Department
of
Mathematics and Statistics

School of Mathematical and Physical Science

Curriculum Framework
M.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 Department:

The Department of Mathematics and Statistics was established at very beginning of the establishment of year 1946.The founder of the university and the founder vice-Chancellor Dr. Harisingh Gour had himself appointed Mr. R.B. Rabugunday as the first Head of Department. Mr. Rabugunday was a scholar of Madras University and was Wrangler of Cambridge tradition.

Scope :

Statistics is the base of all applied sciences. It has predictive approach, computing approach and modeling approach for social, biological, anthropological and management sciences. Students possessing degrees in M.Sc.(Statistics), Ph.D.(Statistics) have a large numbers of job opportunities in fields of Banking, Teaching, Data analyst, Software testing, machine learning, artificial intelligence, Actuaries, Defense analyst, Statistical Assistant ,Statistical officer, Market researcher , Survey organizer etc. Students can also get administrative jobs through UPSC (like ISS).

The course is designed as the student can get employment worldwide. It has multidisciplinary and skill enhancement courses with computer based analytical proficiency.

1. **Name of the Program** : M.Sc. (Statistics)
2. **(A) Objectives**

   (i) To develop trained manpower for data analysis.

   (ii) To develop trained manpower for coping challenges of Data Science and machine learning.

   (iii) To produce students who can serve nation-wide as Statistics Administrator (like officer of Indian Statistics Services).

(B) Program Learning Outcomes:

(a) After completion of this Program, student will be capable enough to handle the data with interpretation and effective analysis.

(b) He can be placed as Data Scientist in private sectors, can be placed in banking sector like Reserve bank of India

(c) He can get opportunity as District Statistical Officer, Statistical Assistant and Data Analyst in Pharmaceutical companies.

(d) He may get jobs in public and private survey organizations like NSSO, MARG, C-voter etc.

(e) After qualifying NET examination and completing the Ph.D. degree, student may be placed in faculty position in universities and colleges.

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3. **Duration of Program** : Four Semesters (with multiple entry and exit) .
4. **Exit:** After exit of completing one year the degree of **Postgraduate Diploma in Statistics** will be provided.
5. **Medium of instruction :** Hindi and English.
6. **Intake : 20 seats**
7. **Eligibility for Admission:** B.Sc. with Statistics as a subject.
8. **Fee** : Same as in other PG courses of Science stream (with Lab Fee)
9. **Structure of Program:** The Program includes various courses in the duration of four semesters including discipline specific, elective papers and skill based papers. The pedagogic approach will be through lectures, field project, seminars, visit to statistical organization, assignments, dissertation, group discussion etc.
10. **Scheme of Evaluation:**

(a) Mid Semester Examination	:	20 marks
(b) Internal Assessment	:	20 marks
(c) End Semester Examination	:	60 marks
	Total :	100 marks

All rules and regulation mentioned in University Ordinance and practices used for running PG programs in science streams shall be applicable. The already running course of M.Sc. (Mathematics) shall be a model of reference wherever and whenever required to discuss.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
Scheme of M.Sc. (Statistics) Program

Syllabus for Sem. I, II, III and IV (Under NEP-2020, Level 8 and 9)

	Paper Code	Title of Paper	Credit	Contact Hours
(Level 8) SEM I	STAT-DSM-121	Algebra	4	60
	STAT-DSM-122	Real Analysis	4	60
	STAT-SEC-121	Survey Sampling and Field work	4	60
	STAT-DSM-123	Statistics Practical –I	4	60
		Opt any one of following		
	STAT-MDM 121	Statistical Computing using Softwares	4	60
	STAT-MDM-122	Linear Models and Regression Analysis	4	60
	STAT-MDM-123	Mathematical Finance	4	60
(Level 8) SEM II	STAT-DSM-221	Statistical Inference – I	4	60
	STAT-DSM-222	Stochastic Processes	4	60
	STAT-SEC-221	Multivariate Analysis using software	4	60
	STAT-DSM-223	Statistics Practical –II	4	60
		Opt any one of following		
	STAT-MDM-221	Distribution Theory	4	60
	STAT-MDM -222	Design and Analysis of Experiments	4	60

	Paper Code	Title of Paper	Credit	Contact Hours
(Level 9) SEM III	STAT-DSM- 321	Operational Research- I	4	60
	STAT-DSM-322	Econometrics	4	60
	STAT-SEC-321	Project Work-I	4	60
	STAT-DSM-323	Statistics Practical-III	4	60
		Opt any one of following		
	STAT-MDM-321	Demography	4	60
	STAT-MDM-322	Numerical Analysis-I	4	60

	Paper Code	Title of Paper	Credit	Contact Hours
(Level 9) SEM IV	STAT-DSM-421	Operational Research- II	4	60
	STAT-DSM-422	Statistical Quality Control	4	60
	STAT-SEC-421	Project Work- II	4	60
	STAT-DSM-423	Statistics Practical-IV	4	60
		Opt any One of following		
	STAT-MDM-421	Official Statistics	4	60
	STAT-MDM-422	Time Series Analysis	4	60
	STAT-MDM-423	Statistical Inference - II	4	60

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Department of Mathematics and Statistics
M.Sc.–I Semester (Statistics)

STAT-DSM-121	ALGEBRA	L	T	P	C
		3	1	0	4
		Max.Marks-100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the basic features of Advanced Abstract algebra.
2. To teach class equation, P-group and Sylow's theorem.
3. To teach solvable and nilpotent groups.
4. To introduce Galois Theory

Course Learning Outcomes:

After completion of this course students will understand the composition series.

CO1: Understand Jordan- Holder theorem, solvable groups, nilpotent groups.

CO2: understand field extension and Galois Theory and solvability of polynomial equation using the Galois theory.

Unit Wise Learning Outcomes:

UO1. To learn about Class equation, p-group, Sylow theorem.
UO2. To learn about normal series, solvable group and nilpotent group.
UO3. To learn about Rings.
UO4. To learn about polynomial rings and its application.
UO5. To learn about Galois theory and example.

Unit-I	**(12 hours)**
Inner Automorphism, Characteristic Subgroup, Conjugate element, Conjugate class of H in G, Class equation, p-groups, Sylow p-subgroups, Sylow theorems.	
Unit-II	**(12 hours)**
Normal series, subnormal series of group, composition series, Jordan- Holder theorem, solvable groups, nilpotent groups.	
Unit- III	**(12 hours)**
Rings, Subrings, Sum of two subrings, Product of Rings, Ideals, Sum and product of two Ideals, Prime and maximal ideals, Quotient rings, Homomorphisms and imbedding of rings, Unique factorization domain (UFD), Principal ideal domain (PID), Euclidean domain, Polynomial rings.	
Unit-IV	**(12 hours)**
Irreducible polynomial, Gauss lemma, Einstein criterion, Adjunction of roots, Algebraic extensions, Algebraically closed fields. Splitting fields, Uniqueness of splitting fields, Normal extensions, Multiple roots, Finite fields, Separable & inseparable extensions.	
Unit-V	**(12 hours)**
Fields, Subfields, Automorphism groups and fixed fields, Dedekind lemma, Fundamental theorem of Galois theory and example.	

Essential Readings:

1. N. Jacobson, Basic Algebra, Vol. I, II & III Hindustan Publishing Company.
2. S. Lang, Algebra, Addision-Wisley.
3. I.S. Luther & IBS Passi, Algebra Vol. I, II & III Narosha Pub. House, New Delhi.
4. M. Artin, Algebra, Prentice- Hall of India, 1991.

Suggested Readings

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University press.
2. I.N. Herstein, Topic in Algebra, Wiley Eastern, New Delhi.

Essential e-Recourse

1. https://www.cs.columbia.edu/~nadimpalli/data/AAL-Notes.pdf
2. https://archive.nptel.ac.in/courses/111/105/111105112/
3. https://nptel.ac.in/courses/111106113
4. https://www.youtube.com/watch?v=iobTKR4-19o
5. https://www.youtube.com/watch?v=MVojEjXdVgA

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Dr. HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. I Semester (Statistics)

STAT-DSM-122	REAL ANALYSIS	L	T	P	C
		3	1	0	4
		Max.Marks-100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives

1) To explain fundamentals of Riemann-Stieltjes integration and its uses.
2) To introduce the Rearrangement of series, Riemann's rearrangement theorem.
3) To explain sequence and series sequence of functions, uniform convergence.
4) To explain the Inverse function and its applications with concept of extremum in several variable

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

CO1: Learn R-S integrability and its relation with uniform convergence.
CO2: Understand rearrangement and Riemann rearrangement theorem.
CO3: To learn partial, directional derivative and derivative of functions from R^n to R^m .

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

UO1: Evaluate the integral of a function with respect to an increasing function integrals.
UO2: Interpret meaning of rearrangement of infinite series and its examples.
UO3: Understand the concepts of uniform and point wise convergence and its consequences.
UO4: Understand the differentiability of functions of several variables and related theorems.
UO5: Understand proof of inverse function theorem and Lagrange multiplier method for extremum problems.

Unit-I	**(12 hours)**
Definition and existence of Riemann-Stieltjes integral, Conditions for R-S integrability. Properties of the R-S integral, R-S integrability of functions of a function. Improper integrals and test for convergence.	
Unit-II:	**(12 hours)**
Rearrangements of terms of a series, Riemann's theorem, Dirichlet's theorem. Sequences and series of functions, point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence.	
Unit-III:	**(12 hours)**
Uniform convergence and continuity, uniform convergence and R-S integration; uniform convergence and differentiation, Power series, uniqueness theorem for power series.	
Unit-IV:	**(12 hours)**
Functions of several variables, derivatives in an open subset of R^n, derivative as linear transformations, directional derivative, chain rule; Partial derivatives, interchange of the order of differentiation, derivatives of higher orders.	
Unit-V:	**(12 hours)**
Taylor's theorem, inverse function theorem, implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.	

Essential Readings:

1. T.M. Apostal: Mathematical analysis, Narosa, 1985.
2. H.L. Royden: Real Analysis, Macmillan (Indian Edition).

Suggested Readings:

1. Walter Rudin: Principles of Mathematical Analysis, McGraw Hill.
2. Terence Tao, Analysis I, Hindustan Book Agency (third edition), 2014.
3. Terence Tao, Analysis II, Springer and Hindustan Book Agency (third edition), 2015.

E- Resource :

1. https://nptel.ac.in/courses/111106053
2. https://nptel.ac.in/courses/111105098
3. https://ocw.mit.edu/courses/18-100a-real-analysis-fall-2020/#:~:text=Course%20Description,the%20interchange%20of%20limit%20operations.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
M.Sc.- I Semester (Statistics)

STAT-SEC- 121	Survey Sampling and Field work	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To understand the concept population and drawing appropriate sample.
(2) To learn various methods of drawing good samples and conducting field work.
(3) To learn procedure of getting the best method for sample estimate.
(4) To be aware of various sampling strategies.

Course Learning Outcomes: After completion of this course the students will be able to

CO1: Understand various types of sampling procedures and their mutual relative merits with adequate applications.
CO2: Student will be capable enough to design a questionnaire and perform field work as survey for data collection.

Unit Wise Learning Outcomes:

UO1. Aware about theory of advance procedure of sampling.
UO2. Learning of intense methods of stratification.
UO3. Understanding of PPS sampling.
UO4. Learning of use of auxiliary information in advance sampling
UO5. Awareness about randomized response techniques.

Unit – I: **(12 hours)**

Concept of Fixed population and super-population approaches. Concepts and distinct features of probability sampling and non – probability sampling schemes, sampling designs and sampling error. Review of some important results in SRSWOR and SRSWR related to the estimation of population mean/total and proportions.
Questionnaire Preparation and field work.

Unit – II: **(12 hours)**

Estimation of population mean/total in stratified populations, Allocation problem in stratified random sampling (i) for fixed cost and (ii) for specified precision and corresponding expressions for variance of stratified sample mean. Post stratification, Deep stratification

Unit – III: **(12 hours)**

Unequal probability sampling: PPSWR/PPSWOR methods of sample selection (including cumulative total method and Lahiri's scheme). Comparison of SRSWR and PPSWR schemes. Ordered estimators of Des Raj and Murthy (for n=2). Construction of unordered estimators from ordered estimators. Horvitz Thompson's estimator of a finite population total/mean. Expressions for variance of Horvitz Thompson's estimator and their unbiased estimators. Issue of negativity of estimated variance and its resolution.

Unit – IV: **(12 hours)**

Double sampling scheme: Ratio, regression and product estimators in double sampling and their comparison with estimators with known population mean of auxiliary variable. Some unbiased ratio type estimators for population mean. Successive Sampling.

Unit –V: **(12 hours)**

Concept of cluster sampling, two stage sampling with equal cluster sizes, interpenetrating sub-sampling. Kinds of non-sampling errors with special reference to non-response problems. Hansen and Hurwitz estimator for population mean. Concept of randomized response and some well-known randomized response techniques for sensitive characteristics.

Essential Readings:

1. Cochran, W.G.: Sampling Techniques (3rd edition. 1977), Wiley.
2. P.V Sukahtme, B.V. Sukhatme, S. Sukhatme and C.Asok: Sampling Theory of Surveys with Applications, ISAS Publication, New Delhi

Suggested Readings and Links:

1. Singh D. and Chaudhary, F.S. (1986): Theory and Analysis of Sample Survey Designs, New Age International
2. M.N. Murthy, Theory and Methods, Statistical Publishing Society, Calcutta

E-Books: National Digital Library

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
M.Sc.–I Semester (Statistics)

STAT-DSM- 123	Statistics Practical - I	L	T	P	C
		0	0	4	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To provide data based practical training to students
(2) To enhance computational ability of students

Course Learning Outcomes:

CO1: After completion of this course students will understand the calculation aspect.
CO2: Theoretical imaginations will be converted into reality.

The practicals will be based on theory papers and list will be decided by the course coordinators. There will be 8 marks for viva-voce and 7 marks for practical records in End. Sem (MM 60).

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
M.Sc..–I Semester (Statistics)

STAT-MDM-121	Statistical Computing using Software	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives: (1) To develop the skill of programming.
(2) To learn idea of data analysis.
(3) To learn about making interpretation on the analysis outcome.

Course Learning Outcomes: After completion of this course the students will be able to
CO1: understand the basic concept of computing
CO2: practice for applications of Statistical tools.

Unit Wise Learning Outcomes:
UO1. Learning of basics of programming language.
UO2. Learning of Python language.
UO3. Learning of control statement in language.
UO4. Learning of R language.
UO5. Learning solution of the numerical analysis problem.

Unit – I:	**(12 hours)**
Programming in a high level language such as C (preferred).	
Unit – II:	**(12 hours)**
Syntax ,basics of R programming and Python programming.	
Unit – III:	**(12 hours)**
Topics include simple syntax, loops, pointers and arrays, functions, input/output, and linking to databases.	
Unit – IV:	**(12 hours)**
Numerical analysis and statistical applications using R and Python. Computation using software in probability, statistics and data analysis.	
Unit –V	**(12 hours)**
Computing in numerical integration, root extraction, random number generation, Monte Carlo integration, and matrix operation computations using software.	

Essential Readings:

1) G.H. Givens and J.A. Hopping, Computational Statistics (2005), Wiley Publication.
2) W.J. Kindley and J.E.Gentle, Statistical Computing (1980), Tayler and Francis.

Suggested Reading and Links:

1) J. Voss, Introduction to Statistical Computing-A simulation based approach, Wiley series.
2) R.A. Thisted, Elements of Statistical Computing.

E-Books Link: National Digital Library.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
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Department of Mathematics and Statistics
M.Sc..–I Semester (Statistics)

STAT-MDM- 122	Linear Models and Regression Analysis	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives : (1) To understand the concept of linear models applicable in different fields.
(2) To learn about problems and issues while using linear models.
(3) To learn about hidden properties in linear models.

Course Learning Outcomes: After completion of this course the students will be able to learn
CO1: about concept, analysis of establishing the linear models.
CO2: properties of linear models applicable in different fields of real life.

Unit Wise Learning Outcomes:
UO1. Learning about linear models.
UO2. Learning about generalized inverse of a matrix.
UO3. Learning about one-way, two-way classifications.
UO4. Learning about use of multiple regression analysis.
UO5. Learning about use of Ridge regression.

Unit I:	**(12 hours)**
Gauuss-Markov linear models, estimable functions, error and estimation space, normal equations and least square estimators, estimation of error variance, estimation with correlated observations, properties of least square estimators.	
Unit - II:	**(12 hours)**
Generalized inverse of a matrix and solution of normal equations, variances and covariances of least square estimators.	
Unit - III:	**(12 hours)**
One way and two-way classifications, fixed, random and mixed effects models. Analysis of variance (two-way classification only), Multiple comparison tests due to Tukey, Scheffe and Student Newmann-Karl.	
Unit - IV:	**(12 hours)**
Simple linear regression, multiple, regression, fit of polynomials and use of orthogonal polynomials. Residuals and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers. Remedies.	
Unit - V:	**(12 hours)**
Multi co-linearity, ridge regression, sub-set selection of explanatory variables, Mallows CP Statistics.	

Essential Readings:
1) Goon, A.M., Gupta, M.K. and Das Gupta, B. (1967): An Outline of Statistical Theory, Vol. 2, The World Press Pvt. Ltd., Calcutta.

Suggested Readings:
1) Graybill, I.A. (1961): An Introduction to Linear Statistical Models, Vol. 1, McGraw Hill Book Co. Inc.

E-Books: National Digital Library.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.- I–Semester (Statistics)

STAT-MDM-123	Mathematical Finance	L	T	P	C
		3	1	0	4
		Max.Marks-100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:
(1) To study random variable and its properties.
(2) To understand Trinomial processes & Brownian motion.
(3) To explain transition Wiener processes & Forward contracts.
(4) To study standard pricing models in the term of Black-Scholes options.
(5) To understand Arbitrage relationship for American options.

Course Learning Outcomes:
(1) After completion of this course the students will understand the basic concept of different models and use in daily life.
(2) To financial advisor in Mutual finance.
(3) To useful in stock trading company.
(4) To stock technical analysis for investor.

Unit Wise Learning Outcomes:
UO1. Learning of probability setup including random variables.
UO2. Learning about stochastic process.
UO3. Understanding of stock market variations.
UO4. Knowledge of various solution approaches.
UO5. Learning of advance methodologies used in mathematical finance.

Unit-I: **(12 hours)** Probability & conditional probability, Random variables, Expectation and conditional expectation, Variance & Covariance, correlation. Normal random variable and its properties. The central limit theorem.
Unit-II: **(12 hours)** Stochastic processes in discrete time, Binomial processes, Trinomial processes, General random walks, Geometric random walks. Binomial models with state dependent increments. Brownian motion.
Unit - III: **(12 hours)** Stochastic integration, Stochastic differential equations. The stock price as a stochastic process. Option pricing, Wiener processes. Derivatives, Forward contracts, spot price, forward price, future price, call & put options.
Unit - IV: **(12 hours)** Ito's lemma, Black-Scholes options pricing model, Binomial model for European options, Cox-Ross Rubinstein approach.
Unit - V: **(12 hours)** Pricing contract via arbitrage. The arbitrage theorem. Arbitrage relationship for American options.

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 links: National Digital Library.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–II Semester (Statistics)

STAT-DSM-221	Statistical Inference - I	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To understand inferential aspect of statistics.
(2) To understand about the best estimate.
(3) To know the basics of decision problems under different situations.

Course Learning Outcomes:

After completion of this course, student will be:

CO1: capable enough to draw inference under situation of uncertainty.
CO2: will be capable enough to estimate parameter under probabilistic environment using sample.

Unit Wise Learning Outcomes:

UO1. Learning of theorems on parameter estimation.
UO2. Learning about properties of estimators.
UO3. Learning of asymptotic properties and applications.
UO4. Learning decision problems based on Bayes rule.
UO5. Learning the construction and application of mini-max estimators.

Unit I: **(12 hours)** Extension of Cramer-Rao inequality for Single parameter with their extension for multi-parameter case, Bhattacharya bounds, information in data about the parameters as variation in likelihood function.
Unit II: **(12 hours)** Ideas of sufficient and minimal complete-sufficient statistics, sufficiency when the range of variate depends on parameter, minimum variance unbiased estimators, Rao-Blackwell and Lehman-Scheffe theorems, examples based on some standard distributions.
Unit III: **(12 hours)** Asymptotic properties of maximum likelihood estimators, solution of likelihood equations, method of scoring using Newton Raphson method, Method of moments ,Method of minimum Chi-square
Unit IV: **(12 hours)** General decision problems, loss function, risk function, estimation and testing viewed as general decision problems, minimax decision, Bayes decision, least favourable prior, Bayes estimation under squared error loss,
Unit V: **(12 hours)** Non-parametric test, need for non -parametric tests, sign test, Wilcoxon sign rank test, Run test, Median test

Essential Readings:

1) Kale, B.K. (1999): A First Course on Parametric Inference, Narosa Publishing House.
2) Rohatgi, V.K. (1988): An Introduction to Probability and Mathematical Statistics, Wiley Eastern, New Delhi.

Suggested Readings and links:

1. Lehmann, E.L. (1986): Theory of Point Estimation, Student Edition.
2. Lehmann, E.L.(1986): Testing Statistical Hypotheses, Student Editions.
3. Rao, C.R. (1973): Linear Statistical Inference and its Applications, Wiley Eastern.
4. Ferguson, T.S. (1967): Mathematical Statistics, Academic Press.
5. Zacks, S. (1971): Theory of Statistical Inference, Wiley, New York.

E Books Link: National Digital Library.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–II Semester (Statistics)

STAT-DSM-222	Stochastic Processes	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:
(1) To understand the concept of stochastic process.
(2) To learn about problems and issues in stochastic process.
(3) To learn about hidden properties in stochastic process.

Course Learning Outcomes: After completion of this course the students will be able
CO1: to know the concepts and properties of stochastic processes.
CO2: to understand the fitting and application of stochastic processes in real world problems.

Unit Wise Learning Outcomes:
UO1. Learning of classifications of stochastic processes.
UO2. Learning of gambler problem and random walk.
UO3. Learning of some specific types of stochastic processes.
UO4. Learning about stationery stochastic processes.
UO5. Understanding about statistical inference using Markov processes.

Unit – I:	**(12 hours)**
Introduction to stochastic processes (SPS): Classification of SPs according to state space and time domain. Countable state Markov chains (MC's), Chapman-Kolmogorov equations; calculation of n-step transition probability and its limit.	
Unit – II:	**(12 hours)**
Stationary distribution, classification of states; transient MC; random walk and gambler's ruin problem; Applications from social, biological and physical sciences.	
Unit – III:	**(12 hours)**
Discrete state space continuous time MC: Kolmogorov – Feller differential equations; Poisson process, birth and death process; Wiener process as a limit of random walk; first-passage time and other problems.	
Unit – IV:	**(12 hours)**
Renewal theory: Elementary renewal theorem and applications. Statement and uses of key renewal theorem; study of residual life time process. Stationary process; weakly stationary and strongly stationary processes;	
Unit – V:	**(12 hours)**
Branching process: Galton-Watson branching process, probability of ultimate extinction, distribution of population size. Martingale in discrete time, inequality, convergence and smoothing properties. Statistical inference in MC and Markov processes.	

Essential Readings:
1) Medhi, J. (1982): Stochastic Processes, Wiley Eastern.

Suggested Readings :
1) Adke, S.R. and Manjunath, S.M. (1984): An Introduction to Finite Markov Processes, Willey Eastern.
2) Bharat, B.R. (2000): Stochastic Models: Analysis and Applications, new Age International, India.

E-Books Link: National Digital Library.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–II Semester (Statistics)

STAT-SEC-221	Multivariate Analysis using Software	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives: (1) To understand the concept of mutual effect of many variables.
(2) To learn about problems and issues while dealing with many variables.
(3) To learn about hidden properties in a multivariate system.

Course Learning Outcomes:

After completion of this course the students will be able to

CO1: understand the basics of multivariate theory.
CO2: study the interaction effects of multiple hidden factors in statistical analysis.

Unit Wise Learning Outcomes:

UO1. Learning of multivariate normal distribution and its properties.
UO2. Learning of null and non-null distribution of multiple correlation coefficient.
UO3. Learning of Hotelling T and distribution.
UO4. Learning about classification problems.
UO5. Learning about principle components.

Unit–I: **(12 hours)** Multivariate normal distribution and its properties. Random sampling from multivariate normal distribution. Maximum likelihood estimators of parameters, distribution of sample mean vector. Analysis using software.
Unit–II: **(12 hours)** Wishart matrix – its distribution and properties, distribution of sample generalized variance, null and non-null distribution of multiple correlation coefficient.
Unit–III: **(12 hours)** Hotelling's T-square and its sampling distribution, application in test on mean vector for one and more multivariate normal population and also on equality of components of a mean vector in multivariate normal population.
Unit–IV: **(12 hours)** Classification problem: Standards of good classification, procedure of classification based on multivariate normal distributions.
Unit–V **(12 hours)** Principal components, dimension reduction, canonical variate and canonical correlation— definition, use, estimation and computation. Analysis using software.

Essential Readings:

1) Anderson, T.W. (1983): An Introduction to Multivariate Statistical Analysis, 2nd Ed., Willey.
2) Giri, N.C. (1977): Multivariate Statistical Inference, Academic Press.

Suggested Readings and Link:

1) Kshirsagar, A.M. (1972): Multivariate Analysis, Marcel Dekker.
2) Morrison, D.F. (1976): Multivariate Statistical Methods, 2nd Ed. McGraw Hill.
3) Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, J. Wiley.
4) Rao, C.R. (1973): Linear Statistical Inference and its Applications, 2nd Ed. Wiley.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–II Semester (Statistics)

STAT-DSM- 223	Statistics Practical-II	L	T	P	C
		0	0	4	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To provide data based practical training to students.
(2) To enhance computational ability of students.

Course Learning Outcomes:

CO1: After completion of this course students will understand the calculation aspect
CO2: Theoretical imaginations will be converted into real learning.

The practicals will be based on theory papers and list will be decided by the course coordinators. There will be 8 marks for viva-voce and 7 marks for practical records in End. Sem (MM 60).

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
M.Sc.–II Semester (Statistics)

STAT-MDM-221	Distribution Theory	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives: (1) To understand the concept of probability distribution.
(2) To learn about problems and issues of specific distributions.
(3) To learn about hidden properties in linear models.

Course Learning Outcomes: After completion of this course students will be able to
CO1: understand the properties of distributions
CO2: learn applications, role, functions and importance of Order Statistics.

Unit Wise Learning Outcomes:
UO1. Learning of some basic distributions with properties.
UO2. Learning of transformation of variables.
UO3. Learning about application of distributions for problem solving.
UO4. Learning of sampling distributions.
UO5. Learning of order statistics and application.

Unit – I: **(12 hours)** Brief review of basic distribution theory, joint, marginal conditional p.m.f.'s and p.d.f's, standard discrete and continuous distributions, bivariate normal, bivariate exponential, multivariate normal and multinomial distributions,
Unit – II: **(12 hours)** Functions of random variables and their distributions using Jacobian of transformation and other tools
Unit – III: **(12 hours)** Compound, truncated and mixture distributions, multiple and partial correlations, linear and multiple regressions. Markov, Holder, Jensen, Liapunov inequalities.
Unit – IV: **(12 hours)** Sampling distributions, non-central chi-square, t and F distributions and their properties. distributions of quadratic forms under normality and related distribution theory.
Unit – V: **(12 hours)** Order statistics, their distributions and properties, joint and marginal distributions of order statistics, extreme values and their asymptotic distributions (statement only) with applications. approximating distributions Delta method and its applications, approximating distributions of sample moments, transformations of statistics.

Essential Readings:
1. Rohatagi, V.K. (1984): An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.

Suggested Readings:
1. Rao, C.R. (1973); Linear Statistical Inference and its Applications, Wiley Eastern.
2. Pitman, J. (1993): Probability, Narosa Publishing House.
3. Jonson, S. and Kotz, S. (1972): Distribution in Statistics Vol. I-II & III, Houghton and Mifflin.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. –II Semester (Statistics)

STAT-MDM-222	Design and Analysis of Experiments	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learnig Objectives: (1) To understand the concept and importance designing an experiment.
(2) To learn how to choose a best design for conducting an experiment.
(3) To learn analytical aspect and experimental error reduction procedure for a design.

Course Learning Outcomes: After student will be able to
CO1: understand the effectiveness of designing an experiment with merits and demerits.
CO2: learn the comparison of one design with other under occurrence of experimental error.

Unit Wise Learning Outcomes:
UO1. Learning of analysis of covariance in CRD and RBD.
UO2. Learning of theory of block designs.
UO3. Knowledge of Factorial effects with partial and complete confounding.
UO4. Awareness about split plot designs.
UO5. Learning of response surface in design of experiments.

Unit–I: **(12 hours)** Review of linear estimation and basic designs, missing plot technique:- General theory and applications, Analysis of Co-variance for CRD and RBD
Unit–II: **(12 hours)** Incomplete block design: Balanced incomplete block designs, simple lattice designs, Two associate partially balanced incomplete block designs: association scheme and intra-block analysis, group divisible designs.
Unit–III: **(12 hours)** General factorial experiments, factorial effects; best estimates and testing the significance of factorial effects; study of 2n and 3r factorial experiments in randomized blocks; complete and partial confounding,
Unit–IV: **(12 hours)** Construction of symmetrical confounded factorial experiments, fractional replications for symmetrical factorials, split plot and strip-plot experiments.
Unit–V: **(12 hours)** Application areas: Response surface experiments; first order designs, and orthogonal designs; clinical trials, treatment-control designs; model variation and use of transformation; Tukey's test for additivity.

Essential Readings:

1. Alok Dey (1986): Theory of Block Designs, Wiley Eastern.
2. Das, M. and Giri, N. (1979): Design and Analysis of Experiments, Wiley Eastern.

Suggested Readings:

1. Montgomery, C.D. (1976): Design and Analysis of Experiment, Wiley, New York
2. Giri (1986): Analysis of Variance, South Asian Publishers.

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Passed by Board of Studies Dated. 11/6/24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. –II Semester (Statistics)

STAT-DSM-321	Operations Research - I	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

(1) To study the tools and techniques for finding solutions under constraints of resources.
(2) To understand the demand, storage, supply and profit in business.

Course Learning Outcomes:

After completion of this course student will learn
CO1: application of optimality under constraints
CO2 : understanding on constraint based solution
CO3: understanding on project management.

Unit Wise Learning Outcomes:

UO1. To learn the optimization techniques
UO2. To learn the application of LPP methods
UO3. To be capable enough for project evaluation
UO4. To learn about transport and task optimization
UO5. To develop analytical capability in network analysis.

Unit I: Operations research and its scope. Necessity of Operations Research in Industry. Linear Programming Problem. Graphical Method, Simplex method.	**(12 hours)**
Unit II: Convex sets, theory of the simplex method, revised simplex method. Two phase simplex method, Big-M method, duality and dual simple method and sensitivity analysis.	**(12 hours)**
Unit III: Inventory models, Economic order quantity models with constant rate of demand. Production lot size model with shortage Buffer stock.	**(12 hours)**
Unit IV: Transportation problem-initial basic feasible solution. Initial Basic Feasible Solution by North-west Corner method, Matrix minima method and Vogel's approximation method. Optimal solution, degeneracy in transportation problems. Assignment Problems: Hungarian Method for solution, Crew based problems, Travelling – Salesman (Routing) problems.	**(12 hours)**
Unit V: Network analysis Shortest path problems, minimum spanning tree problems. Critical path method, Project evaluation and review technique.	**(12 hours)**

Essential Readings:

1. H.A. Taha, Operations Research- An Introduction, Macmillian. Publishing INC, New- York
2. F.S. Hiller & GJ Lieberman, Introduction to Operation Research, (sixth-edition), McGraw Hill International Edition

Suggested Readings and links:

1. J C Pant, Operations Research and optimization, Jain publisher (7th Edition)
2. S. D Sharma, Operation Research, Kedar Nath Ram Sons & co publisher Meerut (13th edition) 2001.
3. Kanti Swaroop, PK Gupta & Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–III Semester (Statistics)

STAT-DSM-322	Econometrics	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

(1) To learn the generalized linear models and their applications.
(2) To learn the statistical models used in economics.
(3) To understand problem of interrelationship and conditional dependencies of variable.
(4) To be capable for generating economic model.
(5) To develop analytical capability for solution of equations.

Course Learning Outcomes:

After completion of this course students will understand the
CO1: development of Econometric models and their applications.
CO2: Inter-relationship among economic variables and analysis of their hidden effects.

Unit Wise Learning Outcomes:

UO1. Learning of GLM and OLS with disturbance.
UO2. Learning of BLUE and multicolinearity.
UO3. Learning of stochastic regression and lag model.
UO4. Learning of identification problem with rank and order conditions.
UO5. Learning of simultaneous equation model with recursive system.

Unit I: **(12 hours)** Nature of econometrics, the general linear model (GLM) and its extensions, ordinary least squares (OLS) estimation and prediction, generalized least squares (GLS) estimation and prediction, heteroscedastic disturbances, pure and mixed estimation.
Unit II: **(12 hours)** Auto correlation, its consequences and tests. Theil BLUS procedure, estimation and prediction, multicollinearity problem, its implications and tools for handling the problem, ridge regression.
Unit III: **(12 hours)** Linear regression and stochastic regression, instrumental variable estimation. errors in variables, autoregressive linear regression, lagged variables, distributed lag models, estimation of lags by OLS method, Koyck's geometric lag model.
Unit IV: **(12 hours)** Simultaneous linear equations model and its generalization, identification problem, restrictions on structural parameters, rank and order conditions.
Unit V: **(12 hours)** Estimation in simultaneous equations model, recursive systems, 2 SLS estimators.

Essential Readings:

1. Apte, P.G. (1990): Text books of Econometrics, Tata McGraw Hill.
2. Cramer, J.S. (1971): Empirical Econometrics, North Holland.
3. Gujarathi, D. (1979): Basic Econometrics, McGraw Hill.

Suggested Readings and links:

1. Intrulligator, M.D. (1980): Econometric models—Techniques and applications, Prentice Hall of India.
2. Johnston, J. (1984): Econometric methods. Third edition, McGraw Hill.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–III Semester (Statistics)

		L	T	P	C
STAT-SEC- 321	**Statistics Project-I**	**0**	**0**	**4**	**4**
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To train students for data analysis.
(2) To train students for use of statistical software.
(3) To develop skill of interpretation using data.
(4) To learn art of report writing after data analysis.

Course Learning Outcomes:

After completion of this course students will learn how to analyse data,
CO1: how to write interpretation,
CO2: how to present data in graphical form in the final report.

The Project will be based on primary or secondary statistical data analysis (or research based statistical analysis) and topic will be decided by course coordinators. A report (in binded/spiral-binded form) duly signed by the course coordinators and HOD both, have to be submitted by the students, with an attached certificate declaring that the content of project is their original contributions. The evaluation (in MM60) of the project work is to be done by a committee constituted by the HOD. Students will have to give a power-point presentation of the outcomes of the project work before the committee.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–III Semester (Statistics)

STAT-DSM- 323	Statistics Practical-III	L	T	P	C
		0	0	4	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To provide data based practical training to students

(2) To enhance computational ability of students

Course Learning Outcomes:

CO1: After completion of this course students will understand the calculation aspect

CO2: Theoretical imaginations will be converted into real learning.

The practicals will be based on theory papers and list will be decided by the course coordinators.
There will be 8 marks for viva-voce and 7 marks for practical records in End. Sem (MM 60).

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. III Semester (Statistics)

STAT-MDM-321	Demography	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the basic features of population studies.
2. To teach Indian demographic management system.
3. To teach measures of demographic parameters and life table construction
4. To introduce the concept of population growth & projection with measures.

Course Learning Outcomes:

After completion of this course students will understand the

CO1: various measures of population parameters.
CO2: different characteristics of population and life table.

Unit Wise Learning Outcomes:

UO1. Learning about different demographic registration systems.
UO2. Learning of measures and indicators of population.
UO3. Learning of life table construction.
UO4. Learning about various measures of population growth.
UO5. Learning the population projection and nuptiality.

Unit I: Concept and sources of demographic data: Population census, Civil Registration System in India, Sample Registration System (SRS), National Sample Surveys (NSS), Demographic Health Surveys (DHS), National Family Health Surveys (NFHS). Whipple's Index, Myer's Index, Completeness of Vital Registration Data, Chandrasehkaran - Deming formula.	**(12 hours)**
Unit II: Concept of Fertility Measures of fertility; Fertility Indicators: sources of data and their computation; stochastic models for reproduction, distributions of time of birth, inter-live birth intervals and of number of births (for both homogeneous and homogeneous groups of women), estimation of parameters; estimation of parity progression from open birth interval data.	**(12 hours)**
Unit III: Measures of Mortality; construction of abridged life tables, infant mortality rate and its adjustments, model life table.	**(12 hours)**
Unit IV: Stable and quasi-stable populations, intrinsic growth rate. Models of population growth and their filling to population data. Internal migration and its measurement, migration models, concept of international migration	**(12 hours)**
Unit V: Methods for population projection, component method of population projection, Nuptiality and its measurements.	**(12 hours)**

Essential Readings:

(1) Kumar,R. , Technical Demography, Wiley Eastern Publication
(2) Keyfitz,N. Introduction to Demographic Analysis,Harward University Press
(3) Ox, P.R. demography, Cambridge University Press,

Suggested Readings and links:

(1) Sinha, V.C and Ecso Zacharia, Elements of Demography, Allied Publisher
(2) Majumdar,P.K., Fundamantals of Demography, Rawat Publisher
(3) Chattopadhya, A.K. and Shah, A.K., Demography,Viva Publication

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. III Semester (Statistics)

STAT-DSM-322	Numerical Analysis-I	L	T	P	C
		3	0	1	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the application of numerical methods.
2. To teach iterative methods used in numerical analysis.
3. To teach extrapolation methods and applications.
4. To introduce the solution of ordinary differential equation.

Course Learning Outcomes:

After completion of this course students will understand the

CO1: solution of problems using numerical methods.
CO2: solution of differential equation using numerical method.

Unit Wise Learning Outcomes:

UO1. Solution of algebraic and trancedental equations.
UO2. Solution of non-linear system of equation.
UO3. Solution of integrals and different extrapolation methods.
UO4. Solution of differential equations.
UO5. Solution of Boundary value problem.

Unit I: **(12 hours)** Solution of algebraic and transcendental equations, Non-linear equations in one variable, Fixed point iterative methods, convergence criterion. Autken's Δ_2-process for acceleration the convergence of fixed point iterative method, Newton-Raphson's method, convergence criterion, order and rate of convergence.
Unit II: **(12 hours)** Linear and nonlinear system of equations. Indirect methods: Jacobi and Gauss Seidel iterative methods with convergence criterion successive over relaxation Interpolation Lagrange, Hermite interpolation.
Unit III: **(12 hours)** Numerical Integration, Newton-Cotes formulae, construction of Gaussian quadrature formulae, error estimates, Radau and Lobatto quadrature rules, Gauss-Legendre, Gauss-Chebeshev formulas, Gauss Leguerre, Gauss Hermite quadrature rules. Spline integration- Integration over rectangular and general quadrilateral areas and multiple integration with variable limit. Extrapolation methods and their applications.
Unit IV: **(12 hours)** Numerical solution of ordinary differential equations: Initial value problem. Euler and backward Euler Method, higher order Taylor methods. Modified Euler's method. Runge-Kutta methods of second and fourth order. Stability and convergence of single step method, absolute stability, A-stability, zero-stability, Region of absolute stability of explicit and implicit Runge-Kutta methods.
Unit V: **(12 hours)** Boundary- Value problems, finite difference and cubic spline methods for ordinary differential equations. Numerical solution of partial differential equations using finite difference method. Basic concepts of finite element method, weak formulation of BVP Ritz 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 I Hrris (1999) Applied Numerical Methods for Engineers using MATLAB and C Thomsen-Brooks/Cole.

Suggested Readings and links:

1. S S Sastry (2010) introduction Methods of Numerical analysis, PHI learning Private Limited, New Delhi.
2. C F Gerald & P O Wheatley (2008) Applied Numerical Analysis (7th edition), Pearson Education, India
3. Melvin J Maron (1982) Numerical Analysis A Practical Approach, Macmillan Publishing Company Inc. New York.

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Passed by Board of Studies Dated 11/6/2024

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. IV Semester (Statistics)

STAT-DSM-421	Operational Research - II	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the basic features of game theory.
2. To teach different models used in queuing theory.
3. To teach tools and techniques of linear integral programming.
4. To introduce procedure of problem solving using dynamic programming.

Course Learning Outcomes:

After completion of this course students will understand the

CO1: solution of game theory problem, queuing theory problem and integer programming problem.
CO2: solution of quadratic programming problem and dynamic programming problem.

Unit Wise Learning Outcomes:

UO1. Learning for game theory solutions.
UO2. Learning for queuing theory solutions.
UO3. Learning for integer programming solutions.
UO4. Learning for classical optimization problem.
UO5. Learning for dynamic programming solution.

Unit I: **(12 hours)** Game theory, Two-person zero-sum game, game with mixed strategies. Principle of dominance, rectangular game. Graphical solution by linear programming.
Unit II: **(12 hours)** Elementary queuing models, Steady-state solutions of Markovian queuing models M/M/1, M/M/1 with limited waiting space. Queuing models M/M/C.
Unit III: **(12 hours)** Integral linear programming: Pure and mixed. Gomory's cutting plane method, branch and bound method.
Unit IV: **(12 hours)** Classical optimization problem: Unconstrained problem of maxima and minima (necessary & sufficient condition) Kunh-Tucker conditions for constrained problem. Wolfe method for quadratic programming problem.
Unit V: **(12 hours)** Dynamic programming: Minimum path problems on single additive constraints, additive separable return, single multiplicative constraints and additive separable return.

Essential Readings:

1. H.A. Taha, Operations Research- An Introduction, Macmillian. Publishing INC, New- York
2. F.S. Hiller & GJ Lieberman, Introduction to Operation Research, (sixth-edition), McGraw Hill International Edition
3. S. D Sharma, Operation Research, Kedar Nath Ram Sons & co publisher Meerut (13th edition) 2001.

Suggested Readings and links:

1. P K Gupta and D S Hira (2004) Operations Research, S Chand and company, New Delhi
2. Kanti Swaroop, PK Gupta & Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

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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
M.Sc. IV Semester (Statistics)

STAT- DSM-422	Statistical Quality Control	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the basics of statistical quality control.
2. To teach various sampling inspection plans.
3. To teach Bayesian sampling plans.
4. To introduce multivariate quality control theory.

Course Learning Outcomes:

After completion of this course students will be able to understand

CO1: basic tools and techniques of statistical quality control useful for industry

CO2: different sampling plans for testing the items with their relative merits and demerits.

Unit Wise Learning Outcomes:

UO1.Learning of basic control charts.
UO2. Learning of acceptance sampling plan.
UO3. Learning about sequential sampling plans.
UO4. Learning about factorial experiments.
UO5. Learning of multivariate quality control.

Unit I:	**(12 hours)**
Basic concepts of process monitoring ad control; process capability and process optimization. General theory and review of control charts for attribute and variable data; O.C. and A.R.L. of control charts; control by gauging; moving average and exponentially weighted moving average charts; Cu-Sum charts using V-masks and decision intervals; Economic design of X-bar chart...	
Unit II:	**(12 hours)**
Acceptance sampling plans for attributes inspection; single and double sampling plans and their properties; plans for inspection by variables for one-sided and two sided specification. Mil Std. and IS plans; continuous sampling plans of Dodge type and Wald-Wolfiwitz type and then properties.	
Unit III:	**(12 hours)**
Sequential sampling plan and its properties; Bayesian sampling plans. Capability indices Cp, Cpk and Cpm; estimation, confidence intervals and tests of hypotheses relating to capability indices for normally distributed characteristics	
Unit IV:	**(12 hours)**
Use of design of experiments in SPC; factorial experiments, fractional factorial designs; construction of such designs and analysis of data	
Unit V:	**(12 hours)**
Multivariate quality control; use of control ellipsoid and of utility functions.	

Essential Readings:

1. Montgomery, D.C. (1985): Introduction to Statistical Quality Control; Wiley.
2. Montgomery, D.C. (1985): Design and Analysis of Experiments; Wiley.
3. Ott, E.R. (1975): Process Quality Control; McGraw Hill
4. Phadke, M.S. (1989): Quality Engineering Through Robust Design; Prentice Hall.

Suggested Readings and links:

1. Wetherill, G.B. (1977): Sampling Inspection and Quality Control; Halsted Press.
2. Wetherill, G.B. and Brown, D.W.: Statistical Process Control: Theory and Practice.

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DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc.–IV Semester (Statistics)

		L	T	P	C
STAT-SEC- 421	**Statistics Project-II**	**0**	**0**	**4**	**4**
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To train students for data analysis.
(2) To train students for use of statistical software.
(3) To develop skill of interpretation using data.
(4) To learn art of report writing after data analysis.

Course Learning Outcomes:

After completion of this course students will learn

CO1: how to analyse data,
CO2: how to write interpretation and conclusions.
CO3: how to present data in graphical form in the final report.

The Project will be based on primary or secondary statistical data analysis (or research based statistical analysis) and topic will be decided by course coordinators. A report (in binded/spiral-binded form) duly signed by the course coordinators and HOD both, have to be submitted by the students, with an attached certificate declaring that the content of project is their original contributions. The evaluation (in MM60) of the project work is to be done by a committee constituted by the HOD. Students will have to give a power-point presentation of the outcomes of the project work before the committee.

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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
M.Sc.–IV Semester (Statistics)

		L	T	P	C
STAT-DSM- 423	Statistics Practical - IV	0	0	4	4
		Max. Marks : 100			

Mid Sem-20
Internal Assessment-20
End Sem-60

Learning Objectives:

(1) To provide data based practical training to students
(2) To enhance computational ability of students

Course Learning Outcomes:

After completion of this course students will
CO1: understand the calculation of the theoretical aspect
CO2: Theoretical imaginations will be converted into real learning.

The practicals will be based on theory papers and list will be decided by the course coordinators. There will be 8 marks for viva-voce and 7 marks for practical records in End. Sem (MM 60).

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
M.Sc. IV Semester (Statistics)

STAT-MDM-421	Official Statistics	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

1. To inculcate the basic feature of Indian official Statistics.
2. To teach about methodology of maintaining official statistics.
3. To teach the conduct of census and national account.
4. To introduce social-economic indicators and their applications.

Course Learning Outcomes:

After completion of this course students will understand the

CO1: structure of maintaining the official statistics.
CO2: procedure of creating national indicators.

Unit Wise Learning Outcomes:

UO1. Learning about International Statistical Organizations.
UO2. Learning about agencies involved for population growth.
UO3. Learning for sector-wise statistics.
UO4. Learning about data collection in agricultural and forest.
UO5. Learning about Industrial statistics.

Unit I:	**(12 hours)**
Introduction to Indian and International statistical systems. Important role, function and activities of central and state Indian statistical organizations, organization of large scale sample surveys, National Statistical Organization: Vision and Mission, NSSO and CSO; roles and responsibilities; Important activities, Publications, etc.	
Unit II:	**(12 hours)**
National Statistical Commission: Need, Constitution, its role, functions, etc.; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts. Compilation, data collection mechanism, Processing, Analysis and Dissemination systems, Agencies Involved, population growth in developed and developing countries, evaluation and performance of family welfare programmes.	
Unit III:	**(12 hours)**
Scope and content of population census of India, method of data collection. Sector Wise Statistics: Agriculture, Environment and Forestry, Health, Education, Women, and Child, etc. Important Surveys & Census, Indicators, Agencies, and Usages, etc.	
Unit IV:	**(12 hours)**
National Accounts: Definition, Basic Concepts; issues; the Strategy, Collection of Data and Release. System of collection of agricultural and forestry statistics, crop forecasting and estimation, productivity, fragmentation of holdings, support prices.	
Unit V:	**(12 hours)**
Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics. Socio-Economic Indicators, Gender Awareness/Statistics, Important Surveys, and Censuses.	

Essential Readings:

1. Statistical System in India (CSO, MoSPI).
2. Official Websites of various Ministries of GoI
3. Principles and accommodation of National Population Censuses, UNESCO.
4. Panse, V.G.: Estimation of Crop Yields (FAO).

Suggested Readings and links:

1. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.
2. India State of Forest Report, Forest Survey of India

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11.6.24 Dshukla 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
M.Sc. IV Semester (Statistics)

STAT-MDM-422	Time Series Analysis	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

(1) To inculcate components and properties of time series.
(2) To teach moving average and ARMA, ARIMA processes.
(3) To teach model order estimation techniques.
(4) To introduce spectral distribution and periodgram.

Course Learning Outcomes:

After completion of this course students will understand
CO1: varying nature of time series with trend and fluctuations.
CO2: various features, measures and properties of time series.

Unit Wise Learning Outcomes:

UO1. To learn about stationary, non stationary stochastic processes.
UO2. To learn properties of states including auto-regressive process.
UO3. To learn identification of processes with ACF and PACF.
UO4. To learn non-stationary time series and random walk.
UO5. To learn spectral density, spectral distribution and cross-spectrum.

Unit I: **(12 hours)** Time series as a stationary or nonstationary stochastic process, sample auto covariance function (acvf) and autocorrelation function (acf) at lag k, partial autocorrelation function (pacf), correlogram, lag operators and linear filters, Ergodicity and Stationarity.
Unit II: **(12 hours)** Wold decomposition, general linear process and its acvf, acf. Autoregressive (AR) process, moving average (MA) process, acf and pacf for AR and MA processes, Yule-Walker equations for AR processes, mixed ARMA process.
Unit III: **(12 hours)** Stationarity and invertibility conditions, ARIMA (p,d,q) model, estimation of parameters for AR, MA, ARMA and ARIMA processes, identification of processes with ACF PACF, Model order estimation techniques-AIC, AICC, BIC, EDC, FPE and forecasting.
Unit IV: **(12 hours)** Forms of nonstationarity in time series, random walk model, Dickey-Fuller, augmented Dickey-Fuller and Phillips-Perron tests for unit root. ARCH and GARCH processes.
Unit V: **(12 hours)** Frequency domain analysis- spectral density and its properties, spectral density function of stationary linear processes, cross-spectrum for multivariate processes, Spectral distribution function, estimation of spectral density function, Periodogram analysis.

Essential Readings:

1. Box, George E. P., Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung. (2015) Time Series Analysis, Forecasting and Control, Wiley.
2. Brockwell, P.J. and Davis, (2009) R.A. Time Series: Theory and Methods (Second Edition), SpringerVerlag.
3. Chatfield, C. (1975) The Analysis of Time Series: Theory and Practice Springer-Verlag.
4. Granger, C.W.J. and Hatanka, M. (1964): Spectral Analysis of Economic Time Series, Princeton Univ. Press, N.J.
5. Granger, C.W.J. and Newbold (1984): Forecasting Econometric Time Series, Third Edition, Academic Press.

Suggested Readings and links:

1. Kirchgassner, G. and Wolters, J. (2007). Introduction to Modern Time Series Analysis, Springer.
2. Montgomery, D.C. and Johnson, L.A. (1977): Forecasting and Time Series Analysis, McGraw Hill.
3. Priestley, M.B. (1981). Spectral Analysis & Time Series, Griffin, London
4. Izenman, A.J., (2008), Modern Multivariate Statistical Techniques: Regression, Classification, and Manifold learning, Springer.

E Books Link : National Digital Library

11.6.24

Passed by Board of Studies Dated. 11.6.24

DOCTOR HARISINGH GOUR VISHWAVIDYALAYA, SAGAR
(A Central University)
Department of Mathematics and Statistics
M.Sc. IV Semester (Statistics)

STAT-MDM-423	Statistical Inference - II	L	T	P	C
		3	1	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Learning Objectives:

(1) To inculcate advance concept of testing a hypothesis
(2) To teach applications of NP-Lemma
(3) To teach power of test of hypothesis
(4) To introduce variance stabilizing transformations

Course Learning Outcomes:

After completion of this course students will understand
CO1: advance procedure of hypothesis testing
CO2: existence and non-exitence of UMP test and LRT test

Unit Wise Learning Outcomes:

UO1. To learn about composite hypothesis and power of statistical test
UO2. To learn the application of NP-Lemma
UO3. To learn about Pitman family and its property in reference to UMP test
UO4. To learn LRT test with asymptotic distribution
UO5. To learn the concept of interval estimation with application.

Unit I: **(12 hours)** Tests of Hypotheses, test functions, size function, power function, composite hypothesis MP and UMP test in class of size alpha level tests. Examples of them on standard distributions.
Unit II: **(12 hours)** Neyman - Pearson Lemma, MP test for simple null against simple alternative hypothesis. UMP tests for simple null hypothesis against one sided alternatives and for one sided null against one sided alternatives in one parameter exponential family.
Unit III: **(12 hours)** Extension of the above Unit results to Pitman family when only upper or lower end depends on the parameter and to distributions with MLR property, non-existence of UMP test for simple null against two sided alternatives in one parameter exponential family.
Unit IV: **(12 hours)** Likelihood Ratio Test (LRT), Asymptotic distribution of LRT statistic, Wald Test, Rao's score test, Pearson Chi-square test for Goodness of fit, Bartlett's Test for homogeneity of variances.
Unit V: **(12 hours)** Interval estimation: concept and methods, Pivot quantity method, Large sample method, criteria for good confidence interval, SELCI-criteria, uniformly most accurate criteria. Examples on standard distributions.

Essential Readings:

1.Kale, B. K. (1999) A first Course on Parametric Inference. Narosa Publishing House.
2. Rohatgi V. (1988). An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)
3.Dudewicz. E, J. and Mishra, S. N. (1988). Modern Mathematical Statistics, Wiley Series in Prob. Math., Stat , John Wiley and Sons, New York (International Student Edition)
4. Lehmann, E. L. (1986). Testing Statistical hypotheses (Student Edition)

Suggested Readings and links:

1. C. R. Rao (1973) : Linear Statistical Inference and its applications , John Wiley and Sons

E Books Link : National Digital Library.

11-6-24

DShukla

11/6/24

Passed by Board of Studies Dated. 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
Dr. Harisingh Gour V.V., Sagar (M.P.)

Dr. Maheshwar Panda
Member & Assistant Professor
Department of Physics
Dr. Harisingh Gour V.V., Sagar (M.P.)

Ms. Shivani Khare
Member & Assistant Professor
Department of Vedic Studies
Dr. Harisingh Gour V.V., Sagar (M.P.)

Prof. R.K. Tangele
Chairman, School Board & Dean, SMPS
Dr. Harisingh Gour V.V., Sagar (M.P.)