DEPARTMENT OF MATHEMATICS & STATISTICS
UNIVERSITY COLLEGE OF SCIENCE
MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

M.A. /M.Sc. STATISTICS (CBCS) 2022-23

Semester- III

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M3 STA 01 – CT 09	Core Course- 09 Multivariate Analysis	4-1-0	5	80	20	100
II	M3 STA 02 – CT 10	Core Course- 10 Theory of Sample survey	3-1-0	4	80	20	100
III	M3 STA 03 – CP 05	Core Course P- 05 Practical Based on CT 09 & CT 10	0-0-6	3	80	20	100
IV	M3 STA 0X- DSE 0X	DSE- 0 X	3-1-0	4	80	20	100
V	M3 STA 0X- DSE 0X	DSE- 0 X	3-1-0	4	80	20	100
VI	M3 STA 0X- DSE 0X	DSE- 0 X	2-0-4	4	80	20	100

Discipline Specific Elective Course (DSE) for Semester III

Note: Students are to opt any three DSE courses among the following as per the availability of faculty and with the permission of the Head of the Department.

Course no.	Course Code PSSSCCXX	Title of the Course	L-T-P	No. of Credits	Max. Marks		Total
					University Exam.	Internal Assessment	
	1	2		3	4	5	6
I	M3 STA 01- DSE 01	DSE- 01 Operations Research	3-1-0	4	80	20	100
II	M3 STA 02- DSE 02	DSE- 02 Stochastic Processes	3-1-0	4	80	20	100
III	M3 STA 03- DSE 03	DSE- 03 Practical Based on two papers selected as DSE	2-0-4	4	80	20	100
IV	M3 STA 04- DSE 04	DSE- 04 Mathematical Economics	3-1-0	4	80	20	100
V	M3 STA 05- DSE 05	DSE- 05 Statistical Quality Control	3-1-0	4	80	20	100
VI	M3 STA 06- DSE 06	DSE- 06 Information Theory	3-1-0	4	80	20	100

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

There will be Two core courses, Two elective courses, one core course practical and 1 Discipline specific elective practical.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 01 – CT 09

MULTIVARIATE ANALYSIS

L-T-P	4-1-0

TIME: 3 hours **External Assessment 80**

Internal Assessment 20

UNIT I

Multivariate Analysis: Multivariate normal distribution and its properties, density function, marginal and Conditional distribution. Distribution of Quadratic forms.

UNIT II

Maximum likelihood estimators of the mean vector and covariance matrix, and related distributions. Null and Non-null distributions of partial and multiple correlation coefficients, Multivariate central limit theorem and asymptotic distribution of $Z = \tanh^{-1} r$.

UNIT III

Hotelling's T^2 its properties and uses, Mahalanobis $D^{2.}$

UNIT IV

Wishart Distribution and its properties, Classification of observations.

UNIT V

Principal components, dimension reduction, canonical variates and canonical correlation—definition, use, estimation and computation.

Books Recommended

1. Anderson T.W. : An Introduction to Multivariate statistical Analysis first seven Chapters.
2. Rao, C.R. : Linear statistical Inference and its applications.
3. Kshirsagar, A.M. : Multivariate Statistical Inference
4. Morrison : Multivariate Statistical Methods.
5. Kendall M.G. and Stuart, A. : Advanced Theory of Statistics, Vol. III.
6 Giri, N.C Multivariate Statistical Inference

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 02 – CT 10

THEORY OF SAMPLE SURVEYS

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**

Internal Assessment 20

UNIT-I

Elements of unistage sampling with varying probabilities with replacement, Successive sampling on two occasions and h-occasions.

Theory of sample surveys: Partition of sample space and definition of T-classes of linear estimators. The wideness of set of seven classes of linear estimators. A unified approach to T_2 class of linear estimators Non-sampling Errors, their sources and elimination.

UNIT-II

Two-stage sampling with equal and unequal first stage units. Double sampling

The theory of multi-stage sampling with varying probabilities with and without replacement, Des Raj ordered estimators, Murthy's unordered estimators.

UNIT III

Ratio and regression methods of estimation: Bivariate extension of the Ratio and Regression Methods of estimation when population means of auxiliary variables are known

Varying Probabilities without replacement: Horvitz-Thompson-estimator and its variance, Yates and Grundy form of variance unbiased estimators of variance of Horvitz-Thompson's estimators.

UNIT-IV

Quenouille's Techniques of bias reduction and its application to Ratio type estimators, Hartley and Ross Unbiased Ratio type estimator Ratio method of estimation in PPSWR sampling. Ratio method of estimation under Midzuno's scheme of sampling when X is known.

UNIT-V

Sen-Midzuno scheme of sampling and simplification of inclusion probabilities for Yates-Grundy estimate of variance with advantages. Rao-Hartley-Cochran sampling schemes and their estimation procedures.

). REFERENCES : 1. M.N.Murthy: Sampling Theory and Methods 2. Sukhatme P.V. &Sukhatme B.V.: Sampling theory of surveys with applications 3. Desraj: Sampling Theory 4. Clase, Magus Cassel: Foundations of Inference in Survey Sampling 5. Kish L.: Survey Sampling Syllabus Covered till March 14, 2020

Recommended Books:

1. Sukhatme P.V and sukhatme B.V. : Sampling Theory of surveys with Applications.
2. Mukhopadhyay, P : Theory & Methods of Survey sampling.
3. Tikkiwal, B.D. Lecture notes on Advanced Theory of sample surveys.

Reference Books:

2. Deming W.E. : Some Theory of sampling.
3. Des Raj : Sampling Theory.
4. Hansen Hurwitz and Madow : Sampling surveys Methods I and Theory, Vol. II & I.
5. Murthy M.N. : Sampling Theory and Methods.

6 Cochran, W.G. Sampling Techniques

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 03 – CP 05

PRACTICALS BASED ON CT-09 & CT-10

L-T-P	0-0-6

Duration: 4 Hours **External Assessment 80**

Internal Assessment 20

External Assessment 80: Practicals : 60 Marks
(Practicals based on Multivariate Analysis)
Viva-voce : 20 Marks

Internal Assessment 20: Practical Record (Internal Assessment) : 20 Marks

Note: A candidate will have to attempt 3 Practicals.
Students will be required to do practicals, based on topics listed below, using R-Software:

List of Practicals:

1. Linear combination of correlated normal variates and evaluation of probabilities.
2. Estimation of mean vector and covariance matrix.
3. Testing of mean vector(s).
4. Estimation and testing of partial and multiple correlation coefficients.
5. Discriminant function.
6. Estimation of mean and variance by (i) ratio and (ii) regression methods of estimation.
7. Estimation of mean & variance in two-stage sampling
8. Estimation in double sampling.
9. Horvitz and Thompson's procedure of estimating mean (total) of the population, variance of estimator and estimate of variance.
10. Yate's and Grundy method.
11. Midzuno's sampling scheme.
12. Rao-Hartley-Cocharan schemes.
13. Two stage sampling method (a) f.s.u being select with pps with replacement (b) s.s.u with equal prob without replacement (c) Estimation of optimum number of f.s.u and s.s.u.
14. Hartley-Ross unbiased Ratio method of estimation.
15. Bivariate Extension of Ratio & regression method of estimation (Olkin's technique).
16. Software development of above practical problems in C-language and running the same on computers.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 01 - DSE 01

OPERATIONS RESEARCH

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Operations Research: Definition, scope and general nature of O.R, .Transportation and Assignment problems.

UNIT II

Inventory Control: Deterministic Inventory models with at most one linear restriction and without restriction Probabilistic inventory models.

UNIT III

Queuing Theory: Examples of queuing processes, Models of queuing processes M/M/1 and M/M/S with Poisson arrivals; Exponential service time distribution, Length of queue and the queue discipline being F.I.F.O.

UNIT IV

Simulation: Definition, types, uses and limitations, phases of simulation model, Generation of random numbers, Monte-Carlo simulation. Application to inventory control and queuing theory. Game theory: Two-person zero sum game, saddle point, pure & mixed strategies, dominance principle and solution of game by graphical method.

UNIT V

Steady state, Solutions of Markovian queuing models: M/M/1, M/M1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

Books Recommended:

1. Sharma S.D. : Operating Research.
2. Gupta P.K. & Hira D.S. : Operations Research.
3. Kanti Swarup Gupta. P.K. and Manmohan : Operations Research
4. Goel B.S. & Mittal S.K. : Operations Research.
5. Sasieni Yaspan and Friedman : Operations Research

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 02 –DSE 02

STOCHASTIC PROCESSES

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Definition and examples of stochastic process: Stochastic processes and their classification, Markov process and Markov Chain, Transition probabilities and properties of transition functions, Classification of states, transient Markov chain, Determination of higher order transition probability and its limits. Limit theorems for Markov Chains, Discrete time Markov chain, Stationary distribution and its interpretation, Chapman-Kolmogorov equation,

UNIT II

Continuous time Markov Chain: Poisson process and related inter-arrival time distribution, compound Poisson process, Pure birth process, pure death process, birth and death process, Problems.

UNIT III

Random Walks: One-dimensional, two-dimensional and three-dimensional random walks. Duality in random walk. Simple random walks, Barriers, Gambler ruin problems. Applications from social, biological and physical sciences.

UNIT IV

Markov process with continuous state space, Weiner process, Wiener process as a limit of random walk; first-passage time and other problems. Renewal processes, Elementary renewal theorem and its applications. Brownian motion process and its basic properties.

UNIT V

Galton -Watson branching processes: Definition and examples of discrete time branching process, Probability generating function and its properties, Offspring mean and probability of extinction. Statistical inference in MC and Markov processes.

Books Recommended:

1. Hoel, P.G., Port. S.C. and Stone, C.J. : Introduction to stochastic processes.
2. Feller W. : An Introduction to Probability Theory and its Applications Vol.- 1, 3 Chapters XI-XV.
3. Bailey, N.T.J. : The Elements of stochastic Processes.
4. Takacs : Stochastic Processes Chapters I and II.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 03 – DSE 03

PRACTICALS BASED ON DSE-01 & DSE-02

L-T-P	2-0-4

Duration: 4 Hours **External Assessment 80**

Internal Assessment 20

External Assessment 80: Practicals : 60 Marks
(Practicals based on Multivariate Analysis)
Viva-voce : 20 Marks

Internal Assessment 20: Practical Record (Internal Assessment) : 20 Marks

Note: A candidate will have to attempt 3 Practicals.

Students will be required to do practicals, based on topics listed below, using R-Software:

List of Practicals:

1. Problem Based on Monte Carlo Simulation
2. Duality Problems
3. Transportation Problems
4. Assignment Problems
5. Simulation Problems based on Inventory Control and Queuing Problems.
6. Calculation of n-step transition probabilities and limiting distribution in Markov chain.
7. Realization of Markov chain.
8. Estimation of transition probability of Markov chain using realization.
9. Operations Research and Stochastic Process and their software development in R-software and running the same on computers.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 03 –DSE 04

MATHEMATICAL ECONOMICS

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Mathematical Economics Use of Mathematics and Statistics in Economics Theory of consumer behavior, indifference curves, equilibrium, of exchange, family budget enquiries, Angles curve, the derivation of slutsky's equation for 2 commodity, Elasticity relations in demand theory.

UNIT II

Nature of cost, Equalibrium of the firm: Pricing under' conditions of perfect competition and monopoly, Walrasion genral equilibrium of exchange, Leontiefs static input-output analysis.

UNIT III

Component of time' series Methods of their determination, variates -difference method Yule-slutsky effect Correlograrn analysis.

UNIT IV

Concept of structure and model: Theoretical models and decision models, Growth models of Harrod and D Mar, Mahalanobis model.

UNIT V

The Pareto distribution, the lognormal distribution, Lorenz curve.

Books Recommended:

1. Allen R.G. D. : Mathematical Analysis for Economics.
2. Chennery, H.B. : Inter-Industrial Economics.
3. Gicks : Value and Capital.
4. Wold, H. : Demand Analysis.
5. Baumol, W.J. : Economic Dynamics.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 03- DSE 05
STATISTICAL QUALITY CONTROL

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Statistical Quality Control: Meaning of specification limits, item quality, Process and Product Control, Objectives of S.Q.C., Control chart for measurable quality characteristic, Chance variation and assignable variation of a process. Distribution of chance variates. Need for detection of assignable causes of Variation $\overline{X}$ and R-charts, Determination of control limits and central line in various situations.

UNIT II

Meaning of Statistical Control and its relation with specification limits, Modified control limits, warning limits and tolerance limits Rational sub-grouping Control charts for Attributes: p, np and c-charts. Advantages of S.Q.C., comparison of $\overline{X}$ and R-chart with p-chart when both can be used for same situation.

UNIT III

Acceptance sampling by attributes, Need for sampling inspection, methods for acceptance. Lot quality and lot-by-lot acceptances A.Q.L., A.Q.Q.L., producer's risk, consumer's risk, rectification, O.C function, A.S.N and average to inspection of an acceptance procedure.

UNIT IV

Single and double sampling plans and their mathematical analysis: Knowledge of standard sampling inspection tables Dodge and Romig table of Military standard 150.

UNIT V

Sampling inspection plans for continuous production process where lots cannot be formed. Sampling inspection plans by variables - One-sided specification standard (known and unknown). Two sided specification (standards known).

Books Recommended:

1. Grant E.L.and Leavenworth, R.S. : Statistical Quality Control.
2. Brooker and Goode : Sampling Inspection by variables.
3. Burr. I.W. : Engineering Statistics and Quality Controls.
4. Montgomery D.C. : Statistical Quality Control.
5. M.Mahajan : Statistical Quality Control Dhanpat Rai & Co. Pvt. Ltd. Nai sarak, Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

SEMESTER III M. Sc. STATISTICS 2022-23

M3 STA 03 –DSE 06

INFORMATION THEORY

L-T-P	3-1-0

TIME: 3 hours **External Assessment 80**
Internal Assessment 20

UNIT I

Information Theory: A quantitative measure of information discrete memory-less channel the entropy function.

UNIT II

Conditional joint and marginal entropy and relation between them redundancy efficiency and channel capacity.

UNIT III

B.S.C. and B.E.C. elements of encoding unique decipherability and noiseless coding theorem.

UNIT IV

Minimum distance principle and parity check coding.

UNIT V

Shanon-Fano encoding Shanon's binary encoding Huffman's code error correcting codes.

Books Recommended:

1. Ash, R. : Information Theory.
2. Reza, F.M. : An Introduction to Information Theory.
3. Hancocd : Principles of communication Theory.