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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2023/102/36 Date: 15.06.2023

CIRCULAR

The University has decided to implement the UGC Curriculum and Credit Framework for the Undergraduate Programme (CCFUP) of **Bachelor of Science in Mathematics/Bachelor of Science in Mathematics (Honours)** under the National Education Policy (NEP) 2020 from the Academic Year 2023-2024 onwards.

The approved Syllabus of Semesters I and II of the **Bachelor of Science in Mathematics/Bachelor of Science in Mathematics (Honours)** Programme is attached.

Principals of Affiliated Colleges offering the **Bachelor of Science in Mathematics/Bachelor of Science in Mathematics (Honours)** Programme are requested to take note of the above and bring the contents of this Circular to the notice of all concerned**.**

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2023.06.15 11:22:56 +05'30'

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

1. The Principals of Affiliated Colleges offering the Bachelor of Science in Mathematics /Bachelor of Science in Mathematics (Honours) Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Physical and Applied Sciences, Goa University.
3. The Vice-Deans, School of Physical and Applied Sciences, Goa University.
4. The Chairperson, BOS in Mathematics.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Goa University

Programme Structure for Semester I to VIII Under Graduate Programme - Mathematics

Semester	Major -Core	Minor	MC	AEC	SEC	I	D	VAC	Total Credits	Exit
I	Major-1 MAT-100 (Foundational Mathematics) (3L+1P)	Minor -1 MAT-111 (Elementary Mathematics) (3L+1T) OR MAT-112 (Elementary Statistics) (3L+1T)	MC-1 MAT-131 (Mathematical Techniques in Competitive Exams) (3L)		SEC-1 MAT-141 (Numerical Analysis using Python/SageMath) (1L+2P)				20	
II			MC-2 MAT-132 (Discreptive Statistics) (3L)		SEC-2 MAT-142 (Statistical Methods Using R/SPSS/PSPP) (1L+2P)				20	MAT-161 (4)*
III	Major- 2 MAT-200 (Calculus of One Variable) (3L+1T)) Major- 3 MAT-201 (Ordinary Differential Equations) (3L+1T)	Minor -3 MAT-211 (Matrix Algebra) (3L+1P) OR MAT-212 (Enumerative Combinatorics) (3L+1P) OR MAT-213 (Transformation Techniques) (3L+1P)	MC-3 MAT-231 (Basic Financial Mathematics) (3L)		SEC-3 MAT-241 (Technical Typesetting Using LaTeX) (1L + 2P)				20	

IV	**Major-4 MAT-202 (Analysis) (3L+1T)** **Major-5 MAT-203 (Linear Algebra) (3L+1T)** **Major-6 MAT-204 (Basic Number Theory) (3L+1T)** **Major-7 MAT-205 (Analytical 2D Geometry) (2L)**	**Minor-4 VET MAT-221 (Probability Theory) (3T+1P)** **OR** **MAT-222 (Theory of Equations) (3L+1T)** **OR** **MAT-223 (Graph Theory) (3L+1T)**							20	**MAT-162 (4)***
V	**Major-8 MAT-300 (Riemann Integration and Improper Integrals) (3L+1T)** **Major- 9 MAT-301 (Group Theory I) (3L+1T)** **Major- 10 MAT-302 (Metric Spaces) (3L+1T)** **Major- 11 MAT-303 (Analytical 3D Geometry) (2L)**	**Minor-5 VET MAT-321 (Linear Programming Problems) (3L+1T)** **OR** **MAT-322 (Applied Statistics) (3L+1T)** **OR** **MAT-323 (Bio Mathematics) (3L+1T)**				**Internship (2)**			20	

VI	**Major-12 MAT-304 (Group Theory II) (3L+1T)** **Major- 13 MAT-305 (Complex Analysis) (3L+1T)** **Major- 14 MAT-306 (Vector Calculus) (3L+1T)** **Major- 15 MAT-307 (Project) (3L+1T)**	**Minor-6 VET MAT-324 (Operations Research) (3T+1P) OR MAT-325 (Econometrics) (3L+1T) OR MAT-325 (Mathematical Demography) (3L+1T)**							20	
VII	**Major-16 MAT-400 (Advanced Real Analysis) (3L+1T)** **Major- 17 MAT-401 (Rings and Fields) (3L+1T)** **Major- 18 MAT-402 (Advanced Linear Algebra) (3L+1T)** **Major- 19 MAT-403 (Advanced Complex**	**Minor -7 MAT-411 (Difference Equations) (3L+1T) OR MAT-412 (Measure Theory) (3L+1T)**							20	

	Analysis) (3L+1T)									
VIII	**Major-20 MAT-404 (Functions of Several Variables) (3L+1T)** **Major-21 MAT-405 (Topology) (3L+1T)** **Major- 22 MAT-406 9Functional Analysis) (3L+1T)** **Major- 23 MAT-407 (Advanced Differential Equations) (3L+1T)**	**Minor-8 MAT-413 (Integral Equations) (3L+1T) OR MAT-414 (Partial Differential Equations) (3L+1T)**							20	

*** List of Exit Courses along with the syllabus will be provided separately**.

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-100
Title of the Course: Foundational Mathematics
Number of Credits: 4 (3L+1P)
Effective from AY: 2023-24

Prerequisites	Basic 12^{th} standard mathematics.	
Course	Objectives: To develop logical reasoning among students in order to be able to organize all aspects of mathematics in such a way that at the base are the most fundamental concepts, assumptions and principles, and the other aspects depend on this base.	
Content		Hours
Unit I	**Statements and Logic**: Statements; Statements with quantifiers; Compound statements; Implications; Proofs in Mathematics. **Sets**: Basic Terminologies; Operations on sets; Family of sets; Power sets; Cartesian product of sets.	03 06
Unit II	**Functions**: Basic definitions: One-One, Onto functions and Bijections; Composition of functions; Inverse of a function; Image of subsets under functions; Inverse image of subsets under functions.	12
Unit III	**Relations**: Relation on sets; Types of relations; Equivalence relations; Equivalence classes and partitions of sets. **Induction Principles**: The Induction Principle; The Strong Induction Principle; The Well – Ordering Principle; Equivalence of the three principles.	05 05
Unit IV	**System of Linear Equations:** Solutions & Elementary Operations: Linear system of equations and their solutions; Equivalence of two systems; Elementary operations on equations; elementary row operations. Gaussian Elimination: Row reduced echelon forms; Gaussian algorithm; Rank. Homogeneous Equations: Sufficient condition for the existence of a non-trivial solution. **Determinants:** The Laplace Expansion: Determinants and their properties. Determinant & Matrix inverses: Product theorem and other related theorems (Statements of these theorems only. However, the idea of the proof, though not a part of the syllabus, is encouraged); Adjoint formula for A^{-1}; Cramer's rule.	08 06
Practical	**30 hours are to be dedicated for working with exercises and solving problems on the following:** 1. Identifying and using quantifiers, Negating statements with single and multiple quantifiers, Compound statements with quantifiers, Conjunction and disjunction of statements, and Negation of a compound statement. 2. Different forms of implications, Converse of implications, Negating implications, and Contrapositive of implications.	30

	3. Different types of proofs in mathematics. 4. Operations on sets like union, intersection, set difference, and complementation. 5. Identifying one – one and onto functions – I. 6. Identifying one – one and onto functions – II. 7. Finding "natural" bijections between given sets and finding the inverse of a bijective function. 8. Inverse image of subsets under functions. 9. Identifying the type of relation and Obtaining equivalence classes of an equivalence relation. 10. Using induction principles to establish statements. 11. Solving systems of linear equations using elementary operations. 12. Reducing a matrix to row – echelon form using Gaussian algorithm. 13. Solving homogeneous systems of equations. 14. Computing determinants using the properties of determinants. 15. Solving a system of equations using Cramer's rule.	
Pedagogy	Lectures/Practical/Self study. Lectures should include theory and examples. Practical to be exclusively dedicated for problem solving. The record of practical shall be maintained by students in a separate manual/journal duly certified by the instructor.	
References/Readings	1) Ajit Kumar, S. Kumaresan, and B. K. Sarma: *A Foundation Course in Mathematics*, Narosa Publishers, 2018. (**Principal Text**) 2) W. K. Nicholson: *Linear Algebra with Applications,* 4th Edition, McGraw – Hill Ryerson Limited, 2003. (**Principal Text**) 3) Vipul Kakkar: *Set Theory: Read it, Absorb it and Forget it*, Narosa Publishers, 2018. 4) Paul Halmos: *Set Theory*, Springer – Verlag, 1960. 5) S. Lipschitz: *Schaum's Outlines: Theory and Problems of Linear Algebra*, McGraw Hill, 2009.	
Course Outcomes	The student will be able to, 1. Infer the truth of various sentences and its equivalents and outline various properties of sets. 2. Examine and Identify the types of relations and functions. 3. Make use of the strong and weak induction. 4. Solve systems of linear equations. 5. Discuss the properties of determinants.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-111
Title of the Course: Elementary Mathematics
Number of Credits: 4 (3L+1T)
Effective from AY: 2023-24

Prerequisites	Basic 12^{th} standard mathematics.	
Course Objectives	To help students understand and acquire basic mathematical concepts and computational skills and apply these fundamental concepts in related disciplines.	
Content		Hours
Unit I	**Logic and Propositional Calculus:** Propositions and Compound Statements; Basic Logical Operations; Propositions and Truth Tables; Tautologies and Contradictions; Logical Equivalence; Algebra of Propositions; Conditional and Biconditional Statements. **Sets:** Sets and their representation; The empty set; Finite and Infinite Sets; Equal Sets; Subsets; Power Set; Universal Set; Union and Intersection of sets; Venn Diagrams; Operations on Sets; Complement of a set. **Relations and Functions:** Cartesian product of sets; Relation and their types; Functions and their types; Algebra of functions; Composition of functions; Invertible functions; Binary operations.	05 04 06
Unit II	**Limits:** Geometric meaning of limits; Standard limits. **Continuity:** Geometric meaning of continuity; Continuous functions; Algebra of continuous functions; Examples of continuous functions; Discontinuities; Types of discontinuities. **Differentiability:** First principle of differentiation; Algebra of differentiability namely sum/product/quotient rule; Examples; Result that every differentiable function is continuous; Derivative of the composition; Chain rule; (Statements of these results only. However, the idea of the proof, though not a part of the syllabus, is encouraged) Examples; Optimization problems.	02 04 04
Unit III	**Complex Numbers:** Algebra of complex numbers; Modulus and Complex conjugate; Argand plane and polar representation. **Vector Algebra:** Types of vectors; Addition of vectors; Multiplication of a vector by a scalar; Dot product and cross product of vectors, and their geometrical interpretation; Concept and computation of gradient, divergence, and curl of a vector field.	04 06
Unit IV	**Ordinary Differential Equations:** Types of differential equations; Order and Degree of a differential equation; Solution of a differential equation; Types of solutions; Formation of a differential equation by eliminating arbitrary constants; Methods of solving first – order and first – degree differential equations.	10
Tutorial	**15 hours shall be utilized for solving the following:** 1. Constructing and understanding truth tables.	15

	2. Problems on set theory. 3. Identifying types of relations. 4. Identifying injective/surjective functions. 5. Computing the inverse of a bijective function. 6. Evaluating limits of functions. 7. Testing the continuity/discontinuity of a function and identifying the type of discontinuity. 8. Using the various differentiation rules to find the derivative of a given function. 9. Finding the maximum value of functions. 10. Finding the minimum value of functions. 11. Expressing complex numbers in polar form. 12. Solving problems involving gradient, divergence, and curl. 13. Forming a differential equation. 14. Solving ordinary differential equations – I. 15. Solving ordinary differential equations – II.	
Pedagogy	Lectures/Tutorials/Self-study. Lectures should include theoretical concepts and examples. Tutorial to be exclusively dedicated for problem solving. The record of tutorials may be maintained by students in a separate notebook.	
References/Readings	1) E. Mendelson: *Shaum's Outlines: Beginning Calculus*, 3rd Edition, McGraw Hill Education, 2007. 2) M. R. Spiegel, S. Lipschutz, J. J. Schiller, and D. Spellman: *Shaum's Outlines: Complex Variables*, 2nd Edition, McGraw Hill Education, 2017. 3) M. R. Spiegel, S. Lipschutz, and D. Spellman: *Shaum's Outlines: Vector Analysis*, 2nd Edition, McGraw Hill Education, 2017. 4) R. Bronson: *Shaum's Outlines: Differential Equations*, 3rd Edition, McGraw Hill Education, 2017. 5) S. Lipschutz, and M. L. Lipson: *Shaum's Outlines: Discrete Mathematics*, 3rd Edition, McGraw Hill Education, 2017.	
Course Outcome	The student will be able to, 1. Identify the truth and falsity of a statement. 2. Comprehend the concept of Sets, Relations, and Functions. 3. Evaluate basic limits, Identify discontinuous functions, and Apply the techniques of differentiation. 4. Construct the polar form of complex numbers. 5. Compute the gradient, curl, and divergence. 6. Formulate and Solve differential equations.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-112
Title of the Course: Elementary Statistics
Number of Credits: 4 (3L+1T)
Effective from AY: 2023-24

Prerequisites	NIL	
Course Objectives:	This course is intended to familiarize students with organizing, summarizing, analyzing data, and drawing appropriate conclusions from it. The various tools and techniques are also intended to be used in day-to-day real – world problems.	
Content		Hours
Unit I	**Introductory concepts**: Definition and scope of Statistics; Concept of population and sample. **Types of data**: Quantitative; Qualitative; Attributes; Variates. **Tabulation of data:** Class intervals; Frequency tables. **Presentation of data**: Diagrams and graphs: Bar diagrams and their types; Pie charts; Frequency polygon; Histogram; Ogives. Consistency and independence of data with special reference to attributes. **Scales of measurement:** Nominal, Ordinal, Interval, Ratio. **Measures of Central Tendency**: Mathematical and Positional – Mean, Median, Mode, Quartiles, Percentiles. **Measures of Dispersion**: Range, Quartile deviation, Standard deviation, Coefficient of variation.	15
Unit II	**Bivariate data**: Definition; Scatter diagram. **Correlation and Regression:** Simple, Partial and Multiple Correlation (3 variables only); Rank correlation; Simple linear regression.	10
Unit III	**Probability**: Introduction; Random experiments; Sample space; Events and algebra of events; Definitions of Probability – Classical, Statistical, and Axiomatic; Conditional Probability; Addition and Multiplication theorem of probability; Independent events; Theorem of Total probability; Bayes' theorem and its applications.	10
Unit IV	**Statistical Quality Control:** Introduction; Causes of variation in quality; Objective, advantages, and techniques of SQC. **Attribute data:** P chart, U chart, C chart. **Numerical data:** X bar chart, R bar chart, S bar chart. **Sampling techniques**: Various methods of data collection; Census survey and sample survey. **Sampling Methods:** Simple random sampling; Systematic sampling; Stratified sampling; Clustered sampling. **Non – probability Sampling Methods:** Convenience sampling; Consecutive sampling; Quota sampling; Purposive or Judgmental sampling; Snowball sampling.	10
Tutorial	**15 hours are to be dedicated for illustrations with specific examples and numerical exercises. The following topics are to be covered during practical:**	15

	1. Data entry in Excel and basic tools in Excel. 2. Drawing of Frequency tables for raw, grouped, and ungrouped data. 3. Graphical representations using various diagrams. 4. Finding Mean, Median, Mode. 5. Finding Quartiles and Percentiles. 6. Computing measures of dispersion, namely, Range, Quartile deviation, Standard deviation, and Coefficient of variation. 7. Computing and Analyzing the various types of correlation. 8. Finding the Rank correlation. 9. Analysing Multiple correlation. 10. Analysing Regression. 11. Solving problems on the addition and multiplication theorem of probability. 12. Solving problems on conditional probability and total probability. 13. Solving problems on Bayes' theorem. 14. Demonstration of quality control using P chart, U chart, C chart. 15. Demonstration of quality control using X bar chart, R bar chart, S bar chart.	
Pedagogy	Lectures/Tutorials/Self-study. Lectures should include theoretical concepts and examples. Tutorial to be exclusively dedicated for problem solving. In Unit I and II, more focus is to be kept on the applications of measures. The record of tutorials may be maintained by students in a separate notebook. Tutorial to be conducted using case studies/secondary data. The use of simple software like Excel during tutorial, wherever possible, is encouraged.	
References/Readings	**Principal Text** 1) S. C. Gupta: *Fundamentals of Statistics,* 7th Edition, Himalaya Publishing House, 2018. **Other Texts** 2) A. M. Goon, M. K. Gupta, and B. Dasgupta: *Fundamentals of Statistics, Vol. I*, 8th Edition, The World Press, Kolkata, 2016. 3) S. C. Gupta, and V. K. Kapoor: *Fundamentals of Mathematical Statistics*, 12th Edition, S. Chand and Sons, Delhi, 2020. 4) S. P. Gupta: *Statistical Methods,* S. Chand & Sons, 2017. 5) S. Bernstein, and R. Bernstein: *Schaum's Outlines: Elements of Statistics I – Descriptive Statistics and Probability*, McGraw Hill, 2020.	
Course Outcomes	The student will be able to, 1. Interpret data and graphically represent it. 2. Calculate measures of central tendencies and variations.	

	3. Analyze correlation and regression. 4. Solve problems in Probability theory. 5. Understand different data sampling techniques. 6. Apply statistical quality control.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-131
Title of the Course: Mathematical Techniques in Competitive Exams
Number of Credits: 3 (3L)
Effective from AY: 2023-24

Prerequisites	NIL	
Course Objectives	To make students competent enough to answer competitive examinations like Banks, Post Office, SSC, LIC, CDS, CSAT, CAT, CMAT, GMAT, MAT, UPSC, CBI, CPO, Civil Services, Hotel Management, Railway, Police, Defence, etc.	
Content		Hours
Unit I	**Ratio and Proportion:** Ratio; Comparison of ratios; Proportion. **Mixture or Alligation:** Mixture; Rule of mixture or allegation. **Partnership:** Types of partnerships; Types of partners. **Problems Based on Ages:** Rules for problems based on ages.	15
Unit II	**Work and Time:** Basic rules related to work and time. **Work and Wages:** Important points. **Pipes and Cisterns:** Facts related to pipes and cisterns. **Clock and Calendar:** Clock; Calendar; Day Gain/Loss.	15
Unit III	**True Discount and Banker's Discount:** True discount; Banker's discount. **Speed, Time and Distance:** Basic formulae related to speed, time and distance. **Problems Based on Trains:** Basic rule related to problems based on trains. **Boats and Streams:** Concepts and formulae on boats and streams.	15
Pedagogy	Lectures/Problem Solving/Self study.	
References/Readings	1) R. Verma: *Fast Track Objective Artithmtic*, Arihant Publications Limited, 2017. (**Principal Text**) 2) A. Sharma: *How to Prepare for Quantitative Aptitude for CAT*, 9th Edition, McGraw Hill, 2021. 3) P. K. Mishra, and R. Mishra: *Elementary & Advanced Mathematics For Competitive Exams*, Source Books, 2018. 4) R. S. Aggarwal: *Quantitative Aptitude for Competitive Examinations*, S. Chand Publications, 2017. 5) R. Mathuriya: *Mathematics for all Competitive Exams SSC (Pre./Mains),* Sunita Publications, 2017.	
Course Outcomes	The student will be able to, 1. Apply mathematical techniques in solving problems. 2. Identify tricks in solving problems quickly. 3. Employ various strategies to solve problems arising in various competitive exams. 4. Manage time in answering several questions appearing in the exam.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-132
Title of the Course: Descriptive Statistics
Number of Credits: 3 (3L)
Effective from AY: 2023-24

Prerequisites	NIL	
Course Objectives:	To make students aware of various statistical tools and techniques that can be employed in data analysis and simple research.	
Content		Hours
Unit I	**Data Visualization** Introduction to Statistics: Definition and scope of Statistics; Concepts of statistical population and sample; Variates and attributes. Types of Data: Quantitative and Qualitative data, Cross-sectional and Time-series data, Discrete and continuous data. Different types of scales: Nominal, Ordinal, Interval and Ratio. Collection and Scrutiny of Data: Primary data, Secondary data – its major sources, Complete enumeration; Construction of tables with one or more factors of classification; Frequency distributions and cumulative frequency distributions and their graphical representations (Histograms, frequency polygon, Ogives).	15
Unit II	**Data Summarization** Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation, Skewness and Kurtosis.	15
Unit III	**Correlation and Regression** Bivariate data: Scatter diagram; Karl Pearson's coefficient of correlation; Spearman's rank correlation coefficient. Bivariate Regression Analysis: Regression lines; Properties of regression coefficients; Residual variance. Principle of least squares and fitting of polynomials and exponential curves.	15
Pedagogy	Lectures/Problem Solving/Self study.	
References/Readings	1) S. C. Gupta: *Fundamentals of Statistics,* 7th Edition, Himalaya Publishing House, 2018. (**Principal Text**) 2) A. M. Goon, M. K. Gupta, and B. Dasgupta: *Fundamentals of Statistics, Vol. I*, 8th Edition, The World Press, Kolkata, 2016. 3) S. C. Gupta, and V. K. Kapoor: *Fundamentals of Mathematical Statistics*, 12th Edition, S. Chand and Sons, Delhi, 2020. 4) S. P. Gupta: *Statistical Methods,* S. Chand & Sons, 2017. 5) S. Bernstein, and R. Bernstein: *Schaum's Outlines: Elements of Statistics I – Descriptive Statistics and Probability*, McGraw Hill, 2020.	
Course Outcomes	The student will be able to,	

	1. Understand concepts of sample v/s. population and Identify different types of scales. 2. Distinguish between primary and secondary data and Organize the Statistical data. 3. Calculate measures of central tendencies and variations. 4. Interpret correlation and regression.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-141
Title of the Course: Numerical Analysis using Python/SageMath
Number of Credits: 3 (1L+2P)
Effective from AY: 2023-24

Prerequisites:	Basic 12^{th} standard mathematics.	
Course Objectives:	To make students aware of numerical methods that can be employed to obtain good approximate numerical solutions to problems that may not be able to be solved in a closed form and to effectively use software in these computations.	
Content		Hours
Unit I	**Elementary Error Analysis:** Numbers: Exact and Approximate; Significant digits; Errors: Absolute, Relative and Percentage errors; Examples. **Solution of Algebraic and transcendental Equations:** Bisection Method; Regula – Falsi Method; Secant Method; Newton – Raphson Method; Special Cases of Newton – Raphson Method like finding q^{th} root of a positive real number 'd' and finding reciprocal of a positive real number 'd' without using division; Bairstow's Method; Remarks on convergence. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Unit II	**Calculus of Finite Differences:** Operators Δ, ∇, & E; Difference Tables; Properties of Δ, ∇, & E; Fundamental Theorem of Difference Calculus; Expression of any value of a function in terms of leading term and leading differences of a difference table. **Interpolation and Extrapolation:** Newton's Forward and Backward Interpolation formulae; Central difference Interpolation formula; Lagrange's Interpolation formula; Newton's Divided Difference formula. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Unit III	**Numerical Differentiation and Integration:** Differentiation formulae for equidistant arguments; General quadrature formula for equidistant ordinates (Newton – Cotes Formula or Gauss Legendre quadrature formulae); Trapezoidal rule and its Geometrical interpretation; Simpson's one – third rule; Simpson's three – eighth rule; Weddle's rule. **Method of Least Squares:** Fitting of straight line, Fitting of quadratic curve; Fitting of an exponential curve. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Practical	**Out of the 60 total hours for practical, around 30 hours may be dedicated for manual problem solving.** **The remaining time of around 30 hours shall be utilized for executing the following computations using Python/SageMath:**	60

	1. Finding roots of equations using Bisection method. 2. Finding roots of equations using Regula – Falsi method. 3. Finding roots of equations using Secant method. 4. Finding roots of equations using Newton – Raphson method and Finding q^{th} roots and reciprocals of equations using Newton – Raphson method. 5. Finding roots of polynomials using Bairstow's method. 6. Interpolating data using Newton – Gregory's Forward Difference Interpolation Formula. 7. Interpolating data using Newton – Gregory's Backward Difference Interpolation Formula. 8. Interpolating data using Central Difference Interpolation Formula. 9. Interpolating data using Newton's Divided Difference Interpolation Formula. 10. Interpolating data using Lagrange Interpolation Formula. 11. Computing the first and second order numerical derivative. 12. Calculating the numerical integral using Trapezoidal rule. 13. Calculating the numerical integral using Simpson's $1/3^{rd}$ and $3/8^{th}$ rule. 14. Fitting a straight line to a given data. 15. Fitting quadratic and exponential curves to a given data.	
Pedagogy	Lectures/Practical/Self study. Visualizations using software, wherever possible, is encouraged.	
References/Readings	1) B. S. Grewal: *Numerical Methods in Engineering and Science with Programs in C & C++*, Khanna Publishers, 2010. (**Principal Text**) 2) A. N. Kamthane, and A. A. Kamthane: *Programming and Problem Solving with Python*, McGraw Hill Education, 2017. 3) P. P. Gupta, G. S. Malik, and J. P. Chauhan: *Calculus of Finite Differences & Numerical Analysis*, Krishna Prakashan Media, 2015. 4) S. S. Sastry: *Introductory Methods* of *Numerical Analysis,* Prentice Hall India Pvt. Ltd., 2012. 5) SAGE Documentation.	
Course Outcomes	The student will be able to, 1. Find the roots of algebraic and transcendental equations. 2. Apply Interpolation to solve real life problems. 3. Make use of the techniques of numerical differentiation and integration. 4. Determine the best line/quadratic curve/exponential curve to fit the give data. 5. Utilize Python/SageMath software to aid mathematical pursuits.	

Name of the Programme: B.Sc. (Mathematics)
Course Code: MAT-142
Title of the Course: Statistical Methods Using R/SPSS/PSPP
Number of Credits: 3 (1L+2P)
Effective from AY: 2023-24

Prerequisites:	NIL	
Course Objectives	To make students aware of various statistical methods that can be employed in data analysis, hypothesis testing and research.	
Content		Hours
Unit I	**Introduction – Meaning and Scope**: Definition of Statistics; Importance and scope of Statistics; Limitations of Statistics. **Data Summarization:** Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation; Skewness and Kurtosis. Graphical representation of various measures of location and dispersion: Bar Graphs, Histograms, Frequency polygons, Ogives, Pie Charts. **Correlation and Regression Analysis**: Introduction; Karl Pearson's coefficient of Correlation; Spearman's Rank correlation; Bivariate Linear Regression Analysis. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Unit II	**Theory of Probability**: Introduction; Mathematical probability; Statistical probability; Axiomatic probability; Addition theorem of probability; Multiplication theorem of probability; Pair wise and mutual independence; Total probability theorem; Bayes' theorem. **Random Variables**: Random variable; Probability distribution of a Discrete Random Variable; Probability distribution of a Continuous Random Variable; Mathematical Expectations. **Theoretical Distributions**: Binomial distribution; Poisson Distribution; Normal Distribution. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Unit III	**Testing of Hypothesis**: Interval Estimation; Testing of Hypothesis. **Large sample tests**: Introduction; Sampling of Attributes; Sampling of Variables. **Parametric tests**: Student's t distribution (Independent and Paired 't' test); One Way and Two Way ANOVA. **Non-Parametric tests**: Chi Square test; Mann-Whitney test; Kruskal Wallis test. **(PROBLEMS IN THIS UNIT TO BE DONE IN PRACTICAL)**	05
Practical	**Out of the 60 total hours for practical, 40 hours may be dedicated for manual problem solving.**	60

	The remaining 20 hours shall be utilized for executing the following computations using R/SPSS/PSPP: 1. Importing data from CSV or Excel file. Data entry in R/SPSS/PSPP. 2. Finding measures of central tendency, namely, mean, median and mode. 3. Finding measures of dispersion, namely, range, quartile deviation, mean deviation and standard deviation. 4. Graphical representations and their interpretations. 5. Analyzing correlation and regression. 6. Testing of hypothesis for single mean and difference of means using independent t- test and paired t-test. 7. Testing of hypothesis for more than two means using ANOVA. 8. Testing of hypothesis regarding independence of attributes using Chi square test. 9. Testing the hypothesis stating that the k independent samples have been drawn from the populations which have identical distributions using Kruskal Wallis test. 10. Working with questionnaires for understanding the collected data and their analysis.	
Pedagogy	Lectures/Practical/Case study.	
References/Readings	1) S. C. Gupta: *Fundamentals of Statistics,* 7th Edition, Himalaya Publishing House, 2018. (**Principal Text**) 2) A. M. Goon, M. K. Gupta, and B. Dasgupta: *Fundamentals of Statistics, Vol. I*, 8th Edition, The World Press, Kolkata, 2016. 3) S. C. Gupta, and V. K. Kapoor: *Fundamentals of Mathematical Statistics*, 12th Edition, S. Chand and Sons, Delhi, 2020. 4) S. P. Gupta: *Statistical Methods,* S. Chand & Sons, 2017. 5) S. Bernstein, and R. Bernstein: *Schaum's Outlines: Elements of Statistics I – Descriptive Statistics and Probability*, McGraw Hill, 2020.	
Course Outcomes	The student will be able to, 1. Calculate measures of central tendencies and variations. 2. Interpret correlation and regression. 3. Solve problems in Probability theory. 4. Demonstrate and Infer based on various statistical tests using statistical software.	