Department
of
Mathematics and Statistics

School of Mathematical and Physical Sciences

Curriculum Framework
BA/B.Sc. (Statistics)

Based on National Education Policy-2020

Date of BOS -11/06/2024

Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh-470003

Passed by Board of Studies Dated 11/06/24

About the Department:

The Department of Mathematics & Statistics was established with the very inception of the University in the year of 1946. The founder of the university and the founder vice-chancellor Dr. Harisingh Gour had himself appointed Dr. R.B. Rabugunday as the first Head of the Department. Dr. Rabugunday was a scholar of Madras University and a wrangler of Cambridge tradition.

Curriculum Frame work based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation self-reliant and global leader. Department of Mathematics and Statistics has developed a curriculum framework to encompass the goals of NEP2020.Department has incorporated choice of subjects/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points

As well as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects in statistics

Under Graduate Curriculum Framework for Bachelor of Science

1. **Name of the Programme:** **(1) Certificate in Science (After exit of one year)**
   (2) Diploma in Science (After exit of two years)
   (3) Bachelor in Science (After exit of three years)
2. **About the Programme:**
   Statistics is a backbone of many sciences and social science discipline. Aim of this UG programme is to train young minds in order to handle the critical problems that occur in data handling with application of statistical tools.
3. **Objectives of the Programme**
   - To develop student's kills in Statistical science through various tools and techniques.
   - To provide rigorous instructions in fundamental statistical concepts and skills presented in the context of real- world applications.
   - To introduce students to the enormous diversity and complexity of real-life problems in statistics.
   - To provide the opportunity to get expertise in the applications of statistics.
4. **Programme Learning Outcomes :**
   The programme learning outcomes are attained by learners through the essential learning acquired on completion of selected course of study with in a programme. The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study.

a) After completion of this program of study the students will have an enhanced knowledge and understanding about statistical applications.

b) The statistical skills learned through this program will provide analytical understanding for solving problems in real life situations.

c) Students who will complete this program be able to draw sound inferences through data analysis.

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Structure of the Programme B.A. /B.Sc. Statistics for : (1) Certificate in Science (After exit of one year)

Semester I

Level 5	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-111	Descriptive Statistics	4	Prof. R.K.Gangele
		STAT-DSM-112	Statistics Practical-I	2	Prof. R.K.Gangele
	Multi-Disciplinary Major-3	MTS-MDM-111	Matrix Theory	6	Dr. M.K.Yadav
	Ability Enhancement Course	MTS-AEC-111	Graph Theory	2	Dr. Bhupendra
	Skill Enhancement Course	MTS-SEC-111	Vector Calculus	2	Dr. Bhupendra

Semester II

	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-211	Probability & Distributions	4	Prof. D. Shukla
		STAT-DSM-212	Statistics Practical-II	2	Prof. D. Shukla
	Multi-Disciplinary Major-3	MTS-MDM-211	Numerical Methods	6	Dr. R. K. Pandey
	Ability Enhancement Course	MTS-AEC-211	Fundamentals of Computer	2	Prof. D. Shukla
	Skill Enhancement Course	STAT-SEC-211	Business Statistics	2	Prof. R.K.Gangele

Structure of the Programme B.A. /B.Sc. Statistics for : (2) Diploma in Science (After exit of two years)

Semester III

Level 6	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-311	Sampling Theory & Distributions	4	Prof. D. Shukla
		STAT-DSM-312	Statistics Practical-III	2	Prof. D. Shukla
	Multi-Disciplinary Major-3	MTS-MDM-311	Mechanics	6	Dr. Bhupendra
	Ability Enhancement Course	MTS-AEC-311	Portfolio Optimization	2	Dr. M.K.Yadav

Semester IV

	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-411	Statistical Inference	4	Prof. R.K.Gangele
		STAT-DSM-412	Statistics Practical-IV	2	Prof. R.K.Gangele
	Multi-Disciplinary Major-3	MTS-MDM-411	Metric Space	6	Dr. K.Shrivastava
	Skill Enhancement Course	MTS-SEC-411	Tautology	2	Dr. Bhupendra

Structure of the Programme B.A. /B.Sc. Statistics for : (3) Bachelor in Science (After exit of three years)

Semester V

Level 7	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-511	Financial Statistics	4	Prof. R.K. Gangele
		STAT-DSM-512	Statistics Practical-V	2	Prof. R.K. Gangele
	Multi-Disciplinary Major-3	MTS-MDM-511	Algebra	6	Dr. Bhupendra
	Ability Enhancement Course	MTS-AEC-511	Transportation and Assignment Problems	2	Dr. U.K. Khedlekar

Semester VI

	Nature of Course	Course Code	Course Title	Credits	Course Designer
	Discipline Specific Major-1	STAT-DSM-611	Design of Experiments	4	Prof. D. Shukla
		STAT-DSM-612	Statistics Practical-VI	2	Prof. D. Shukla
	Multi-Disciplinary Major-3	MTS-MDM-611	Dynamics	6	Dr. Bhupendra
	Skill Enhancement Course	MTS-SEC-611	Latex	2	Dr. S. Kumar

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6. **Exit: (1) Certificate in Science (After exit of one year)**
   (2) Diploma in Science (After exit of two years)
   (3) Bachelor in Science (After exit of three years)

7. **Teaching Learning Approach:**

This programme will utilize the following pedagogic approach-

- Lecture/Seminar
- Demonstration
- Readings/written assignment sand Field Projects
- Group discussions/tutorial and Community visit
- Projectwork
- Field Visit/Survey/Dissertation

8. **Assessment**

The learner in the programme will be assessed throughout the duration of the programme in a formative and summative evaluations i.e. Mid (I&II) and End Semester examinations. Tobe eligible to appear in End semester examination, a student must appear in Mid semester examinations along with at least 75 percent attendance in class room.

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester I (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem I	**STAT–DSM- 111**	**Descriptive Statistics**	**4**	**0**	**0**	**4**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. R.K.Gangele**

Lecture Hrs. 60

Objectives:
(1) To learn the data types.
(2) To know how to measure standard statistical parameters.
(3) To study correlation and its analysis.
(4) To explore data pattern by curve fitting methods.
(5) To learn the various economic indices.

Course Learning Outcomes:
CO1: After completion of this course student will learn data analysis wing statistical methodologies.
CO2: Student will understand the pattern of data for future projection of values
CO3: Course will buildup concept to measure the intensity of relationship in qualitative variables

Unit-wise learning outcome:
UO1: Completing Unit-I student will learn data compilation and graphical presentation.
UO2: By completing Unit-II, student will learn basic Statistical analysis tools.
UO3: End of Unit-III provides capacity to learn effect of correlation in two or more variables.
UO4: By completing Unit-IV, student will be able to understand the graphical pattern of data.
UO5: Unit-V develops capacity in student to know intensity of relationship among attributes.

UNIT-I: Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative variables, scales of measurement, nominal, ordinal, interval and ratio. Class intervals, Discrete and continuous frequency distributions, Data presentation: text, tabular and graphical forms, line, bar, multiple bar diagrams, Pie chart, frequency curves, Histogram and Ogives.
UNIT-II: Measures of central tendency: mean, median, mode, GM, HM with properties, combined mean, Quartiles, Measures of dispersion: range, quartile deviation, mean deviation, and standard deviation with merits and limitations coefficient of variation.
UNIT-III: Moments, absolute and central moments, factorial moments, skewness, kurtosis and their measurements, Sheppard's corrections. Bivariate data: scatter diagram, simple correlation, Karl Pearson correlation coefficient with properties, Partial and Multiple correlations with their coefficient and properties (upto3 variables only), Rank correlation. Spearman rank correlation coefficient with applications.
UNIT-IV: Principle of least squares, fitting of straight line, fitting of polynomials and exponential curves. Simple linear regression, properties of regression coefficients
UNIT-V: Theory of attributes, Notation and dichotomy, class and class-frequencies, class-symbols and operators, condition of consistency of data, criterion of independence of attributes, Association of attributes, Yule coefficient. Coefficient of colligation

Essential Readings:

1. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
2. Gupta S.C., Kapoor V.K., Fundamental of Mathematical Statistics, Sultan Chand and Sons,
3. Gupta S.C., Kapoor V.K., Fundamental of Applied Statistics, Sultan Chand and Sons.

Suggested Reading:

1. Goon A.M., Gupta M.K. and Dasgupta,B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn.The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statisticswith Applications, (7th Edn.), Pearson Education, Asia.

E Book Link: National digital Library, e-pgpathshala

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester I (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem I	**STAT–DSM- 112**	**Statistics Practical-I**	**0**	**0**	**2**	**2**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. R.K. Gangele**

Lecture Hrs. 60

Learning Objectives: (1) To learn the calculation procedure of Statistical methods.
(2) To measure some standard statistical parameters.
(3) To calculate values of various Statistical coefficients
(4) To examine bivariate data pattern by curve fitting.
(5) To calculate different coefficients of attributes.

Course Learning Outcomes:

CO1: After completion of this course student will learn creation of graphs, charts and to calculate central tendency, variability, skewness, kurtosis present in data and writing conclusion

CO2: Student will learn to calculate various coefficients of correlation, regression and attributes.

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Calculation Karl Pearson correlation coefficient.
8. Calculation Correlation coefficient for a bivariate frequency distribution.
9. Calculation Lines of regression, angle between lines and estimated values of variables.
10. Calculation Spearman rank correlation with and without ties.
11. CalculationPartial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Practical on consistency of data in terms of attributes.
14. To calculate Yule coefficient in attributes.
15. To calculate coefficient of colligation.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

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B.A./ B.Sc.- Semester I (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem I	**MTS–MDM - 111**	**Matrix Theory**	**5**	**1**	**0**	**6**	**IA (Mid) – 40 EA (End Sem) - 60**	**Dr. Bhupendra**

Lecture Hrs. 90

Learning Objectives:

- To understand the basic concept of matrices and their types
- To familiar with the application of Caley Hamilton theorem in finding inverse of matrix.
- To provide an introduction of Matrices to real life problems

Course Learning Outcomes:

CO 1: Students should have an enhanced knowledge and understanding of Matrix theory.
CO 2: The course skills should provide several methods for approaching problems students encounter in their future endeavors.
CO 3: Students should be better able to understand matrix concept in terms of linear map.

Unit wise Learning Outcomes

UO 1: Students should be able to determine the rank of matrix and elementary operation to convert into Echelon form, normal form, etc.
UO 2: Students should be able to evaluate eigen values and eigenvectors of various square matrices.
UO 3: Students should be able to solve system of linear equations through matrix methods.
UO 4: Students should be able to understand matrix into linear map and vice-versa.
UO 5: Students should be acquainted with the knowledge of MATLAB and applications matrices into real life problems.

Unit I: Matrix algebra, Row and column vectors of a matrix, row rank and column rank, Echelon matrix, reduced Echelon matrix, rank of a matrix, normal form of a matrix, inverse of matrix.
Unit II: Square matrices, square block matrices, eigen values and eigenvectors of a matrix, relationship between eigen values and eigenvectors, nature of eigen values of special types of matrices, the process of finding eigen values and the eigenvectors.
Unit III: Cayley-Hamilton theorem and its use in finding of inverse, application of matrices to system of linear equations, consistency and inconsistency,
Unit IV: Matrix as a linear map: subspace and span, basis and dimension, linear transformation, coordinate vectors, coordinate matrices, change of the basis matrix, equivalence and similarity.
Unit V: MATLAB basics, practical approach of matrices through MATLAB, applications of matrices in real world problems,

Essential Readings

1. Joel L. Franklin, Matrix theory, Dover Publication 2012.
2. David W.Lewis, Matrix theory. World scientific, 1991.

Suggested Readings

1. Fuzhen Zhang, Matrix theory, Basic results and Techniques, Springer 2011.
2. Leonard E Fuller, Basci Matrix theory, Dover Publication 2017.

Essential e-Resources

1. https://www.scribd.com/book/271620206/Matrix-Theory
2. https://link.springer.com/book/10.1007/978-3-030-80481-7

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B.A./ B.Sc.- Semester I (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem I	MTS-AEC-111	Graph Theory	2	0	0	2	IA (Mid)-40 EA (End Sem)- 60	Dr. Kavita Shrivastava

Lectures Hrs:30

Learning Objectives:

1. Students will achieve command of the fundamental definitions and concepts of graph theory.
2. To study proof techniques related to various concepts in graphs.
3. To explore modern applications of graph theory.
4. Able to apply theoretical knowledge acquired to solve realistic problems in real life.

Course Learning Outcomes:

CO1: Understand the basic concepts of graphs, and different types of graphs.
CO2: Understand the properties, theorems and be able to prove theorems.
CO3: Apply suitable graph model and algorithm for solving applications.
CO4: Understand the Travelling Salesman's problem.
CO5: Form Dijkstra's algorithm and apply it in various situations.

Unit Wise Learning Outcomes:

UO1. To learn about graph and its properties.
UO2. To learn about types of graph.
UO3. To learn about travelling salesman problem and its application.
UO4. Aware about planar graph.
UO5. Aware about shortest path, trees and its properties.

Unit I: Definition, examples and basic properties of graphs, graph terminology, types of graph, path, trail, circuit, cycle, complementary graph.
Unit II: Sub graphs, Spanning Subgraph, Isomorphic Graph, Homeomorphism graph, Connected graph, Disconnected graph, Cut set, Cut point, Complete graph, Labelled graph, Weight graph, Regular graph, Bipartite graph, Complete bipartite graph.
Unit III: Definitions: Directed and undirected graphs. Hand shaking property and its problems. Real life applications, Applications- Konigsberg bridge problem, Utility problem and travelling salesman problem. Euler graphs and Hamiltonian graphs (no theorems) problems
Unit IV: Planar graph, Properties of planar graph, Non- planar graph, Euler formula, Kuratowski's theorem, Graph coloring.
Unit V: Shortest path, Dijkstra's algorithm, Trees and their properties, Spanning tree, Kruskal's algorithms.

Essential Reading:

1. NarasinghDeo, Graph Theory with applications to engineering and computer Science, Edition, Printice hall of India Private Limited, 2009.
2. Ralph P. Grimaldi., Discrete and Combinatorial Mathematics, 5th Edition , Pearson, 2006.

Suggested Reading

1. GeirAgnarsson and Raymond Greenlaw, Graph Theory, Modeling, Applications and Algorithms, 1st Edition, Pearson Education, Inc, New Delhi 2009.
2. John Clark and Holton D.A, A First Look at Graph Theory, Edition, Allied Publishers, 2001.
3. Douglas B West, Introduction to Graph Theory, 2nd Edition, Printice hall of India Private Limited, New Delhi.

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B.A./ B.Sc.- Semester I (Statistics)

Level &Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem. I	MTS-SEC-111	Vector Calculus	2	0	0	2	IA(Mid)-40 EA(End Sem)- 60	Dr. U.K. Khedlekar Dr. Bhupendra

Lectures Hrs:30

Learning Objectives:

To understand the concept of differentiation of vector function, and applications of Scalar and vector product. To understand the aspects of gradient, divergence and curl.

Course Learning Outcomes:

CO1: Students capable to understand the vector valued function.
CO2: After completion of this course, students should be able to manipulate vectors to perform geometrical calculations in three dimensions.
CO3: They will also able to calculate and interpret derivatives in up to three dimensions.

Unit Wise Learning Outcomes:

UO1. To learn about vectors and Scalar
UO2. To learn about partial differentiation of vector function.
UO3. To learn about derivative of sum and dot product.
UO4. To find out the derivative of cross product of two vectors.
UO5. To discuss about gradient, divergence and curl.

Unit – I: Differentiation of a vector function and Partial differentiation of a vector function.
Unit – II: Derivative of sum and dot product of two vectors and their properties.
Unit –III: Derivative of cross product of two vectors and their properties.
Unit – IV: Work done and moment by force.
Unit – V: Gradient, divergence and curl.

Essential Readings :

1. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

Suggested Readings :

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

E-resource :

https://onlinecourses.nptel.ac.in/noc22_ma03/preview
https://www.youtube.com/watch?v=M0H1UJbn-V4

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Syllabus as per NEP-2020
B.A./ B.Sc.- Semester II (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem II	**STAT–DSM-211**	**Probability and Distributions**	**4**	**0**	**0**	**4**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. D. Shukla**

Lecture Hrs. 60

Learning Objectives:

1. To study concept of probability.
2. To study nature of random variables& its probability function.
3. To learn average and variability under probability phenomenon
4. To learn about moments of a random variable by various approaches.
5. To study different nature of probability distributions.

Course Learning Outcomes:

CO1: After completion of this course student will learn the concept and calculation of probabilities.
CO2: Student can identify the random variables with their distributions.
CO3: Student will be capable enough to understand properties of probability distributions.

Course Learning Outcomes:

UO1: After completion of unit I, the student will learn the basics of joint probability, conditional probability and probability of union of events.
UO2: This unit II will make students capable for dealing with random variables.
UO3: Unit III will help to understand average and variability under probability setup.
UO4: At end of unit IV student will learn m.g.f., characteristic function and cumulates and their uses.
UO5: Student will learn the various popular probability distributions with properties.

UNIT I: Probability: Introduction, random experiments, sample space, events, Definitions of Probability – classical, statistical, and axiomatic. Joint and Conditional Probability of events, laws of addition and multiplication, independent events, Bayes' theorem.
UNIT II: Random variables: discrete and continuous random variables, p.m.f., p.d.f.,c.d.f of random variables, Two dimensional random variable of discrete and continuous types, joint, marginal and conditional p.m.f, p.d.f.
UNIT III: Independence of random variables, Expectation of single and bivariate random variables and its properties. Conditional Expectation and conditional variance, Theorems on expectation and variance.
UNIT IV: Moment generating function (m.g.f) with properties and applications, Characteristic function and properties. Cumulant generating function, Uniqueness and Inversion theorems (without proof) along with applications.
UNIT V: Standard probability distributions: Binomial, Poisson, geometric, negative binomial, uniform, normal and standard normal, exponential and gamma distributions along with derivation of their mean, variance and other properties.

Essential Readings:

1. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing,
2. Gupta S.C., Kapoor V.K., Fundamental of Mathematical Statistics, Sultan Chand and Sons ,
3. Gupta S.C., Kapoor V.K., Fundamental of Applied Statistics, Sultan Chand and Sons.

Suggested Reading:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Mary lees (2006): John E. Freund's Mathematical Statistics with Applications (7th Edn.), Pearson Education, Asia.

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B.A./ B.Sc.- Semester II (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem II	**STAT–DSM- 212**	**Statistics Practical-II**	**0**	**0**	**2**	**2**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. D. Shukla**

Lecture Hrs. 60

Learning Objectives:

1. Learn to calculate probability of events.
2. To knowhow to create random variables& its probability function.
3. To compute expectations with average and variability under probability setup.
4. To calculate moments of a random variable by various approaches.
5. To fit different probability distributions on real data.

Course Learning Outcomes:

CO1: After completion of this course student will learn the calculation of joint and conditional probabilities of events

CO2: Student will learn fitting of probability distribution over real data

CO3: Student will understand the effect of variations of parameter over shape of probability distributions.

List of Practical **(60 hours)**

1. Two coin, three coin, four coin toss experiments and calculation of joint probabilities and conditional probabilities.
2. One dice, two dices thrown experiments and calculation of joint, conditional probabilities.
3. Calculation of P (AUB), P (AUBUC), P (AUBUCUD) probabilities
4. Practical calculation based on Bayes theorem
5. Calculation of univariate and bivariate expectations for discrete and continuous random variables.
6. Calculation of conditional variance in bivariate discrete probability distributions.
7. Fitting of binomial distributions for n and $p = q = ½$.
8. Fitting of binomial distributions for given n and p.
9. Application problems and fitting of Poisson distribution.
10. To calculate the ordinate for a given value for normal distribution.
11. Application based problems using normal distribution.
12. Fitting of normal distribution when parameters are given.
13. Fitting of normal distribution when parameters are not given.
14. Practical on geometric distribution.
15. Practical on exponential and Uniform distributions.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

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B.A./ B.Sc.- Semester II (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem II	MTS-MDM-211	Numerical Methods	5	1	0	6	IA (Mid)-40 EA (End Sem)- 60	Dr. R.K.Pandey

Lectures Hrs:90

Learning Objectives

1. To explain the construction of numerical method for the solution of algebraic and transcendental equations.
2. To introduce convergence and stability criteria for various numerical method.
3. To explain the numerical methods for solution of system of linear and nonlinear equations.
4. To explain the relaxation and iterative methods.
5. To explain the concept of interpolation, Lagrange and Newton's interpolation.

Course Learning Outcomes: This course will enable the students to:

CO-1 Obtain numerical solutions of algebraic and transcendental equations.
CO-2 Find numerical solutions of system of linear equations and to check the accuracy of the solutions.
CO-3 Learn about various interpolating methods to find numerical solutions initial value problems in differential equations

Unit wise Learning Outcomes: After completion of this course students will be able to:

UO1: Obtain the approximate solution of algebraic and transcendental equations.
UO2: Know the alternative numerical method to find the solutions of system of linear equations and able to know the way to check the accuracy of the solutions.
UO3: Interpret the interpolation to find the missing value form the given set of points. They should also know the concept of finite difference.
UO4: Know the derivation of trapezoidal and Simpson's rule and capable to evaluate the integrals numerically using these methods.
UO5: Understand application of various numerical methods to find the solution of differential equations.

Unit-I: Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Intermediate value theorem and Fixed point theorem (without proof). Bisection method, method of false position, fixed point iteration method.
Unit-II: Newton Raphson and secant method for solving equations. Partial and scaled partial pivoting, LU decomposition and its applications, Gauss Elimination, Gauss Jordan method, Indirect method: Jacobi and Gauss-Seidel methods.
Unit-III: Finite differences; Interpolation; Newton's forward and backward interpolation, Lagrange's interpolation, Newton's divided difference; Piecewise interpolation, Spline.
Unit-IV: First order and second order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rule and error, Gauss Quadrature.
Unit-V: Picard method, Euler's method (Forward, Backward and Modified), Runge-Kutta methods (explicit); Error term of Euler method.

Essential Readings:

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
2. M.K. Jain, S. R. K. Iyengar& R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition), New Age International Publishers.
3. Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.
4. Melvin J. Maron, Numerical Analysis A Practical Approach, Macmillan Publishing Company Inc., New York, 1982.

Suggested Readings:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited, New Delhi, 2010.
2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India

E- Resource :

Numerical methods - Course (nptel.ac.in)
Introduction to Numerical Methods | Mathematics | MIT Open Courseware

11.6.24

Passed by Board of Studies Dated 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester II (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem II	**MTS-AEC- 211**	**Fundamentals of Computer**	**2**	**0**	**0**	**2**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. D. Shukla**

Lecture Hrs. 30

Learning Objectives:

- To confidently operate computers to carry out computational tasks
- To understand working of Hardware and Software, the importance of programming languages, number systems.
- To describe the organization and operation of a computer processor, primary and secondary memory, peripheral devices and to give computer specifications

Course Learning Outcomes:

CO 1: Students should enhance knowledge of computer, structure of computer and its generation.
CO 2: Students should be familiar with conversion of number systems.
CO 3: Students should be able to understand the basic concept of programming languages.

Unit wise Learning Outcomes: After the completion of course students should be able

UO 1: To enhance the basic knowledge of computer and its generation.
UO 2: To understand the basic structure and types of computer.
UO 3: To familiar with the number system and conversion from one to another.
UO 4: To understand various types of computer memory.
UO 5: To gain the basic knowledge of computer programming.

Unit I: Introduction to Computers - Computer Characteristics, Concept of Hardware, Software, Evolution of computer and Generations,
Unit II: Types of Computer – Analog and Digital computers, Hybrid Computers, General Purpose and Special Purpose Computer, Limitations of Computer, Functional Block Diagram of Computer. CPU, ALU, Memory Unit
Unit III: Number Systems – different types, conversion from one number system to another ,Input Device – Keyboard, Mouse, Scanner, MICR, OMR. Output Devices – VDU, Printers – Dot Matrix, Daisy-wheel, Inkjet, Laser, Line Printers and Plotters
Unit IV: Memory Concept, Memory Cell, Memory Organization, Semiconductor Memory – RAM, ROM, PROM, EPROM, Secondary Storage Devices – Magnetic Tape, Magnetic Disk (Floppy Disk and Hard Disk.), Compact Disk.
Unit V: Computer Languages - Machine Level, Assembly Level & High Level Languages, Translator Programs – Assembler, Interpreter and Compiler.

Essential Readings

1. P.K. Sinha and P. Sinha, Computer Fundamentals, BPB Publishers, 2007.
2. SheemaThareja, Fundamental of Computers Oxford University Press, 2019.

Suggested Readings

1. E. Balagurusamy, Fundamental of Computers and Programming, McGraw Hill Education 2011.
2. A. Geol, Computer Fundamentals, Pearson Education, 2010.

Essential e-Resources

- https://www.amazon.in/Fundamentals-Computers-Manaullah-Abid-ebook/dp/B07YZ36XHM
- https://www.mheducation.co.in/fundamentals-of-computers-9780070141605-india

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester II (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L5 Sem II	**STAT–SEC-211**	**Business Statistics**	**2**	**0**	**0**	**2**	**IA (Mid) – 40 EA (End Sem) - 60**	**Prof. D. Shukla**

Lecture Hrs. 30

Learning Objective:(1) To understand business indicators.
(2) To understand fluctuations in business
(3) To visualize the pattern of demand and supply in business

Course Learning Outcome

CO1: After completion of this course student will learn about the business indicators.
CO2: Student will understand the business variations over time.
CO3: Student will be capable enough for taking business decisions over different situations.

Unit wise Learning outcomes

UO1: Unit I will enable students to understand constriction of economic indicators.
UO2: Unit II will make student capable to choose the best economic indicator among all.
UO3: Unit III will establish a foundation of understanding business variations.
UO4: Unit IV provides a platform to know about effect of inter-relationship of business variables.
UO5: This Unit V develops capacity to understand demand-supply laws and their relative rate of variations.

UNIT I: Need of Index number, problems in construction of index number, weighted average and price relative indices Laspeare, Paasche, Edge worth-Marshal, Walsch ,Drobish-Bowley, Fisher indices, numerical examples of calculation.
UNIT II: Fixed base and Chain base indices, test of a good index number, time reversal, factor reversal and circular test Classification of index numbers, cost of living index number. Error in measurement of indices. Advantages of indices
UNIT III: Need of time series, components of time Series, Trend, Seasonal, Cyclic and Random fluctuations, models for time series, Applications in business forecasting.
UNIT IV: Measurement of Trend of time series, Graphic and Semi-average methods, moving average method, measurement of seasonal variations, Ratio to trend, Ratio to moving average and Link relative methods.
UNIT V: Basics of Demand analysis, Law of demand and Supply, price elasticity, partial and cross elasticity, Leontief and Pigou method, Engel's Law and Engel curve.

Essential Reading:

1. Gupta S.C, Kapoor V.K., Fundamental of Applied Statistics, Sultan Chand and Sons.
2. Goon, A.M, Gupta M.K. and Dasgupta B.(2002):Fundamental of Statistics, Vol I and II,
3. S.P. Gupta, Fundamental of Statistics, Sultan Chand and Sons.
4. A.K. Sharma, Text book of Index number and Time series, DPH Mathematics Series.
5. S.P. Gupta and M.P. Gupta, Business Statistics, Sultan chand and Sons.
6. D.R. Aderson and Thomas A Williams, Statistics for Business and Economics, Cengage Learning Publication.

E-resource: e-pgpathshal (Forecasting & time series), Swayam: Applied Time series Analysis

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester III (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Semester III	**STAT-DSM-311**	**Sampling Theory & Distributions**	**4**	**0**	**0**	**4**	**IA (Mid) - 40 EA (End Sem) – 60**	**Prof. Diwakar Shukla**

Lectures Hrs. 60

Learning Objectives:

1. To study various theorems and convergence.
2. To study testing of null hypothesis using various methods.
3. To know how to conduct sample survey.
4. To study various sampling techniques.
5. To study some standard estimation methods.

Course Learning Outcomes:

After completion of this course students will be able to find out parametric value (mean, variance etc.) on the basis of random sample with optimal error. Also the students will be able to organize a sample survey and will be able to draw conclusion using statistical tests.

Unit-Wise learning outcome:

UO1: Understanding the properties of sequence of random variables.
UO2: Learning about fundamentals of testing the hypothesis.
UO3: Understanding of need and importance of sampling.
UO4: Learning and application of various sampling schemes.
UO5: Learning about various estimation methods using sampling.

UNIT I: Sequence of random variables convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution. Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre's and Lindeberg - Levy Central Limit Theorem (C.L.T.) for i.i.d. variates, Liapounoff Central Limit Theorem (without proof).
UNIT II: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, null and alternative hypotheses, level of significance, Type I and Type II errors with probabilities and critical regions. Large sample Z-testing of single proportion, difference of two proportions, single mean, difference of two means, Testing of variance and standard deviation. Tests based on Chi-Square, mean tests based on t, variance test based on F distributions.
UNIT II: Population and sample, need for sampling, advantage and disadvantage of census and sample survey. Basic principles of sampling. Types of sampling, Organization aspects of sample survey. Sample selection and sample size determination, preparation of questionnaire, Sampling error and non-sampling errors, confidence interval of mean.
UNIT IV: Simple Random Sampling (SRS) with and without replacement. Some theorems on SRS, Stratified random sampling, proportional and Neyman allocations. Efficiency comparisons with SRS.
UNIT V: Systematic sampling and its variance, Ratio, Product, Difference and Regression methods of estimation, their bias and m.s.e. under simple random sampling with properties and mutual comparisons.

Essential Readings:

1. Gupta S.C., Kapoor V. K (2007).: Fundamental of Mathematical Statistics, S. Chand.
2. Gupta S.C., Kapoor V.K. (2014): Fundamental of Applied Statistics, S.Chand and Sons.
3. Cochran, W.G (1977). : Sampling and Techniques, John Wiley & Sons Inc; 3rd edition.
4. Sukhatme, P.V. and Sukhatme, B.V. (1970) Sampling Theory of Surveys with Applications. Iowa State University Press, Ames.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Sukhatme, P.V. and Sukhatme, BV, Sukhatme, S and Asok, C (1984): Sampling Theory of Surveys with Applications. Indian society for Agriculture Statistics, New Delhi.

Suggested Reading:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V.K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

E-Resource: National Digital Library

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Passed by Board of Studies Dated 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester III (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Semester III	**STAT-DSM-312**	**Statistics Practical - III**	**0**	**0**	**2**	**2**	**IA (Mid) - 40 EA (End Sem) – 60**	**Prof. Diwakar Shukla**

Lectures Hrs. 60

Learning Objectives:

1. To learn to draw random samples from population.
2. To perform statistical tests of significance based on sample.
3. To draw statistical conclusion and decision.
4. To learn various techniques of sampling.
5. To calculate bias and MSE of various estimation methods using sampling.

Course Learning Outcomes:

After completion of this course, students will be able to apply the appropriate statistical tests of significance on different situations. Also, students will learn parameter estimation under different sampling schemes and will be able to draw valid conclusions using sample data.

List of Practicals:

1. Practical on test of significance and confidence intervals using Z- test for single proportion and difference of two proportions
2. Practical on test of significance and confidence intervals using t-test for single mean, difference of two means and paired tests.
3. Practical on testing of significance and confidence intervals for difference of two standard deviations.
4. Practical on exact sample tests based on Chi-Square distribution. Testing goodness of fit.
5. Practical on test of the population variance using F-test.
6. Practical on SRS based on unbiasedness and variance.
7. Practical on stratified sampling and on various types of sample size allocations.
8. Practical on systematic Sampling.
9. Practical on ratio and product estimators for a calculation of biasedness, MSE.
10. Practical on difference estimator and regression.
11. Practical based on comparison of MSE of different estimators on same data.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester IV (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Semester IV	**STAT-DSM-411**	**Statistical Inference**	**4**	**0**	**0**	**4**	**IA (Mid) - 40 EA (End Sem) - 60**	**Prof. R.K.Gangele**

Lectures Hrs. 60

Learning Objectives:

1. To aware students with fundamental of statistical inference.
2. To teach some specific methods of good and efficient estimation.
3. To make aware students about the power of tests of significance.
4. To introduce to students the theory of sequential estimation, testing and application.
5. To study operating characteristics and ASN of a system.

Course Learning Outcomes:

After completing this course student will learn the concept of statistical inference and various methods of estimation related to population parameter. They will also learn obtaining power of different tests of significance for testing sample statistic. Moreover, they will aware about the use and importance of operating characteristic of a system.

Unit-Wise Learning Outcomes:

UO1: Learning of basic characteristics of estimator.
UO2: Learning about procedure of obtaining best estimator.
UO3: Learning about method of obtaining the most powerful statistical test.
UO4: Understanding about the sequential tests.
UO5: Learning about characteristics of sequential tests with applications.

UNIT I: Estimation: concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. complete statistic, minimum variance unbiased estimator (MVUE), Rao-Blackwell theorem and its applications, Cramer-Rao inequality
UNIT II: Methods of Estimation. method of maximum likelihood with properties, interval estimation, confidence limits for normal distribution, basic idea of Bayes estimators.
UNIT III: Principles of test of significance: Null and alternative hypotheses (simple and composite),Type-I and Type-II errors, size and power of test best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma(statement and applications to construct most powerful test).
UNIT IV: Sequential analysis: Sequential probability ratio test (SPRT) for simple v/s simple hypotheses. Fundamental relations among α, β, A and B, determination of A and B.
UNIT V: Wald's fundamental identity, derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.

Essential Readings:

1. Goon A.M., Gupta M.K. Das Gupta. B. (2005), Fundamentals of Statistics, Vol. II World Press, Calcutta.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability andStatistics.2nd Edn. (Reprint) John Wiley and Sons.

Suggested Readings & Links:

1. Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
2. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics, John Wiley & Sons.
3. Mood A.M, Graybill F.A. and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill.
4. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
5. Snedecor G.W and Cochran W.G. (1967) Statistical Methods. Iowa State University Press.
6. V K. Rohatgi (2003): Statistical Inference, Dover Publication
7. Saxena H.C. and M.K. Surendran P.U. (1967) : Statistical Inference, S.Chand

E-Resource: 1. https://nptel.ac.in/courses/111105043/
2. National Digital Library

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Passed by Board of Studies Dated. 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester IV (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 6 Semester IV	**STAT-DSM- 412**	**Statistics Practical – IV**	**0**	**0**	**2**	**2**	**IA (Mid) - 40 EA (End Sem) – 60**	**Prof. R.K. Gangele**

Lecture Hrs. 60

Learning Objectives:

1. To introduce students with fundamental of statistical Inference.
2. To calculate some specific methods of good estimation.
3. To make aware students about the computation of different tests of significance
4. To introduce students with the theory of sequential estimation, with computation testing and analysis.
5. To aware about derivation and computation of operating characteristics with ASN.

Course Learning Outcomes:

After completing this course student will learn the concept and computation of statistical inference and various methods of estimation relating to population parameter. They will also learn calculation and interpretation of different tests of significance for testing sample statistic.

List of Practicals:

1. Practical on unbiased estimators.
2. Practical on consistent estimators, efficient estimators and relative efficiency of estimators.
3. Practical on Cramer-Rao inequality and calculation on MVB estimators.
4. Practical on sufficient estimators - factorization theorem, Rao-Blackwell theorem, complete sufficient estimators.
5. Practical on calculation of maximum likelihood estimation.
6. Practical on calculation on asymptotic distribution of maximum likelihood estimators.
7. Practical on calculation on estimation by the method of moments, minimum Chi-square.
8. Practical on calculation of Type I and Type II errors.
9. Practical on most powerful critical region (NP Lemma).
10. Practical on calculation on uniformly most powerful critical region.
11. Practical on unbiased critical region.
12. Practical on draw of power curves.
13. Practical on likelihood ratio tests for simple null hypothesis against simple and composite alternative hypothesis.
14. Practical on asymptotic properties of LR tests.
15. Practical on SPRT procedure.
16. Practical on draw of OC function and OC curve.
17. Practical on draw of ASN function and ASN curve.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

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Passed by Board of Studies Dated 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester V (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 7 Semester V	**STAT-DSM-511**	**Financial Statistics**	**4**	**0**	**0**	**4**	**IA (Mid) - 40 EA (End Sem) - 60**	**Prof. R.K.Gangele**

Lectures Hrs. 60

Learning Objectives:

(1) To review basics of probability and stochastic processes.
(2) To learn stochastic integration, derivatives.
(3) To understand Stochastic models used in Finance.
(4) To learn Black-Scholes formula used in solving financial problems.
(5) To study Cox-Ross-Rubinstein approach in financial setup.

Course Learning Outcomes:

CO 1: Learn the tools and technique used in financial Statistics.
CO 2: Learn the graphical structure of the financial problems.
CO 3: Learn the stock models and their applications.
CO 4: Learn the Black- Shole formula and Cox-Ross Rubinstein approach.

Unit-Wise Learning Outcomes:

UO1: Learn about the trading pattern of stock market.
UO2: Learn about the basics of stochastic process with applications.
UO3: Learn about the role of pricing with Put & Call options.
UO4: Learn about various computing options in stock models.
UO5: Learn about some standard models with their properties.

UNIT I: Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic processes, Binomial processes, General Random walks, Geometric random walks, Binomial models with state dependent increments.
UNIT II: Tools needed for Option Pricing: Wiener process, stochastic integration and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and Put options, zero-coupon bonds and discount bonds.
UNIT III: Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price. Stochastic models in finance: Discrete time process- binomial model with period one.
UNIT IV: Stochastic models in finance: Continuous time process- geometric Brownian motion. Ito's lemma, Black-Scholes differential equation, Black-Scholes formula for European options, Hedging portfolios: Delta, Gamma and Theta hedging.
UNIT V: Binomial model for European options: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends.

Essential Readings:

1. Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC.

Suggested Readings:

1. Franke, J., Hardle, W.K. and Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rd Edition, Springer Publications.

E Book Link: National digital Library

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester V (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 7 Semester V	STAT-DSM- 512	Statistics Practical – V	0	0	2	2	IA (Mid) - 40 EA (End Sem) – 60	Prof. R.K.Gangele

Lecture Hrs. 60

Learning Objectives:

(1) To develop ability to compute in financial data.
(2) To learn numerical verification of theoretical results in statistical finance.
(3) To learn Stochastic models based calculations in Finance.
(4) To learn Black-Scholes formula based calculations.
(5) To learn Cox-Ross-Rubinstein approach based calculations.

Course Learning Outcomes:

CO 1: Learn the tools and technique of calculation used in financial Statistics.
CO 2: Learn the numerical solutions of financial problems.
CO 3: Learn the stock models and their computational aspects with applications.
CO 4: Learn the Black- Scholes formula and Cox-Ross Rubinstein approach based specific calculation.

List of Practicals:

1. To verify "no arbitrage" principle
2. To verify relationship between spot price, forward price, future price
3. To price future contracts
4. To verify put-call parity for European options
5. To construct binomial trees and to evaluate options using these trees
6. To price options using Black – Scholes formula
7. To hedge portfolios using delta and gamma hedging
8. To hedge portfolios theta hedging
9. Pricing of Call options using binomial model
10. Computation of dividends on call options as a percentage of stock price.
11. Computation of dividends on call options as a fixed amount of money.
12. Pricing of Put options using binomial model
13. Call-put parity for options following binomial models.
14. Effect of dividends on put options.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

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Passed by Board of Studies Dated 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester VI (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 7 Semester VI	**STAT-DSM-611**	**Design of Experiments**	**4**	**0**	**0**	**4**	**IA (Mid) - 40 EA (End Sem) - 60**	**Prof. D. Shukla**

Lectures Hrs. 60

Learning Objectives:

1. To introduce various linear models used in analysis of variance.
2. To teach fundamentals of experimental design and layout and analysis of some basic designs.
3. To introduce and analyze factorial experiments with confounding aspects.
4. To teach CRD and RBD with merits, demerits and applications.
5. To study LSD and relative efficiency comparisons with other designs.

Course Learning Outcomes:

CO 1: Learning of the ANOVA applications.
CO 2: Learning of the fundamentals of design of experiments.
CO 3: Learning of some standard basic designs with mutual merits & demerits.
CO 4: Learning of the factorial experiment with confounding knowledge of missing plot analysis.

Unit-Wise Learning Outcomes:

UO1: Learning of different types of models.
UO2: Learning of fundamental properties of design of experiments.
UO3: Learning about the properties of CRD and RBD.
UO4: Learning of basics of LSD with comparison and handling of missing data case.
UO5: Learning of about the factorial experiment with confounding.

UNIT I: Fundamental of analysis of variance, Fixed, random and mixed effect models. One-way and two-way analysis of variance.
UNIT II: Experimental designs: Terminology, yield, Block, Plot, Treatment, Experimental material, experimental error, basic principles of design, fertility size of plot.
UNIT III: Completely Randomized Design (CRD), Randomized Block Design (RBD). RBD with missing plot analysis, advantages and disadvantages, efficiency comparison.
UNIT IV: Latin Square Design (LSD)–layout, model and statistical analysis, relative efficiency comparison, missing observations critical difference analysis.
UNIT V: Factorial experiments: notations and concepts, 2^2, 2^3factorial experiments, design and analysis. Total and Partial confounding for 2^3 experiments, construction of such experiments in RBD only.

Essential Readings:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
2. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
3. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

Suggested Readings:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.

Links: https://nptel.ac.in/courses/102106051/32

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Passed by Board of Studies Dated 11/06/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
Syllabus as per NEP-2020
B.A./ B.Sc.- Semester VI (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L 7 Semester VI	**STAT-DSM- 612**	**Statistics Practical – VI**	**0**	**0**	**2**	**2**	**IA (Mid) - 40 EA (End Sem) – 60**	**Prof. D. Shukla**

Lecture Hrs. 60

Learning Objectives:

1. To calculate sum of squares using linear models used in analysis of variance.
2. Calculations and interpretation using CRD, RBD, LSD.

Course Learning Outcomes:

CO 1: Learn the ANOVA application using data analysis.
CO 2: Learn the fundamentals of design of experiments with data analysis.

List of Practicals:

1. Analysis of one-way ANOVA.
2. Analysis of two-way ANOVA.
3. Analysis of a CRD.
4. Analysis of an RBD.
5. Analysis of an LSD
6. Analysis of an RBD with one missing observation.
7. Analysis of an LSD with one missing observation.

There will be 8 marks on Viva-voce and 7 marks on practical records in the End sem in MM60.

11.6.24 DShukla 11/6/24

Passed by Board of Studies Date 11/06/24

School Board Meeting held on 14th June, 2024

The School Board has approved the minute of meeting of BOS of Department of Mathematics and Statistics held on 11/06/2024.

Prof. A.K. Saxena
External Member
Department of Mathematics, Maharaja Chhatrasal University, Chhatarpur (M.P.)

Prof. K.S. Varsney
External Member
HoD Physics, D.S. College, Aligarh, U.P.

Prof. Narendra Pandey
External Member
Department of Physics,
University of Lucknow (U.P.)

Prof. Diwakar Shukla
Member
HoD, Department of Mathematics & Statistics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Ashish Verma
Member
HoD, Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. R.K. Rawat
Member
Department of Applied Geology,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Ranveer Kumar
Member
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. U.K. Patil
Member
Department of Pharmaceutical Science,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Abhishek Bansal
Member & Associate Professor
HoD, Department of Computer Science & Applications
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. U.K. Khedlekar
Member & Associate Professor
Department of Mathematics & Statistics,
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Rekha Garg Sonaki
Member & Associate Professor
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. Kamal Kant Ahirwar
Member & Assistant Professor
Dept. of Computer Science & Applications
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Mahesh Kumar Yadav
Member & Assistant Professor
Department of Physics
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