echelon form and reduced row echelon form).
2.5.4. Examples based on 2.4.1, 2.4.2 and 2.4.3.
2.6. Characteristic equation, eigen values and eigen vectors of a matrix and examples
2.7. Cayley Hamilton theorem and examples.

Recommended Books:

1. **Applied Mathematics** by Ch.V. Ramana Murthy, N. C. Shrinivas, S. Chand and Company Ltd., 1st Edition, 2001.
   Scope: Unit-I: Chapter No. 1: Art.1.2 to Art.1.13, Art. 1.15, Art. 1.17 to Art. 1.19, Art.1.23
2. **Higher Engineering Mathematics** by H. K. Dass, Er. Rajnish Verma, S. Chand and Company Pvt. Ltd. 3rd Revised Edition 2014.
   Scope: Unit-II: Art. 19.1 to Art. 19.3, Art. 21.1 to Art. 21.6, Art. 21.27 to Art. 21.30, Art. 20.1 to Art. 20.4

Reference Books:

1. **Elementary Linear Algebra (**Application Version**)**, Howard Anton and Chris Rorres, 10th Edition, 2010.
2. **Complex Variables and Applications,** James Ward Brown and Ruel V. Churchill, Mc-Graw Hill, 8th Edition, 2009.
3. **Modern Algebra**, A. R. Vasishtha, Krishna Prakashan, Meerut 1994.
4. **A Text Book of Matrices** - Shanti Narayan (Revised by P. K. Mittal), S. Chand and Co., 11th Edition, reprint 2007.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Major (DSC – II)**
Title of course	**:**	**Calculus**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. find higher derivatives of product two differentiable functions using Leibnitz theorem.
CO 2. learn conceptual variations while advancing from one variable to several variables in calculus.
CO 3. understand the consequences of mean value theorems for differentiable functions.
CO 4. apply L' Hôpital's rule to various indeterminate forms.

Unit – 1: Differentiation **(15 hrs.)**

1.1. Successive Differentiation
- 1.1.1. Higher order derivatives: notations.
- 1.1.2. Calculation of n^{th} derivative: Standard results
- 1.1.3. Determination of n^{th} derivative of rational functions: Examples.
- 1.1.4. The n^{th} derivative of product of the powers of sine and cosines: Examples.
- 1.1.5. Leibnitz's Theorem. The n^{th} derivative of product of two functions.
- 1.1.6. Examples on Leibnitz's Theorem.

1.2. Partial differentiation
- 1.2.1. Introduction to functions of two and more variables
- 1.2.2. Partial derivative: first order and higher order – examples.
- 1.2.3. Geometrical interpretation of partial derivatives of first order.

Unit – 2: Mean Value Theorems and Indeterminate forms **(15 hrs.)**

2.1. Mean Value Theorems
- 2.1.1. Rolle's Mean Value Theorem, Geometrical interpretation.
- 2.1.2. Lagrange's Mean Value Theorem, Geometrical interpretation.
- 2.1.3. Meaning of sign of derivative
- 2.1.4. Cauchy's Mean Value Theorem.
- 2.1.5. Examples on 2.1.1, 2.1.2, 2.1.3 and 2.1.4

2.2. Indeterminate forms
- 2.2.1. Indeterminate forms: L' Hôpital's rule for $\frac{0}{0}$ and $\frac{\infty}{\infty}$ form (Statement only).
- 2.2.2. The indeterminate forms $0 \times \infty$, $\infty - \infty$, 0^0 , 1^∞ , ∞^0

2.3. Expansion of functions
- 2.3.1. Maclaurin's theorem (statement only): Examples.
- 2.3.2. Taylor's theorem (statement only): Examples.

Recommended Books:

1. **Differential Calculus,** Shanti Narayan and P.K. Mittal, S. Chand publishing, 15th edition (2016).

Scope:

Unit 1 – 1.1: Chapter 5: 5.1 to 5.5

1.2: Chapter 11: 11.6, 11.6.1, 11.7.1

Unit 2 – 2.1: Chapter 8: 8.1, 8.2, 8.3, 8.5

2.2: Chapter 10: 10.1 to 10.6

2.3: Chapter 6: 6.1, 6.2

Reference Books:

1. **Differential Calculus**, Gorakh Prasad, Pothishala Pvt. Ltd., 19th edition (2016).
2. **Aspects of Calculus**, Gabriel Klambauer, Springer-Verlag (1986).
3. **Differential Calculus**, Hari Kishan, Atlantic Publishers & Dist. (2007).
4. **Calculus**, George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir, Pearson Education, 14th edition (2018).

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Major (DSC Practical – I)
Title of course : Mathematics Practical – I
Credit : 02

Pr. No	Title of the Practical	No. of Practicals
1.	Examples on De-Moivre's Theorem	1
2.	n^{th} roots of unity	1
3.	Expansion of cos nθ, sin nθ	1
4.	Solution of system of linear homogeneous equations.	1
5.	Solution of system of linear non-homogeneous equations.	1
6.	Eigen values and Eigen vectors of matrix	1
7.	Cayley Hamilton Theorem (Verification and finding inverse of matrix)	1
8.	Examples of n^{th} derivative	1
9.	Examples on Leibnitz's Theorem.	1
10.	Examples on partial differentiation	1
11.	Lagrange's Mean Value Theorems.	1
12.	Cauchy's Mean Value Theorems.	1
13.	L' Hospital's rule for $0 \times \infty$ and $\infty - \infty$ form.	1
14.	L' Hospital's rule for 0^0 , 1^∞ , ∞^0 form.	1
15.	Examples on expansion of functions	1

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Open Elective(OE – I)**
Title of course	**:**	**Foundations of Mathematics**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. describe sets, subsets and perform basic operations on sets
CO 2. learn to identify, represent and recognize relations and functions from schematic descriptions, arrow diagrams and graphs.
CO 3. understand number systems and properties of numbers
CO 4. compute distance formula, midpoint formula, equation of lines, parallel lines and perpendicular lines

Unit 1: Relations and Function **(15 hrs.)**

1.1 Definition of Sets and Subsets
1.2 Types of Sets
1.3 Operations on Sets
1.4 Partitions of Sets
1.5 Cartesian Products of Sets
1.6 Finite Sets
1.7 Infinite Sets
1.8 Relations
1.9 Properties of Relations
1.10 Equivalence Relations
1.11 Equivalence Classes
1.12 Properties of Equivalence Classes
1.13 Function
1.14 Types of Function (One-one, Onto, Even, Odd and Inverse function, Bijective, Composite function)

Unit 2: Number System and Geometry **(15 hrs.)**

2.1. Natural Numbers
2.2. Properties of Natural Numbers
2.3. Integers
2.4. Rational and Irrational Numbers
2.5. Real Numbers
2.6. Properties of real numbers
2.7. The coordinate of a point on a line
2.8. Absolute value
2.9. Coordinate of a point in a plane
2.10. Distance formula, Midpoint Formulas
2.11. Graphs of equations, Straight line, Slope, Equation of a line, parallel lines, perpendicular lines

Recommended Books:

1. Lipschutz, Seymour. (Second Edition). Set Theory and Related Topics. Schaum's Series. McGraw-Hill. New York.
2. Elliott Mendelson, Schaum's Outline of Theory and problems of "Beginning Calculus" Second edition, Tata McGraw-Hill publishing company limited.

Reference Books:

1. Gary Chartrand, Albert D. Polimeni and Ping Zhang, Mathematical Proofs A Transition to Advanced Mathematics, 3rd Edition, Pearson
2. Ian Stewart and David Tall, The Foundations of Mathematics, 2nd Edition, Oxford
3. Elliott Mendelson, Number Systems and the Foundations of Analysis (Dover Books on Mathematics)
4. Kamke, E. Theory of Sets. Dover Publishers.
5. George B. Thomas, Jr. And Ross L. Finney Calculus and Analytical Geometry (Pearson)

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Open Elective(OE – II)**
Title of course	**:**	**Quantitative Aptitude for Competitive Examinations**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. demonstrate proficiency in fundamental arithmetic concepts.
CO 2. apply these concepts to solve everyday problems and demonstrate a practical understanding.
CO 3. gain practical skills in Practical Math Competence.
CO 4. solve real-world problems involving time, distance, and logical reasoning, acquire practical application abilities.

Unit 1: Essential Concepts in Arithmetic and Real-world Applications (15 Hr.)

1.1. HCF and LCM
1.2. Permutation and combination
1.3. Probability
1.4. Ratio and Proportion
1.5. Percentage and Average
1.6. Problems Based on Ages
1.7. Profit and Loss
1.8. Progression and sequence

Unit 2: Temporal Toolbox: Navigating Time, Work, and Distances (15 Hrs.)

2.1. Time and Work
2.2. Work and Wages
2.3. Problems on Trains
2.4. Boats and streams
2.5. Problems on clock and Calendar
2.6. Time and distances
2.7. Heights and distances
2.8. Mathematical Operations and Arithmetical reasoning

Reference books:

1. Praveen, R.V. (2013). Quantitative Aptitude and Reasoning. 2nd Revised Edition, Prentice-Hall of India Pvt. Ltd.
2. Aggarwal, R. S. (2016). Quantitative Aptitude (Fully solved). S. Chand.
3. Ranganath, G. K., Sampangiram, C. S. and Rajaram, Y. (2008), A text Book of Business Mathematics. Himalaya Publishing House.
4. Guha, A. (2016), Quantitative Aptitude for Competitive Examination. Tata McGraw hill Publications.

B.Sc. (Mathematics) (Part I) (Level 4.5) (Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Skill Enhancement Course (SEC – I)**
Title of course	**:**	**Mathematics using Scilab**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. learn basic Mathematical operations using Scilab.
CO 2. understand arrays and matrices in Scilab.
CO 3. acquire skill of plotting functions in Scilab.
CO 4. solve various Mathematical problems using Scilab.

Unit 1: Recipes in Scilab (15 Hrs.)

1.1 Introduction: application, feature, scilab environment workspace, working directory.
1.2 Scilab as a calculator.
1.3 Operators
1.4 Mathematical predefined functions, mathematical predefined constants.
1.5 Variables: global, local, naming conventions for variables, list of variables.
1.6 Data types: Numerical data, How to store floating point numbers.
1.7 Boolean Data
1.8 Strings
1.9 Complex numbers: Real and imaginary parts, Complex conjugates, imult, Checking if a variable has complex components, complex arithmetic.
1.10 Creating Scilab functions, Inline functions and its executions.
1.11 2D Plotting: plot(x,y), plot2d(), plot2d2(), plot2d3(), plot2d4(), polarplot().
1.12 Special Plots: Histograms, Contour maps etc.

Unit 2: Arrays and Matrices in Scilab (15 Hrs.)

2.1 Introduction.
2.2 Arrays and vectors.
2.3 Operations on arrays and vectors: element wise operations, matrix multiplication, inverse of matrix, determinant, trace, rank, magnitude of vector, eigen values and eigen vectors.
2.4 Indexing, Matrices and Vectors using indices, slicing, appending rows and columns, deleting rows and columns, submatrix, concatenation along a dimension.
2.5 Logical operations on arrays.
2.6 Matrix manipulations: scaling and reshaping a matrix.
2.7 Special matrices: upper and lower triangular matrices, one and zeros matrices, diagonal matrices etc.
2.8 Mathematical matrix operations.

Recommended Book:

1. Introduction to Scilab: For Engineers and Scientists, Sandeep Nagar, Apress, First edition, 2018.

References:

1. Advanced Programming in SciLab, Chetana Jain , Alpha Science International Ltd. (2020).
2. Scilab: A Hands on Introduction by Satish Annigeri.
3. Programming in Scilab 4.1, Vinu V. Das, New Age International Publisher, First edition, 2008.
4. Programming using Scilab: Theory and Practicals Book by Akhilesh Kumar.
5. https://www.scilab.org

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Skill Enhancement Course (SEC Practical – I)
Title of course : Computing Mathematics using Scilab
Credit : 02

Pr. No.	Title of the Practical	No. of Practical's
1.	Scilab as a calculator	1
2.	Calculations using variables	1
3.	Complex numbers in Scilab	1
4.	Polynomial	1
5.	User defined functions	1
6.	2D plotting	1
7.	Special Plots	1
8.	Matrices and vectors (include using indices), operation on matrices elementwise and matrix multiplication.	1
9.	Size of Matrix, Length of matrix, accessing element using one index, two indices.	1
10.	Appending rows and columns, deleting rows and columns, submatrix	1
11.	Eigen values and eigen vectors.	1
12.	Verify Caley-Hamilton Theorem using Scilab.	1
13.	Special matrices: upper and lower triangular matrices, diagonal matrices	1
14.	Matrix functions: eye(), zero (), ones (), empty matrix.	1
15.	Determinant, inverse, trace of matrix & diagonal element of matrix.	1

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Indian Knowledge Systems (IKS – I)**
Title of course	**:**	**Vedic Mathematics**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

1. foster love for math's and remove its fear through Vedic Mathematics
2. enhance computation skills in students through Vedic Mathematics
3. develop logical and analytical thinking
4. promote joyful learning of mathematics
5. discuss the rich heritage of mathematical temper of Ancient India.

Unit I: High Speed Addition, Subtraction, Miracle Multiplication and Excellent Division **(15 Hrs.)**

1.1 Vedic Maths: History of Vedic Maths and its Features
1.2 Vedic Maths formulae: Sutras and Upsutras
1.3 Addition in Vedic Maths: Without carrying, Dot Method
1.4 Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah (All from 9 last from 10)
1.5 Fraction-Addition and Subtraction
1.6 Multiplication in Vedic Maths: Base Method (any two numbers upto three digits)
1.7 Multiplication by Urdhva Tiryak Sutra
1.8 Miracle multiplication: Any three-digit number by series of 1's and 9's
1.9 Division by Urdhva Tiryak Sutra (Vinculum method)

Unit II: Lightening Squares ,Rapid Cubes, Enlighten Algebra and Geometry (15 Hrs.)

2.1 Squares of any two-digit numbers: Base method
2.2 Square of numbers ending in 5: Ekadhikena Purvena Sutra
2.3 Easy square roots: Dwandwa Yoga (duplex) Sutra
2.4 Square root of 2: Baudhayana Shulbasutra
2.5 Cubing: Yavadunam Sutra
2.6 Factoring Quadratic equation: Anurupyena, Adyamadyenantyamantya Sutra
2.7 Concept of Baudhayana (Pythagoras) Theorem
2.8 Circling a square: Baudhayana Shulbasutra
2.9 Concept of pi: Baudhayana Shulbasutra.
2.10 Concept angle (8) 0°, 30°, 45°, 60° and 90°: Baudhayana number

Recommended Book:

1. Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.

References:

1. The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi 2019.
2. Vedic Mathematics Made Easy, Dahaval Bathia, Jaico Publishing, New Delhi 2011
3. Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
4. Learn Vedic Speed Mathematics Systematically, Chaitnaya A. Patil 2018.
5. A Modern Introduction to Ancient Indian Mathematics, TS Bhanumurthy, Wiley Eastern Limited, New Delhi.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Minor (MIN – I)**
Title of course	**:**	**Basic Algebra**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. apply De-Moivre's theorem.
CO 2. find rank, eigen values, eigen vectors of the matrix.
CO 3. solve system of linear homogeneous and non-homogeneous equations.
CO 4. understand Hermitian and Skew Hermitian matrices.

UNIT – 1: ALGEBRA OF COMPLEX NUMBERS (15 hrs.)

1.1. Sums and Products, Moduli, Polar form, Geometrical representation of Complex Numbers, Exponential form, arguments of Products and Quotients.
1.2. De-Moivre's Theorem and examples
1.3 Applications of De-Moivre's Theorem
1.3.1 n^{th} roots of unity.
1.3.2 Expansion of $\cos n\theta$, $\sin n\theta$
1.3.3 Circular functions and hyperbolic functions.
1.3.4 Relations between circular and hyperbolic functions.
1.3.5 Inverse circular and hyperbolic functions.

UNIT – 2: MATRICES (15 hrs.)

2.1. Introduction
2.2 Definitions of Hermitian and Skew Hermitian matrices.
2.3. Properties of Hermitian and Skew Hermitian matrices.
2.4. Rank of a Matrix, Row-echelon form and reduced row echelon form, normal form.
2.5. System of linear homogeneous and non-homogeneous equations.
2.5.1. Condition for consistency.
2.5.2. Nature of the general solution.
2.5.3. Gaussian elimination and Gauss Jordon method
(Using row-echelon form and reduced row echelon form).
2.5.4. Examples based on 2.4.1, 2.4.2 and 2.4.3.
2.6. Characteristic equation, eigen values and eigen vectors of a matrix and examples
2.7. Cayley Hamilton theorem and examples.

Note: More focus shall be given to applications and problems.

Recommended Books:

1. **Applied Mathematics** by Ch.V. Ramana Murthy, N. C. Shrinivas, S. Chand and Company Ltd., 1st Edition, 2001.
   Scope: Unit-I: Chapter No. 1: Art.1.2 to Art.1.13, Art. 1.15, Art. 1.17 to Art. 1.19, Art.1.23
2. **Higher Engineering Mathematics** by H. K. Dass, Er. Rajnish Verma, S. Chand and Company Pvt. Ltd. 3rd Revised Edition 2014.
   Scope: Unit-II: Art. 19.1 to Art. 19.3, Art. 21.1 to Art. 21.6, Art. 21.27 to Art. 21.30, Art. 20.1 to Art. 20.4

Reference Books:

1. **Elementary Linear Algebra (**Application Version**)**, Howard Anton and Chris Rorres, 10th Edition, 2010.
2. **Complex Variables and Applications,** James Ward Brown and Ruel V. Churchill, Mc-Graw Hill, 8th Edition, 2009.
3. **Modern Algebra**, A. R. Vasishtha, Krishna Prakashan, Meerut 1994.
4. **A Text Book of Matrices** - Shanti Narayan (Revised by P. K. Mittal), S. Chand and Co., 11th Edition, reprint 2007.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Minor (MIN – II)**
Title of course	**:**	**Calculus**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. find higher derivatives of product two differentiable functions using Leibnitz theorem.
CO 2. learn conceptual variations while advancing from one variable to several variables in calculus.
CO 3. understand the consequences of mean value theorems for differentiable functions.
CO 4. apply L' Hôpital's rule to various indeterminate forms.

Unit – 1: Differentiation **(15 hrs.)**

1.1. Successive Differentiation
- 1.1.1. Higher order derivatives: notations.
- 1.1.2. Calculation of n^{th} derivative: Standard results
- 1.1.3. Determination of n^{th} derivative of rational functions: Examples.
- 1.1.4. The n^{th} derivative of product of the powers of sine and cosines: Examples.
- 1.1.5. Leibnitz's Theorem. The n^{th} derivative of product of two functions.
- 1.1.6. Examples on Leibnitz's Theorem.

1.2. Partial differentiation
- 1.2.1. Introduction to functions of two and more variables
- 1.2.2. Partial derivative: first order and higher order – examples.
- 1.2.3. Geometrical interpretation of partial derivatives of first order.

Unit – 2: Mean Value Theorems and Indeterminate forms **(15 hrs.)**

2.1. Mean Value Theorems
- 2.1.1. Rolle's Mean Value Theorem, Geometrical interpretation.
- 2.1.2. Lagrange's Mean Value Theorem, Geometrical interpretation.
- 2.1.3. Meaning of sign of derivative
- 2.1.4. Cauchy's Mean Value Theorem.
- 2.1.5. Examples on 2.1.1, 2.1.2, 2.1.3 and 2.1.4

2.2. Indeterminate forms
- 2.2.1. Indeterminate forms: L' Hôpital's rule for $\frac{0}{0}$ and $\frac{\infty}{\infty}$ form (Statement only).
- 2.2.2. The indeterminate forms $0 \times \infty$, $\infty - \infty$, 0^0 , 1^∞ , ∞^0

2.3. Expansion of functions
- 2.3.1. Maclaurin's theorem (statement only): Examples.
- 2.3.2. Taylor's theorem (statement only): Examples.

Note: More focus shall be given to applications and problems.

Recommended Books:

1. **Differential Calculus,** Shanti Narayan and P.K. Mittal, S. Chand publishing, 15th edition (2016).

Scope:

Unit 1 – 1.1: Chapter 5: 5.1 to 5.5

1.2: Chapter 11: 11.6, 11.6.1, 11.7.1

Unit 2 – 2.1: Chapter 8: 8.1, 8.2, 8.3, 8.5

2.2: Chapter 10: 10.1 to 10.6

2.3: Chapter 6: 6.1, 6.2

Reference Books:

1. **Differential Calculus**, Gorakh Prasad, Pothishala Pvt. Ltd., 19th edition (2016).
2. **Aspects of Calculus**, Gabriel Klambauer, Springer-Verlag (1986).
3. **Differential Calculus**, Hari Kishan, Atlantic Publishers & Dist. (2007).
4. **Calculus**, George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir, Pearson Education, 14th edition (2018).

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Minor (MIN Practical – I)
Title of course : Mathematics Practical – I
Credit : 02

Pr. No	Title of the Practical	No. of Practicals
1.	Examples on De-Moivre's Theorem	1
2.	n^{th} roots of unity	1
3.	Expansion of cos nθ, sin nθ	1
4.	Solution of system of linear homogeneous equations.	1
5.	Solution of system of linear non-homogeneous equations.	1
6.	Eigen values and Eigen vectors of matrix	1
7.	Cayley Hamilton Theorem (Verification and finding inverse of matrix)	1
8.	Examples of n^{th} derivative	1
9.	Examples on Leibnitz's Theorem.	1
10.	Examples on partial differentiation	1
11.	Lagrange's Mean Value Theorems.	1
12.	Cauchy's Mean Value Theorems.	1
13.	L' Hospital's rule for $0 \times \infty$ and $\infty - \infty$ form.	1
14.	L' Hospital's rule for 0^0 , 1^∞ , ∞^0 form.	1
15.	Examples on expansion of functions	1

Semester II

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Major (DSC – III)**
Title of course	**:**	**Differential Equations - I**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. classify differential equations.
CO 2. solve different types of differential equations.
CO 3. find orthogonal trajectories.
CO 4. apply the knowledge of differential equations to tackle problems occurring in physics and engineering.

Unit 1. Ordinary differential equations of first order and first degree (15 hrs.)

1.1 Introduction.
1.2 Exact differential equations.
  1.2.1 Necessary and sufficient condition for exactness.
  1.2.2 Differential equations reducible to exact, integrating factors with rules.
1.3 Linear differential equations.
1.4 Differential equations reducible to linear.
1.5 Applications of differential equations of first order and first degree:
  1.5.1 Law of growth.
  1.5.2 Law of decay.
  1.5.3 Newton's law of cooling.
  1.5.4 Orthogonal trajectories to Cartesian and Polar curves.
1.6 Examples based on 1.1 to 1.5.

Unit 2. Linear differential equations with constant coefficients (15 hrs.)

2.1 Introduction.
2.2 Auxiliary equation, Complementary function.
2.3 Types of complementary functions:
  2.3.1 Distinct real roots, repeated real roots, complex roots, repeated complex roots,
2.4 Particular integrals:
  2.4.1 Particular integrals of the functions: e^{ax}, sinax, cosax, x^m, $e^{ax}.V$ and $x.V$.

2.5 Applications to Electrical circuits.
2.6 Examples based on 2.1 to 2.5.

Recommended Book:

1. M. D. Raisinghania, Ordinary and Partial Differential Equations, 20th Revised Edition 2022; S.Chand and Company Pvt.Ltd.NewDelhi.
   Scope: Part 1 : Unit 2: 2.12 to 2.32, Unit 3: 3.1 to 3.8, Unit 5 : 5.1 to 5.25.

Reference Books:

1. Dr. A. B. Mathur and V. P. Jaggi, Advanced Engineering Mathematics, Khanna Publishers, 2nd edition, 2001.
2. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, Book and Allied (P) Ltd., Seventh Edition, 2000.
3. D. A. Murray, Introductory Course in Differential Equations, Khosala Publishing House, Delhi.
4. Zafar Ahasan, Differential Equations and Their Applications, Second Edition, PHI2004.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Major (DSC – IV)**
Title of course	**:**	**Discrete Mathematics**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.
CO 2. construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic.
CO 3. understand and apply the fundamental concepts in graph theory.
CO 4. acquire the basic knowledge of graphs namely vertex, edge, special types of graph, isomorphic graphs, matrix representation of graphs.

Unit- 1 Propositional Calculus **(15 hrs.)**

1.1 **Revision**
- 1.1.1 Propositional Logic.
- 1.1.2 Propositional equivalence.

1.2 **Predicates and Quantifiers:**
- 1.2.1 Pedicate, n-place Pedicate, n-ary Pedicate.
- 1.2.2 Quantification and Quantifiers, Universal Quantifier, Existential Quantifier, Quantifiers with restricted domains.
- 1.2.3 Logical Equivalence involving Quantifiers.

1.3 **Rules of Inference:**
- 1.3.1 Argument in propositional Logic.
- 1.3.2 Validity Argument (Direct and Indirect methods)
- 1.3.3 Rules of Inference for Propositional Logic.
- 1.3.4 Building Arguments

1.4 Numerical Problems based on 1.2 to 1.3

Unit- 2 Graph Theory **(15 hrs.)**

2.1 **Graphs:**
- 2.1.1 Basic Terminology
- 2.1.2 Special types of Graphs (Complete graph, Regular graph, Bipartite and complete Bipartite graph)
- 2.1.3 Isomorphism
- 2.1.4 Adjacency and Incidence Matrix of Graph
- 2.1.5 Problems based on 2.1.2 to 2.1.4

2.2 **Operations on Graph:**
- 2.2.1 Subgraphs, vertex deletion, Edge addition.
- 2.2.2 Complement of a graph and self-complementary graphs.
- 2.2.3 Union, Intersection and Product of graphs.
- 2.2.4 Problems based on 2.1.1 to 2.1.3

Recommended Book:

1. Discrete Mathematics, S. R. Patil , M. D. Bhagat , R. S. Bhamare, S. M. Waingade, N. M. Phatangare and K. D. Masalkar, Nirali Prakashan, Pune.

Reference Books:

1. Discrete Mathematics, D. S. Malik and M. K. Sen, Cengage Learning India Pvt. Ltd, New Delhi.
2. Discrete Mathematical Structures (sixth edition), Kolman, Busby, Ross, Pearson Education (Prentice Hall).
3. Introduction to Graph Theory, Mamta Chaudhary, Vani Sharma and Pooja Yadav, Sultan Chand & Sons, Educational Publishers, New Delhi.
4. Schums Outline of Discrete Mathematics, Seymour Lipschutz, Marc Lipson, Revised Third Edition-McGraw-Hill (2009).

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Major (DSC Practical – II)
Title of course : Mathematics Practical – II
Credit : 02

Pr. No	Title of the Practical	No. of Practicals
1.	Differential equations reducible to exact	1
2.	Linear differential equations	1
3.	Bernoulli's Differential equations	1
4.	Law of growth	1
5.	Law of decay	1
6.	Newton's law of cooling	1
7.	Orthogonal Trajectories to Cartesian Curves	1
8.	Orthogonal Trajectories to Polar Curves	1
9.	Linear differential equations with constant coefficients (examples on finding C. F.)	1
10.	Particular integrals of the functions: e^{ax}, sin ax, cos ax	1
11.	Particular integrals of the functions: x^m, $e^{ax}.V$ and $x.V$	1
12.	Test the validity of the argument using truth table.	1
13.	Show the implications without using truth table.	1
14.	Draw the graph represented by the given adjacency matrix.	1
15.	Find the incidence matrix of the given graphs.	1

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Open Elective (OE – III)**
Title of course	**:**	**Logical Reasoning for Competitive Examinations**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. demonstrate proficiency in logical thinking and problem-solving.
CO 2. develop a foundational understanding of cognitive abilities essential for competitive examinations.
CO 3. acquire the skills to analyze and evaluate logical structures.
CO 4. provide nonverbal reasoning.

Unit 1: General Mental Ability **(15 hrs.)**

1.1 Classifications
1.2 Series Completion
1.3 Coding and Decoding
1.4 Logical Venn Diagrams
1.5 Number ranking and Time Sequence test
1.6 Mathematical Operations
1.7 Inserting Missing one
1.8 Logical sequence of Words

Unit 2: Logical Reasoning and Nonverbal reasoning **(15 hrs.)**

2.1 Logic
2.2 Statement and Argument
2.3 Statement and Assumption
2.4 Statement and Conclusion
2.5 Series
2.6 Classification
2.7 Analytical reasoning
2.8 Problems on Cubes and Dice

Reference books:

1. Praveen, R.V. (2013), Quantitative Aptitude and Reasoning. 2nd Revised Edition, Prentice-Hall of India Pvt. Ltd.
2. Aggarwal, R. S. (2016),A modern approach to logical reasoning. S. Chand.
3. Ranganath, G. K., Sampangiram, C. S. and Rajaram, Y. (2008), A text Book of business Mathematics. Himalaya Publishing House.
4. Aggarwal, R. S. (2016), A modern approach to verbal and nonverbal reasoning, S. Chand

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Open Elective (OE – IV)**
Title of course	**:**	**Business Mathematics**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. analyze and solve the problems using the concepts of ratio, proportion, percentage, interest, annuity, shares

CO 2. evaluate financial conditions based on one's income/expenditure using the concepts of ratio, proportion, percentage, interest, annuity, shares.

CO 3. prepare monthly family budget based on one's income/expenditure using the concepts of ratio, proportion, percentage, interest, annuity, shares.

CO 4. acquire knowledge to manage personal finance.

Unit 1: Interest and Annuity **(15 hrs.)**

1.1. Concepts of present value and future value
1.2. Simple interest
1.3. Compound interest
1.4. Nominal and effective rate of interest.
1.5. Examples and problems.
1.6. Ordinary annuity
1.7. Sinking fund
1.8. Annuity due
1.9. Present value and future value of annuity
1.10. Equated Monthly Installments (EMI) by method interest of reducing balance and flat interest rate methods.
1.11. Examples and Problems.

Unit 2: Shares **(15 hrs.)**

2.1. Concept of share
2.2. Types of shares– preference shares & equity shares
2.3. Definitions of face value
2.4. Market value
2.5. Dividend
2.6. Brokerage
2.7. Bonus shares
2.8. Debentures.
2.9. Examples and Problems.

Recommended Book:

1. L. Daisley, T. Kugathasan, D. Huysmans, Mathematics of Business and Finance, 4th Edition, Vretta Inc. Canada

Reference Books:-

1. Gary Bronson, Richard Bronson, Maureen Kieff, Mathematics for Business, 7th Edition, Mercury Learning and Information, New Delhi.
2. GerardO' Regan, A guide to business mathematics, CRC Press.
3. Seymour Lipschutz, John J. Schiller, R. Alu Srinivasan, Theory and Problems of Beginning Finite Mathematics, Schaum's Outline Series, New Delhi

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Skill Enhancement Course (SEC – II)**
Title of course	**:**	**Mathematics in Data Science**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 1. understand and apply foundational mathematical concepts essential for AI and Data Science.
CO 2. analyze and manipulate data using statistical techniques.
CO 3. explain methods of collection of data, statistical survey.
CO 4. calculate compare various measures of central tendencies and dispersions.

Unit 1 Measures of central tendencies and dispersion (15 hrs.)

1.1 Basic terminologies
1.2 Concept of primary and secondary data.
1.3 Organization of Statistical survey.
1.4 Methods of collection of primary and secondary data.
1.5 Classification and tabulation data.
1.6 Histogram, frequency curve, frequency polygon and ogive
1.7 Measures of central tendencies:
  1.7.1 Mean, Median, Mode
  1.7.2 Geometric mean, Harmonic mean, Combined mean
1.8 Measures of dispersion:
  1.8.1 Range, Quartile deviation, Mean deviation
  1.8.2 Standard deviation, Coefficient of variation.

Unit 2 Theory of Probability (15 hrs.)

2.1. Introduction
2.2. Random experiments and events
2.3. Classical and axiomatic approach
2.4. Probability space
2.5. Conditional probability
2.6. Multiplication theorem
2.7. Compound probability
2.8. Bayes's theorem
2.9. Problems based on 2.2 to 2.8

Recommended books:

1. Croxton F. E., Cowden D.J. and Kelin S. Applied General Statistics, Prentice Hall of India, (1973).
2. Mukhopadhyay P., Mathematical Statistics. New Central Book Agency (P) Ltd, Calcutta (1996).

Reference books:

1. Gupta S. P., Statistical Methods, Sultan Chand and Sons, New Delhi, (2002).
2. Probability and Statistics for Data Science: Math + R + Data, Norman Matloff, CRC Press (Taylor & Francis Ltd), 2019
3. Agarwal B. L, Basic Statistics. 4th Ed, New Age international (P) Ltd., New Delhi (2006).
4. Gupta, S. C., and Kapoor, V. K. (1994). Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – I)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Skill Enhancement Course (SEC Practical – II)
Title of course : Applications of Mathematics in Data Science
Credit : 02

Pr. No.	Title of the Practical	No. of Practical's
1	Primary data handling using MS Excel	1
2	Secondary data handling using MS Excel	1
3	Diagrammatic and graphical presentation of data using MS Excel	1
4	Examples on Histogram	1
5	Examples on frequency curve, frequency polygon and ogive curves	1
6	Measures of Centra tendencies -I (Arithmetic mean)	1
7	Measures of Central tendency – II (Geometric mean, Harmonic mean)	1
8	Measures of central tendencies –III (Median)	1
9	Measures of central tendencies –IV (Mode)	1
10	Measures of dispersion – I (Range)	1
11	Measures of dispersion – II (Range, Quartile deviation, mean deviation)	1
12	Measures of dispersion – III (Standard deviation, coefficient of variation)	1
13	Computation of probabilities using Baye's theorem	1
14	Problems based on Conditional probabilities	1
15	Problems based on elementary probabilities	1

Note: Use Excel / R / Scilab to solve numerical problems associated with topics covered in 4 to 10.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Minor (MIN – III)**
Title of course	**:**	**Differential Equations - I**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 5. classify differential equations.
CO 6. solve different types of differential equations.
CO 7. find orthogonal trajectories.
CO 8. apply the knowledge of differential equations to tackle problems occurring in physics and engineering.

Unit 1. Ordinary differential equations of first order and first degree (15 hrs.)

1.1 Introduction.
1.2 Exact differential equations.
  1.2.1 Necessary and sufficient condition for exactness.
  1.2.2 Differential equations reducible to exact, integrating factors with rules.
1.3 Linear differential equations.
1.4 Differential equations reducible to linear.
1.5 Applications of differential equations of first order and first degree:
  1.5.1 Law of growth.
  1.5.2 Law of decay.
  1.5.3 Newton's law of cooling.
  1.5.4 Orthogonal trajectories to Cartesian and Polar curves.
1.6 Examples based on 1.1 to 1.5.

Unit 2. Linear differential equations with constant coefficients (15 hrs.)

2.4 Introduction.
2.5 Auxiliary equation, Complementary function.
2.6 Types of complementary functions:
  2.3.1 Distinct real roots, repeated real roots, complex roots, repeated complex roots,
2.4 Particular integrals:
  2.4.1 Particular integrals of the functions: e^{ax}, sinax, cosax, x^m, $e^{ax}.V$ and $x.V$.

2.5 Applications to Electrical circuits.
2.6 Examples based on 2.1 to 2.5.

Note: More focus shall be given to applications and problems.

Recommended Book:

1. M. D. Raisinghania, Ordinary and Partial Differential Equations, 20th Revised Edition 2022; S.Chand and Company Pvt.Ltd.NewDelhi.
   Scope: Part 1 : Unit 2: 2.12 to 2.32, Unit 3: 3.1 to 3.8, Unit 5 : 5.1 to 5.25.

Reference Books:

1. Dr. A. B. Mathur and V. P. Jaggi, Advanced Engineering Mathematics, Khanna Publishers, 2nd edition, 2001.
2. R. K. Ghosh and K. C. Maity, An Introduction to Differential Equations, Book and Allied (P) Ltd., Seventh Edition, 2000.
3. D. A. Murray, Introductory Course in Differential Equations, Khosala Publishing House, Delhi.
4. Zafar Ahasan, Differential Equations and Their Applications, Second Edition, PHI2004.

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type	**:**	**Minor (MIN – IV)**
Title of course	**:**	**Discrete Mathematics**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of the course students will able to:

CO 5. analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.

CO 6. construct truth tables, prove or disprove a hypothesis, and evaluate the truth of a statement using the principles of logic.

CO 7. understand and apply the fundamental concepts in graph theory.

CO 8. acquire the basic knowledge of graphs namely vertex, edge, special types of graph, isomorphic graphs, matrix representation of graphs.

Unit- 1 Propositional Calculus **(15 hrs.)**

1.1 **Revision**

1.1.1 Propositional Logic.

1.1.2 Propositional equivalence.

1.2 **Predicates and Quantifiers:**

1.2.1 Pedicate, n-place Pedicate, n-ary Pedicate.

1.2.2 Quantification and Quantifiers, Universal Quantifier, Existential Quantifier, Quantifiers with restricted domains.

1.2.3 Logical Equivalence involving Quantifiers.

1.3 **Rules of Inference:**

1.3.1 Argument in propositional Logic.

1.3.2 Validity Argument (Direct and Indirect methods)

1.3.3 Rules of Inference for Propositional Logic.

1.3.4 Building Arguments

1.4 Numerical Problems based on 1.2 to 1.3

Unit- 2 Graph Theory **(15 hrs.)**

2.1 **Graphs:**

2.1.1 Basic Terminology

2.1.2 Special types of Graphs (Complete graph, Regular graph, Bipartite and complete Bipartite graph)

2.1.3 Isomorphism

2.1.4 Adjacency and Incidence Matrix of Graph

2.1.5 Problems based on 2.1.2 to 2.1.4

2.2 **Operations on Graph:**

2.2.1 Subgraphs, vertex deletion, Edge addition.

2.2.2 Complement of a graph and self-complementary graphs.

2.2.3 Union, Intersection and Product of graphs.

2.2.4 Problems based on 2.1.1 to 2.1.3

Note: More focus shall be given to applications and problems.

Recommended Book:

2. Discrete Mathematics, S. R. Patil , M. D. Bhagat , R. S. Bhamare, S. M. Waingade, N. M. Phatangare and K. D. Masalkar, Nirali Prakashan, Pune.

Reference Books:

5. Discrete Mathematics, D. S. Malik and M. K. Sen, Cengage Learning India Pvt. Ltd, New Delhi.
6. Discrete Mathematical Structures (sixth edition), Kolman, Busby, Ross, Pearson Education (Prentice Hall).
7. Introduction to Graph Theory, Mamta Chaudhary, Vani Sharma and Pooja Yadav, Sultan Chand & Sons, Educational Publishers, New Delhi.
8. Schums Outline of Discrete Mathematics, Seymour Lipschutz, Marc Lipson, Revised Third Edition-McGraw-Hill (2009).

B.Sc. (Mathematics) (Part I) (Level 4.5)(Semester – II)
(NEP-2020)
Syllabus to be implemented from Academic Year 2024-25

Course type : Minor (MIN Practical – II)
Title of course : Mathematics Practical – II
Credit : 02

Pr. No	Title of the Practical	No. of Practicals
1.	Differential equations reducible to exact	1
2.	Linear differential equations	1
3.	Bernoulli's Differential equations	1
4.	Law of growth	1
5.	Law of decay	1
6.	Newton's law of cooling	1
7.	Orthogonal Trajectories to Cartesian Curves	1
8.	Orthogonal Trajectories to Polar Curves	1
9.	Linear differential equations with constant coefficients (examples on finding C. F.)	1
10.	Particular integrals of the functions: e^{ax}, sin ax, cos ax	1
11.	Particular integrals of the functions: x^m, $e^{ax}.V$ and $x.V$	1
12.	Test the validity of the argument using truth table.	1
13.	Show the implications without using truth table.	1
14.	Draw the graph represented by the given adjacency matrix.	1
15.	Find the incidence matrix of the given graphs.	1

NATURE OF QUESTION PAPER:

A. **Continuous Assessment (CA):**
Term work shall be of 10 marks for the courses of 2 credits.

B. **End Semester Assessment:**

1. End Semester examination shall be of 40 marks for the courses of 2 credits.
2. The nature of Question Paper for Theory Examination:
   Maximum Marks: 40 Duration: 2 hrs.
   Q. 1) Choose the coorect alternative from the following and rewrite the sentence. [8]
   a) to h) MCQ one mark each with four options
   i) ii) iii) iv)
   Q. 2) Attempt any TWO of the following [16]
   a)
   b)
   c)
   Q. 3) Attempt any FOUR of the following [16]
   a)
   b)
   c)
   d)
   e)
   f)

C. Practical Examination:

1. Practical examination shall be of 50 marks for the courses of 2 credits.
2. Distribution of marks: Practical question paper – 40 marks, Certified Journals – 05 marks, Viva – voce – 05 marks.
3. The nature of Question Paper for Practical Examination:
   Q.1 (A) (10 Marks)
   (B) (05 Marks)

   OR

   Q.1 (A) (10 Marks)
   (B) (05 Marks)

   Q.2 (A) (10 Marks)
   (B) (05 Marks)

   OR

   Q.2 (A) (10 Marks)
   (B) (05 Marks)

   Q.3 Attempt any TWO of the following
   (A) (05 Marks)
   (B) (05 Marks)
   (C) (05 Marks)
   (D) (05 Marks)

Equivalence of Courses

B. Sc. Part I (Semester I and II)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Credit**	**Course Code**	**Title of New Course**	**Credit**
I	DSC – A5	Calculus	2	DSC – II	Calculus	2
I	DSC – A6	Differential Equations	2	DSC – III	Differential Equations – I	2
II	DSC – B5	Multivariable Calculus	2	DSC – VII	Differential Calculus	2
II	DSC – B6	Basic Algebra	2	DSC – I	Basic Algebra	2
I and II	CCPM-I	Core Course Practical in Mathematics - I	4	DSC Practical – I and DSC Practical – II	Mathematics Practical – I and Mathematics Practical - II	2 + 2

B. Sc. Part II (Semester III and IV)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Cr.**	**Course Code**	**Title of New Course**	**Cr.**
III	DSC – C5	Elements of Differential Equations	2	DSC – V	Differential Equations – II	2
III	DSC – C6	Numerical Methods	2	DSC – VI	Numerical Methods	2
IV	DSC – D5	Vector Calculus	2	DSE – I	Vector Calculus	2
IV	DSC – D6	Integral Calculus	2	DSC – VIII	Integral Calculus	2
III and IV	CCPM-II	Differential equations, Numerical methods, Vector and Integral Calculus	4	DSC Practical – III	Mathematics Practical – III (Sem – III)	4
III and IV	CCPM-III	Numerical Recipes in Scilab	4	DSC Practical – IV	Mathematics Practical – IV (Sem – IV)	4

B. Sc. Part III (Semester V and VI)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Cr.**	**Course Code**	**Title of New Course**	**Cr.**
V	DSE – E09	Mathematical Analysis	2	DSC – IX	Real Analysis	2
	DSE – E10	Abstract Algebra	2	DSC – X	Modern Algebra	2
	DSE – E11	Optimization Techniques	2	DSC – XVI	Operations Research	2
	DSE – E12	Integral Transforms	2	DSC – XII	Integral Transform	2
VI	DSE – F09	Metric Spaces	2	DSC – XIII	Metric Spaces	2
	DSE – F10	Linear Algebra	2	DSC – XIV	Linear Algebra	2
	DSE – F11	Complex Analysis	2	DSC – XV	Complex Analysis	2
	DSE – F12	Discrete Mathematics	2	DSC – IV	Discrete Mathematics	2
	CCPM-IV	Operations Research	4	DSC Practical – V	Mathematics Practical – III (Sem – V)	8
	CCPM-V	Laplace and Fourier Transforms	4			
	CCPM-VI	Python Programming	4	DSC Practical – VI	Mathematics Practical – IV (Sem – VI)	8
	CCPM-VII	Project, sturdy tour, viva.	4			