Department of Statistics

Mizoram University, Aizawl

School of Physical Sciences

Curriculum and Credit Framework for Under Graduate Programmes (CCFUP)

B.Sc. Statistics Syllabus as per

NEP2020 Guidelines

Date of Approval by BOS: 18th May,2023

Date of Approval by School Board: 22nd May,2023

Course Structure of CCFUP B.Sc. (Statistics) as per NEP2020

Year	Sem	Course Category	Course Code	Name of Paper	Marks Scale			Credit			
					C/A	End Sem	Tot	L	T	P	Tot
First Year	1st	**FIRST SEMESTER**									
		MAJOR	STA 100	Statistical Methods	25	75	100	3	1	0	4
		MAJOR	STA 101*	Descriptive Statistics	25	75	100	3	1	0	4
		MINOR	*From other Department*					4	0	0	4
		Multidisciplinary	*From other Department*		25	75	100	3	0	0	3
		Ability Enhancement									3
		Value Added									2
	Sem	**SECOND SEMESTER**									
	2nd	MAJOR	STA 160	Probability Theory	25	75	100	3	1	0	4
		MAJOR	STA 161*	Probability Distributions	25	75	100	3	1	0	4
		MINOR	*From other Department*					4	0	0	4
		Multidisciplinary	From other	Department	25	75	100	3	0	0	3
		Skill Enhancement									3
		Value Added									2
Year	Sem	**THIRD SEMESTER**									
Second Year	3rd	MAJOR	STA 200	Sampling Techniques	25	75	100	3	0	1	4
		MAJOR	STA 201*	Statistical Estimation	25	75	100	3	1	0	4
		MINOR	*From other Department*					4	0	0	4
		Multidisciplinary	*STA 110 Basic Statistics*		25	75	100	3	0	0	3
		Skill Enhancement									3
		Value Added									2
	Sem	**FOURTH SEMESTER**									
	4th	MAJOR	STA 260	Vital Statistics	25	75	100	3	1	0	4
		MAJOR	STA 261*	Statistical Hypothesis Theory	25	75	100	3	1	0	4
		MINOR	*From other Department*					4	0	0	4
		Ability Enhancement									3
		Skill Enhancement									3
		Value Added									2
Year	Sem	**FIFTH SEMESTER**									
		MAJOR	STA 300	Sampling Distributions	25	75	100	3	0	1	4
		MAJOR	STA 301	Testing Statistical Hypothesis	25	75	100	3	0	1	4
		MAJOR	STA 302*	Order Statistics	25	75	100	3	1	0	4

Year	Sem							L	T	P	C
Third Year	5th	MINOR		*From other Department*				4	0	0	4
		Ability Enhancement									2
		Internship									2
	Sem			**SIXTH SEMESTER**							
	6th	MAJOR	STA 360	Linear Models and Design of Experiments	25	75	100	3	0	1	4
		MAJOR	STA 361	Applied Statistics	25	75	100	3	0	1	4
		MAJOR	STA 362	Reliability Theory	25	75	100	3	0	1	4
		MAJOR	STA 363*	Official Statistics	25	75	100	4	0	0	4
		MINOR		*From other Department*				4	0	0	4
Year	Sem			**SEVENTH SEMESTER**							
Fourth Year	7th	MAJOR	STA 400	Research Methodology and Statistical Computing	25	75	100	3	0	1	4
		MAJOR	STA 401*	Stochastic Processes	25	75	100	4	0	0	4
		MAJOR	STA 402*	Sequential Analysis and Decision Theory	25	75	100	4	0	0	4
		MINOR		*From other Department*				4	0	0	4
		MINOR		*From other Department*				4	0	0	4
	Sem			**EIGHT SEMESTER**							
				EIGHT SEMESTER (HONOUR WITH RESEARCH)							

		MAJOR	STA 460	Operations Research	25	75	100	4	0	0	4
	8th	MAJOR	STA 461	Time Series Analysis	25	75	100	4	0	0	4
		Research Project/Dissertation	RPD 470	Research Project/Dissertation	25	75					12
Sem	EIGHT SEMESTER										
	EIGTH SEMESTER(HONOUR)										
	8th	MAJOR	STA 460	Operations Research	25	75	100	4	0	0	4
		MAJOR	STA 461	Time Series Analysis	25	75	100	4	0	0	4
		MAJOR	STA 462	Statistical Computing Using R	25	75	100	3	0	1	4
		MAJOR	STA 463	Discrete Data Analysis	25	75	100	3	0	1	4
		MAJOR	STA 464	Multivariate Analysis	25	75	100	3	0	1	4

signifies Minor Courses offered for other subjects

Key Points:

1. Contact hour: Theory-1 Contact hour is 1 Credit and Practical- 2 Contact hours is 1 Credit.

2. Internal Tests/Assignments will be conducted as a part of Internal Assessment as per CCFUP Regulations (UG) of Mizoram University.

FIRST SEMESTER

DISCIPLINARY

MAJOR

STAT 100: Statistical Methods

Full Marks: 100   (4 Credits)

Course Outcome: Understanding the Origin and meaning of Statistics concept of Diagrammatic presentation of data Measures of central tendency Measures of dispersion.

Unit 1

Origin and meaning of Statistics: General uses, relation with other disciplines, Limitations and misuses of Statistics, Different scales of measurement, Methods of collection and editing of primary data. Designing of a questionnaire and a schedule. Sources and editing of secondary data. Classification and tabulation of data.

Unit - 2

Diagrammatic presentation- line diagram, bar diagrams and pie diagrams. Diagrammatic representation of data, pictograms, cartograms etc., Graphical representation of frequency distribution by frequency polygon, frequency curve and ogives.

Unit-3

Measures of central tendency-arithmetic mean, weighted arithmetic mean, median, mode, geometric mean, harmonic mean. Properties of these averages. Positional averages –quartiles, deciles and percentiles.

Unit - 4

Measures of dispersion- range, quartile deviation, mean deviation, standard deviation. Properties of these measures. Relative measures of dispersion – coefficient of variation.Definition and measures of skewness and kurtosis.

Books for references:

1   Goon A.M., Gupta M.K. and DasguptaB. :*Fundamentals of Statistics*, Vol. I, 8th

         Edn. The World Press, Kolkata.

2.   Miller, Irwin and Miller, Marylees : John E. *Freund's Mathematical Statistics*

         with Applications, (8th Edn.), Pearson Education, Asia.

3.   Mood, A.M. Graybill, F.A. and Boes, D.C. :*Introduction to the Theory of Statistics*, 3rdEdn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

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FIRST SEMESTER

DISCIPLINARY

MAJOR

STAT 101: Descriptive Statistics

Full Marks: 100   (4 Credits)

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Course Outcome: Understanding the Concept of central tendency, measures of central tendency concept of Moments Correlation Theory of attributes.

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Unit – 1

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Concept of centraltendency, measures of central tendency: mathematical and positional, partition values, measures of dispersion: range, quartile deviation, mean deviation, standard deviation, relative dispersion, coefficient of variation. Their related propertiesuses and limitations.

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Unit – 2

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Moments, absolute moments, factorial moments, kurtosis, skewness and their different measures, Sheppard's corrections (without proof), Bivariate data: Scatter diagram, product moment correlation coefficient and its properties, coefficient of determination, rank correlation.

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Unit – 3

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Partial and multiple correlation in three variables, their measures and related results, Correlation ratio, Intraclass correlation, Regression, principle of least square, fitting of regression line and related results.

<div align="center">Unit – 4</div>

Theory of attributes: Independence and Associationofattributes. Measuresof association for two way classified data. Consistency and independence of data with special reference to attributes. Coefficient of colligation.

Books for references:
1. Bhat B.R., Srivenkataramana T. and Rao Madhava K.S. (1996): *Statistics, A Beginner's Text*, Vol. I and II, New Age International (P) Ltd.
2. Goon A.M., Gupta M.K. and Das Gupta B. (1991): *Fundamental of Statistics*, Vol. I, World Press, Calcutta.
3. Hogg R.V. and Craig A.T. 91972): *Introduction to mathematical Statistics*, Amerind Publishing Co.
4. Hoel P.G. (1971): *Introduction to Mathematical Statistics*, Asia Publication.

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SECOND

SEMESTER

DISCIPLINARY

MAJOR

STAT 103: Probability Theory

Full Marks: 100   (4 Credits)

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Course Outcome:☐ Understanding the Concept of Random experiment ☐ concept of Random variables
•acquire knowledge of Continuous random variable ☐moments and central limit theorems.
<div align="center">Unit – 1</div>

Random experiment: Trial, sample point, sample space, definitions of equally-likely, mutually exclusive and exhaustive events, definitions of probability, classical and relative frequency approach to probability, axiomatic approach to probability and its properties, merits and demerits of these approaches, total and compound probability, conditional probability theorems, independence of events, Bayes theorem and its applications.

<div align="center">Unit – 2</div>

Random variables, two-dimensional random variables, discrete and continuous, Discrete random variable: probability mass function and distribution function, joint probability mass function of several discrete random

variables, marginal and conditional probability mass functions, independence of random variables.

Unit – 3

Continuous random variable: Probability density function, distribution function, joint density function of two continuous variables, marginal and conditional probability density functions.Expectation of random variable and its properties, conditional expectation.

Unit – 4

Moment in terms of expectation, moment generating function and cumulant generating function of a random variable, their properties and uses, Tchebycheff's inequality and its applications.Statements of weak law of large numbers and central limit theorems.

Books for references:
1. Meyer P.L. (1970): *Introductory Probability and Statistical Applications*, Addision Wesley.
2. Mood A.M., Greybill, F.A. and BoseD.C. (1974): *Introduction to the Theory of Statistics*, McGraw Hill.
3. Hogg R.V. and Craig A.T. (1972): *Introduction to Mathematical Statistics*, Amerind Publishing Co.
4. Parzen E. (1960): *Modern Probability Theory and its Applications*, Wiley Eastern.
5. Rohtagi V.K. (1967): *An Introduction to Probability Theory and Mathematical Statistics*, John Wiley and Sons.
6. Hoel P.G. (1971): *Introduction to Mathematical Statistics*, Asia Publishing House.

SECOND

SEMESTER

DISCIPLINARY

MAJOR

STAT 104: Probability Distributions

Full Marks: 100   (4 Credits)

Course Outcome: Understanding the Concept of Some standard discrete probability distributions and their properties some standard continuous probability distributions and their properties.

Unit – 1

Some standard discrete probability distributions and their properties: Binomial and Poisson distributions.

Unit – 2

Some standard discrete probability distributions and their properties (Cont…): Negative Binomial, Geometric, and Hypergeometric distributions.

Unit – 3

Some standard continuous probability distributions and their properties: Normal and Poisson distributions.

<div align="center">Unit – 4</div>

Some standard continuous probability distributions and their properties (Cont…): Exponential, Beta and Gamma distributions.

Books for references:

1. Meyer P.L. (1970): *Introductory Probability and Statistical Applications*, Addision Wesley.
2. Mood A.M., Greybill, F.A. and BoseD.C. (1974): *Introduction to the Theory of Statistics*, McGraw Hill.
3. Hogg R.V. and Craig A.T. (1972): *Introduction to Mathematical Statistics*, Amerind Publishing Co.
4. Parzen E. (1960): *Modern Probability Theory and its Applications*, Wiley Eastern.
5. Rohtagi V.K. (1967): *An Introduction to Probability Theory and Mathematical Statistics*, John Wiley and Sons.
6. Hoel P.G. (1971): *Introduction to Mathematical Statistics*, Asia Publishing House.

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SECOND SEMESTER

MULTIDISCIPLINARY

STAT 110: Basic Statistics

Full Marks: 100   (3 Credits)

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Course Outcome: Understanding the Concept of types od data and measurements, methods of data collection, methods of data representation and applications of different chart.

<div align="center">Unit – 1</div>

Nature and scope of Statistics, types of data: discrete and continuous data, frequency and non-frequency data, primary and secondary data, measurement scales and their types.

<div align="center">Unit – 2</div>

Methods of collection of primary data (designing a questionnaire and a schedule), Secondary data (major sources including some government publications). Concept of data summarization and condensation.

<div align="center">Unit – 3</div>

Methods of data representation, text, tabular, diagrammatic and graphical representation of data, classification of data and their types, construction of tables(with one or more factors), their general structure and types, line diagram, bar diagram, pi-chart and frequency distribution with applications.

Books for references:

1. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
2. Snedecors G.W. and Cochran W.G. (1967): Statistical Methods, Iowa State University Press.
3. Goon A.M., Gupta M.K. and Das Gupta B. (1991): Fundamental of Statistics, Vol. I, WorldPress, Calcutta
4. Hogg R.V. and Craig A.T. 91972): Introduction to mathematical Statistics, AmerindPublishing Co.
5. Hoel P.G. (1971): Introduction to Mathematical Statistics, Asia Publication.
6. Croxton F.E., Cowden D.J. and Karlin S. (1973) Applied General Statistics.
7. Goon, A.M., Gupta, M.K., Dasgupta, B. : Fundamental of Statistics Vol.-I
8. Kapoor, V.K. and Saxena, H.C. : Mathematical Statistics
9. Yul, G.V. and Kendall, M.G. : Introduction to the Theory of Statistics.

THIRD SEMESTER

DISCIPLINARY

MAJOR

STAT 200: Sampling Techniques

Full Marks: 100   (4 Credits)

Course Outcome: ☐ Understanding the basic concepts of sampling ☐ Stratified random sampling, Allocation problems ☐acquire knowledge of Systematic sampling ☐ Ratio, product and regression methods of estimation.

Unit – 1

Basic concepts in sampling: concept of population and sample, need for sampling, complete enumeration versus sampling, sampling and non-sampling errors. Probability sampling, simple random sampling with and without replacement (SRSWR and SRSWOR) and their properties. Estimation of population mean and their standard errors.

Unit – 2

Stratified random sampling, Allocation problems - proportional and optimum allocations, Standard error of population mean under these allocation procedures. Comparison with simple random sampling for fixed sample size.

Systematic sampling when population size, *N* is an integer multiple of sampling size, *n*. Estimation of population mean and standard error of this estimate. Comparison of systematic sampling with SRSWOR. Elementary ideas of cluster sampling.

Unit – 4

Ratio, product and regression methods of estimation, estimation of population mean, evaluation of bias and variance to the first order of approximation, comparison with simple random sampling.

Books for references:

1. Sukhtme P.V., Sukhatme B.V., Sukhatme S. and Asok C. (1984) : *Sampling Theory of Surveys with Applications*, Indian Society of Agricultural Statistics, New Delhi.
2. Cochran W.G. (1977) : *Sampling Techniques*, John Wiley and Sons, New York
3. Hansen M.H., Hurwitz W.N. and Madow W.G. (1975) : *Sample Survey Method and Theory*, Vol. I, Methods and Applications, Vol. II, New York and London, Wiley Publication.
4. Kish L (1965): *Survey Sampling*, John Wiley and Sons, New York.
5. Murthy M.N. (1967) : *Sampling Theory and Methods*, Statistical Publishing Society, Calcutta.
6. Sampath S. (2000) : *Sampling Theory and Methods*, Narosa Publishing House, New Delhi.
7. Des Raj (2000) : *Sample Survey Theory*, Narosa Publishing House, New Delhi.
8. Goon A.M., Gupta M.K. and Das Gupta B. (1986) : *Fundamentals of Statistics*, Vol. II, world Press, Calcutta.

THIRD SEMESTER

DISCIPLINARY

MAJOR

STAT 201: Statistical Estimation

Full Marks: 100   (4 Credits)

Course Outcome: ☐ Understanding the Concept of Point estimation ☐ Cramer-Rao lower bound of variance and estimators ☐acquire knowledge of Concept of complete sufficient statistics ☐ Methods of estimations and confidence interval.

Unit – 1

Point estimation: properties of estimators, mean square error (MSE) and minimum mean square error estimator. Unbiasedness of an estimator and minimum variance unbiased estimator (MVUE). Data Reduction : Sufficiency, factorization theorem (without proof), Illustrations.

Unit – 2

Cramer-Rao lower bound of variance, amount of information, Minimum variance bound estimator (MVBE).Consistency of estimators and sufficient conditions for consistency. Relative efficiency of an estimator, asymptotic efficiency.

Unit – 3

Concept of complete sufficient statistics, Rao-Blackwell theorem, Lehman Scheffe theorem, Methods of estimation : method of moments, Method of Maximum likelihood. Statements of properties of MLE. Illustrative Examples, BAN estimators.

Unit – 4

Method of minimum chi-square. Method of least squares with examples, Interval Estimation: Concepts of confidence interval and confidence coefficient, confidence intervals for the parameters of univariate normal distributions.

Books for references:

1. Freund J.E. (2001) : *Mathematical Statistical*, Prentice Hall of India.
2. Hogg R.V. and Craig A.T. (1978) : *Introduction of Mathematical Statistics*, Fourth Edition, Collier Macmillon Publishers.
3. Mood A.M., Graybill E.A. and BoseD.C. (1974) : *Introduction to the Theory of Statistics*, McGraw Hill.
4. Rao, C.R. (1973) : *Linear Statistical Inference and its Applications*, Revised edition Wiley Eastern.
5. Rohtagi V.K. (1967) : *An Introduction to Probability Theory and Mathematical Statistics*, John Wiley and Sons.
6. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : *An Outline of Statistical Theory*, Vol. 2, The World Press Publishers Pvt. Ltd. Calcutta.

FOURTH SEMESTER

DISCIPLINARY

MAJOR

STAT 203: Vital Statistics

Full Marks: 100   (4 Credits)

Course Outcome: ☐ Acquire the Concept of rates of births☐Important characteristics of births, such as births by sex, location and maternal age☐acquire knowledge of Concept of Deaths by essential characteristics such as age, sex, location and cause of death.

Unit – 1

Mortality and its measurement, Crude death rate, specific death rate, age-specific death rate, their merits and demerits, standardized death rates, need of standardization, methods of standardizing death rates, Infant Mortality rate (IMR).

Unit – 2

Life tables as a tool of depicting mortality, types and main features of life tables, complete and abridged life tables, various life table functions and their interrelationships, construction of complete life table, uses of life table.

Unit – 3

Fertility, fecundability and fecundity, definitions, importance and problems in analyzing fertility data. Measurement of Fertility: Crude birth rate, general fertility rate, age specific birth rate, total fertility rate, their merits and demerits.

Unit – 4

Measures of population growth, its difference w.r.t. fertility measures, crude rate of natural increase, gross reproduction rate, net reproduction rate with their merits and demerits.

Books for references:

1. Mukhopadhyay, P. (1994) :*Applied Statistic*s, new Central Book Agency Pvt. Ltd., Calcutta.
2. Srivastava O.S. (1983) : *A Text Book of Demography*, Vikas Publishing House, new Delhi.
3. Benjamin B. (1959): *Health and Vital Statistics*, Allen and Unuwin.
4. Goon A.M., Gupta M.K. and Das Gupta B. (1986): *Fundamentals of Statistics*, Vol. II, World Press, Calcutta

FOURTH SEMESTER

DISCIPLINARY MAJOR

STAT 204: Statistical Hypothesis Theory

Full Marks: 100   (4 Credits)

Course Outcome: Acquire the Concept of Principlesoftestofsignificance Students will understand concepts of Statistical hypothesis, developing tests to test the hypothesis Formulation of Statistical hypothesis is real life situations. Apply appropriate test to validate the hypothesis.

Unit – 1

Principlesoftestofsignificance:simpleand composite hypothesis, nullandalternative hypotheses,Type-I and Type-II errors, critical region, level of significance, size and power.

Unit – 2

Concept of best critical region, power curve, best test, most powerful (MP) test anduniformly most powerful (UMP) test and procedures to obtainsuitable test with illustrative examples.

Unit – 3

Neyman Pearson Lemma, statement, proof and its applications to construct most powerful test. Unbiased and uniformly most powerful unbiased (UMPU) tests and its applications and simple illustrations.

Unit – 4

Randomized and non-randomized tests. Illustrative examples, Likelihood ratio tests, properties of likelihood ratio test (without proof).

Books for references:

1. Freund J.E. (2001) : *Mathematical Statistical*, Prentice Hall of India.
2. Hogg R.V. and Craig A.T. (1978) : *Introduction of Mathematical Statistics*, Fourth Edition, Collier Macmillon Publishers.
3. Mood A.M., Graybill E.A. and Bose D.C. (1974): *Introduction to the Theory of Statistics*,McGraw Hill.
4. Rao, C.R. (1973) : *Linear Statistical Inference and its Applications*, Revised edition Wiley Eastern.
5. Rohtagi V.K. (1967) : *An Introduction to Probability Theory and Mathematical Statistics*,John Wiley and Sons.
6. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : *An Outline of Statistical Theory*, Vol. 2, The World Press Publishers Pvt. Ltd. Calcutta.

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FIFTH SEMESTER

DISCIPLINARY

MAJOR

STAT 300: Sampling Distributions

Full Marks: 100   (4 Credits)

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Course Outcome: Understanding various sampling distributions and their applications Solve real life problems in practical.

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Unit – 1

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Definitions of random sample, parameter and statistic, sampling distribution of a statistic, standard error, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportions.

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Unit – 2

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Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 with n degrees of freedom using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution and its uses.

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Unit – 3

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Exact sampling distributions: Student's t and Fishers t-distribution, Derivation of its p.d.f., nature of probability curve, mean, variance, moments and limiting form of t distribution and other important properties

and uses.

Unit – 4

Snedecore's F-distribution: Derivation of p.d.f.,nature of p.d.f. curve with different degrees of freedom, mean, variance and mode, reciprocal property and other important properties and uses. Relationships between t, F and χ^2 distributions, Fisher's Z transformation and its uses.

Books for references:

1. Hogg R.V. and Craig A.T. (1978) : *Introduction of Mathematical Statistics*, Fourth Edition, Collier Macmillon Publishers.
2. Mood A.M., Graybill E.A. and Bose D.C. (1974) : *Introduction to the Theory of Statistics*,McGraw Hill.
3. Rohtagi V.K. (1967) : *An Introduction to Probability Theory and Mathematical Statistics*,John Wiley and Sons.
4. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : *An Outline of Statistical Theory*, Vol. 1, The World Press Publishers Pvt. Ltd. Calcutta.

FIFTH SEMESTER

DISCIPLINARY

MAJOR

STAT 301: Testing Statistical Hypothesis

Full Marks: 100   (4 Credits)

Course Outcome: Students will understand concepts of Statistical hypothesis, developing tests to test the hypothesis Formulation of Statistical hypothesis is real life situations. Apply appropriate test to validate the hypothesis.

Unit – 1

General Procedure of Testing of Hypothesis, Large sample tests: use of central limit theorem for testing significance of single proportion, difference of two proportions, single mean, difference of two means.

Unit – 2

Small sample tests: testing of significance of single mean and difference of two means for known variance case. Exact tests involving application of χ^2 distribution, test of goodness of fit and independence of attributes, contingency tables.

Unit – 3

Exact testing procedures involving applications of t and F distributions: exact tests of significance of mean and variance from normal population with unknown variance, paired and non-paired t tests, test of simple and multiple correlation coefficients, equality of variances, uses of fisher's Z transformation.

Unit – 4

Non-parametric test, Need of non-parametric test. sign test, run test, median test, Spearmen's rank correlation test, Wilcoxon Mann-Whitney test, Kolmogorov Smirnov - one sample and twosample tests.

Books for references:

1. Hogg R.V. and Craig A.T. (1978) : *Introduction of Mathematical Statistics*, Fourth Edition, Collier Macmillon Publishers.
2. Mood A.M., Graybill E.A. and Bose D.C. (1974) : *Introduction to the Theory of Statistics*,McGraw Hill.
3. Rohtagi V.K. (1967) : *An Introduction to Probability Theory and Mathematical Statistics*,John Wiley and Sons.
4. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : *An Outline of Statistical Theory*, Vol. 1, The World Press Publishers Pvt. Ltd. Calcutta.

FIFTH SEMESTER

DISCIPLINARY MAJOR

STAT 302: Order Statistics

Full Marks: 100   (4 Credits)

Course Outcome:☐ Students will understand concepts of Transformations of random variables☐Order Statistics.

Unit – 1

Transformations of random variables: Transformations of one dimensional and two dimensional random variables, discrete and continuous cases, definitions.

Unit – 2

Simple applications of transformation of random variables, illustrations and derivations involving important distributions of random variables and sampling distributions and/or their functions.

Unit – 3

Order Statistics: Introduction, ordered sample, definition of order statistics, sample median, sample range, smallest and largest order statistics and their distributions.

Unit – 4

Distribution of the rth order statistics. Joint distribution of $r^{th}$and s^{th}order statistics, distribution of samplemedian and sample range.

Books for references:

1. Hogg R.V. and Craig A.T. (1978) : *Introduction of Mathematical Statistics*, Fourth Edition, Collier Macmillon Publishers.
2. Mood A.M., Graybill E.A. and Bose D.C. (1974) : *Introduction to the Theory of Statistics*,McGraw Hill.
3. Rohtagi V.K. (1967) : *An Introduction to Probability Theory and Mathematical Statistics*,John Wiley and Sons.
4. Goon A.M., Gupta M.K. and Dasgupta B. (1980) : *An Outline of Statistical Theory*, Vol. 1, The World Press Publishers Pvt. Ltd. Calcutta.

SIXTH SEMESTER

DISCIPLINARY MAJOR

STAT 303: Linear Models and Design of Experiments

Full Marks: 100   (4 Credits)

Course Outcome: Students will understand the concepts of Linear model and ANOVA different randomized design and layout.

Unit – 1

Concepts of Linear model (fixed, random, and mixed): Analysis of Variance (ANOVA) for one way and two way classifications (equal number of observations per cell).

Unit – 2

Analysis of covariance (ANCOVA). Need for design of experiments, basic principle of experimental design: randomization, replication and local control.

Unit – 3

Complete analysis and layout of completely randomized design (CRD) and randomized block design (RBD)

Unit – 4

Analysis and layout of Latin square design (LSD).Factorial experiments and their advantages, main and interaction effects in 2^2 and 2^3 factorial experiments.

Books for references:

1. Goon A.M., Gupta M.K. and Das Gupta B. (1986) : *Fundamentals of Statistics*, Vol. II, world Press, Calcutta.
2. Cochran W.G. and Cox G.M. (1957) : *Experimental Design*, John Wiley and Sons.
3. Das, M.N. and Giri J. (1986) : *Design and Analysis of Experiments*, Springer Verlag.
4. Kempthorne O. (1965) : *The Design and Analysis of Experiments*, Wiley Eastern.
5. Duncan A.J. (1974) : *Quality Control and Industrial Statistics*, IV Edition, Taraporewala and Sons.
6. Montomery, D.C. (1991): *Introduction to the Statistical Quality Control*, 2nd Edition, John Wiley and Sons.

SIXTH SEMESTER

DISCIPLINARY MAJOR

STAT 304: Applied Statistics

Full Marks: 100   (4 Credits)

Course Outcome: Students will understand concepts of Index Numbers, construction of index numbers and their types trend and Measurement of seasonal variations.

Unit – 1

Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives, properties of relatives, construction of index numbers and their types, Laspeyre's, Paasche's, Marshal Edgeworth's and Fisher's index numbers.

Unit – 2

Ideal index numbers, tests for index number;chain base index numbers, cost of living index number.Time series: chorological data and time series, economic time series, illustration, additive and multiplicative models, definition and importance of time series analysis.Components of time series: secular trend, seasonal, cyclical and irregular components, their importance, characteristics and examples.

Unit – 3

Measurement of secular trend, seasonal and cyclical fluctuations: graphical method, method of mathematical curve fitting: use of least squares principle,moving average method and their merits and demerits

Unit – 4

Measurement of seasonal variations: simple average method, ratio to trend method, link relative method along

with merits and demerits of different procedures.

Books for references:

1. Mukhopadhyay, P. (1994) :*Applied Statistics*, new Central Book Agency Pvt. Ltd., Calcutta.
2. Goon A.M., Gupta M.K. and Das Gupta B. (1986): *Fundamentals of Statistics*, Vol. II, World Press, Calcutta.
3. Duncan A.J. (1974) : *Quality Control and Industrial Statistics*, IV Edition, Taraporewala andSons.
4. Montomery, D.C. (1991): *Introduction to the Statistical Quality Control*, 2nd Editions, JohnWiley and Sons.
5. Brown R.G. (1963): *Smoothing, Forecasting and Prediction of Discrete Time Series*,Prentice Hall.
6. Chatfield C. (1980) : *The Analysis of Time Series*, 2nd Edition, Chapman and Hall.

<p align="center">SIXTH SEMESTER</p>

<p align="center">DISCIPLINARY MAJOR</p>

<p align="center">STAT 305: Reliability Theory</p>

<p align="center">Full Marks: 100   (4 Credits)</p>

Course Outcome: ☐ Students will know about Indian Official Statistical system. ☐System reliability concepts.

<p align="center">Unit – 1</p>

Life testing and reliability theory: Basic concepts of life testing experiments, reliability, hazardfunction and their relationship.Elementary notion of censored data, type I and type II censoring schemes, Poisson process.

<p align="center">Unit – 2</p>

Parametric distributions: Weibull, gamma, lognormal, exponential as life time distributions, point and interval estimation procedures for the above distributions.

<p align="center">Unit – 3</p>

Reliability hypothesis, Testing reliability hypothesis for exponential and Weibull distributions, examples and simple elementary problems.

<p align="center">Unit – 4</p>

System reliability concepts: Parallel system, series system and k out of n system.Elementary idea of reliability models for non – maintained systems.

Books for references:

1. Bain, L. J. and Engelhardt, M.(1991): *Statistical Analysis of Reliability and Life Testing Models*, Marcel Deckker.
2. Zack, S.(1992): *Introduction to Reliability Analysis: Probability Model and Statistical Methods*,Springer Verlag.
3. Barlow, R. E. and Proschan, F.(1975): *Statistical Theory of Reliability and Life Testing: Probability Models*, HolitRinechart and Winston.
4. Gnedenko, Bylyayer and Solovyer (2014): *Mathematical Methods of Reliability Theory*.
5. Kale, B. K. and Sinha, S. K.(1980): *Life Testing and Reliability*

SIXTH SEMESTER

DISCIPLINARY MAJOR

STAT 306: Official Statistics

Full Marks: 100   (4 Credits)

Course Outcome:□ Students will know about Indian Official Statistical system □The different methods of collection of official statistics and their reliability. Principal publications and the various official agencies responsible for data collection and their main functions.

Unit – 1

Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role ofMinistry of Statistics& Program Implementation(MoSPI), Central Statistical Office (CSO).

Unit – 2

National Sample Survey Organization (NSSO), andNational Statistical Commission. Government of India's Principal publications containingdata on the topics such as population, industry and finance.

Unit – 3

Sources of population data: demographic and vital statistics,vital registration, ad-hoc surveys, hospital records, problems in vital registration system, dual report system, civil registration system in India.

Unit – 4

Population census, procedure of censusundertaking:various steps in conducting census, history of census undertaking in India, census administrative setup in India, demographic profiles of the Indian census.

Books for references:

1. Basic Statistics Relating to the Indian Economy, CSO, 1990.
2. Guide to Official Statistics, CSO, 1999.
3. Statistical System in India, CSO, 1995.
4. V.G. Panse, Estimation of Crop Yields, FAO (Rome), 1964.
5. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.

<p style="text-align:center">SEVENTH SEMESTER</p>

<p style="text-align:center">DISCIPLINARY MAJOR</p>

<p style="text-align:center">STAT 400: Research Methodology and Statistical Computing</p>

<p style="text-align:center">Full Marks: 100   (4 Credits)</p>

Course Outcome: Students will know about Research Methodology and problem identification Calculation of different statistical methods using R language.

<p style="text-align:center">Unit – 1</p>

Research Methodology: Concept and definitions, variables and hypotheses, theory and facts, formulation of researchproblems, development of research methodology, developments of knowledge-approaches, rationalistic mode, scientific mode.

<p style="text-align:center">Unit – 2</p>

Identification of problem, formulation of hypotheses, imagination in the formulation of scientific law, recognition of a problem area and identifying the relative questions.

<p style="text-align:center">Unit – 3</p>

Statistical Computing: Introduction to statistics as applied to the social sciences. Basic methodological and statistical issues in managing and analyzing data using *R*softwarewith emphasis on underlying statistical concepts.

<p style="text-align:center">Unit – 4</p>

Simple applications concerning analysis and interpretation of data using *R*: problems in frequency distribution, measures of location andvariation, probability and sampling, tests of hypotheses and significance, linear regression and correlation, time series etc.

Books for references:

1. Kothari, C.R. (1985): *Research Methodology: Methods and Techniques*, Wiley Eastern.
2. Dominowski, R.L. (1980): *Research Methods*, Prentice Hall Inc., New Jersey.
3. Mishra, R.P. (1980): *Research Methodology*, Handbook Concept Publishing Company, New Delhi.
4. Landau S. and Everitt S. (2004):*A Handbook ofStatistical Analysesusing SPS*S, Chapman & Hall/CRC Press LLC
5. Harvey G. (2019): *Excel 2019 All-in-One For Dummies.*

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SEVENTH SEMESTER

DISCIPLINARY MAJOR

STAT 401: Stochastic Processes

Full Marks: 100   (4 Credits)

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Course Outcome: Students will know fundamental concepts of dependent data sets Analyzing and interpreting financialdata sets.

<div align="center">

Unit – 1

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Definition and examples of stochastic process: classification of general stochastic processes into

discrete/continuous   time,   discrete/continuous   state   spaces,   types   of   stochastic   processes elementaryproblems, random walk, gambler's ruin problem.

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Unit – 2

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Markov chains: Definition and examples of Markov chain, transition probability matrix, classification of states, recurrence, simple problems, basic limit theorem of Markov Chain (statement only), stationary probability distribution.

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Unit – 3

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

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Unit – 4

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Branching process: Definition and examples of discrete time branching process, probability generating function,

mean and variance, probability of extinction problems.

Books for references:

1. Karlin S. and Taylor H.M. (1995): *A First Course in Stochastic Process*, Academic Press
2. Hoel P.G., Port S.C. and Stone C.J. (1991): *Introduction to Stochastic Process*, Universal Book Stall.
3. Parzen E. (1962): *Stochastic Process*, Holden-Day
4. Cinlar E. (1975) : *Introduction to Stochastic Processes*, Prentice Hall.
5. Adke S.R. and Manjunath S.M. (1984) : *An Introduction to Finite Markov Processes*, WileyEastern.
6. Medhi J. (1996) : *Stochastic Processes*, new Age International (P) Ltd.
7. Ross S.M. (1983) : *Stochastic Process*, John Wiley.
8. Taylor H.M. and Karlin S. (1999) : *Stochastic Modeling*, Academic Press.

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SEVENTH SEMESTER

DISCIPLINARY MAJOR

STAT 402: Sequential Analysis and Decision Theory

Full Marks: 100   (4 Credits)

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Course Outcome: ☐ Students will know fundamental concepts of Sequential Analysis ☐ Decision problem and Bayes Rule.

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Unit – 1

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Sequential Analysis, Sequential probability ratio test (SPRT) for simple vs simplehypotheses. Fundamental relations among α, β, A and B, determination of A and B in practice.

<div align="center">

Unit – 2

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Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal distributions.

<div align="center">

Unit – 3

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Decision problem, utility theory, loss functions, expected loss, decision rules(non-randomized and randomized), decision principles, Concept of admissibility and completeness.

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Unit – 4

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Bayes rules, admissibility of Bayes rules, minimax theorem of for finite parameter space, minimax estimators, admissibility of minimax rules, Invariant decision rules, admissibility of invariant rules.

Books for references:

1. V.K. Rohatgi (1988):*An Introduction to Probability and Mathematical Statistics*, Wiley Eastern (New Delhi),
2. J.O. Berger (1985): *Statistical Decision Theory and Bayesian Analysis*, 2nd ed., Springer-Verlag.
3. T.S. Ferguson,(1967):*Mathematical Statistics – A Decision Theoretic Approach*, Academic Press.
4. C.P. Robert (2001):*The Bayesian Choice*, Springer.
5. J.M. Bernando and A.F.M. Smith (1994):*Bayesian Theory*, John Wiley and Sons.

EIGHT SEMESTER

DISCIPLINARY

MAJOR

STAT 403: Operations Research

Full Marks: 100   (4 Credits)

Course Outcome: ☐ Students will know the different optimal techniques to solve physical problems ☐ Apply the various optimization techniques in areas of manufacturing, transportation, job assignment, inventories of stock, project monitoring.

Unit – 1

Definitions and scope of operation research, different types of models in operations research – their construction and general method of solution.

Unit – 2

Elements of linear programming problem (LPP): Canonical and standard forms, formulation of LPP,graphical method to solve two variable LPP, solution of LPP using simplex procedure, use of artificialvariables in LPP, generation of extreme point solutions, principle of duality in LPP, statement andproof of duality theorem, simple problems based on duality theorem.

Unit – 3

Allocation Models: Transportation problem (T.P.), different methods of finding initial feasible

solution of a T.P., UV method of finding optimal solution of a T.P., solution of assignment problemusing Hungarian method.Inventory Control: Definitions of various costs involved in inventory control.

Unit – 4

Theory of games: Two person zero-sum games, pure and mixed strategies, saddle point, maximin-minimax principle of rectangular games, games without saddle point, dominance and modifieddominance principles, graphical solution of 2xN and Mx2 games, reduction of game problems to aL.P.P.

Books for references:

1. Hiller F.S. and Libermann G.J. (1995): *Introduction to Operations Research*, McGraw Hill.
2. Taha, H.A. (1999): *Operations Research*, Macmillan Publishing Company.
3. Hadley G. (1965) : *Linear programming*, Addison Wesley.
4. Gass G.I. (1958): *Linear Programming- Methods and Applications*, McGraw Hill.
5. McKinsey J.C.C. (1952): *Introduction to the Theory and Games*, McGraw Hill Book Co.
6. KantiSwaroop, Gupta P.K. and Singh M.M. (1985) : *Operations Research*, Sultan Chand and Sons.

EIGHT SEMESTER

DISCIPLINARY

MAJOR

STAT 404: Time Series Analysis

Full Marks: 100   (4 Credits)

Course Outcome: Students will understanding of the concepts of time series and its applications in different areas.

Unit-1

Introduction: Examples, simple descriptive techniques, trend, seasonality, the correlogram.

Unit-2

Probability models for time series: stationary, moving average (MA), autoregressive (AR),ARMA and ARIMA models.

Unit-3

Estimating the autocorrelation function and fitting ARIMA models.Forecasting: Exponential smoothing, forecasting from ARIMA models.

Unit-4

Stationary processes in the frequency domain: The spectral density function, the periodogram,spectral analysis.State-space models: Dynamic linear models and the Kalman filter.

Books for references:

1.George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel*(2008): Time Series Analysis*, John Wiley &

Sons, Inc.

2.W.A.Fuller (1995):*Introduction to Time Series Analysis*, 2nd Edition, <u>Wiley Series in Probability and Statistics</u>
3. A.StuartKendall and J.K. Ord(1967):*The Advanced Theory of Statistics*, Vol. 2: Inference and
Relationship, 2nd Edition

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EIGHT SEMESTER

DISCIPLINARY

MAJOR

STAT 405: Statistical Computing Using R

Full Marks: 100   (4 Credits)

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Course Outcome: □ Students will know the history of R and different loading packages □Mathematical and logical operator, Basic introduction to Graphics and Basic Statistical Methods.

<div align="center">Unit-1</div>

History of R, introduction and some preliminaries concepts to R, Getting help and loading packages, R as a calculator.Object types in R: numeric, logical, character, integer and complex. Various data types in R: Vectors and matrices, lists and data frames. Manipulation with numbers and vectors. Data Input, reading data from files, export data.

<div align="center">Unit-2</div>

Mathematical and logical operator, conditional execution and looping (if, if else, for, while, switch, repeat) and their illustration. Arrays: One dimensional, two dimensional and multidimensional arrays.

<div align="center">Unit-3</div>

Basic introduction to Graphics: High level & low level, Summarizing Data, Numerical Summary and Graphical Summary (Box plot, histogram, and other useful plots).

<div align="center">Unit-4</div>

Basic Statistical Methods: Descriptive Statistics, Linear Regression and Correlation using R function, Analysis of Variance. Parametric and Non parametric statistical test using R.

Books for References:

1. Crawley, M.J. (2005): Statistics: *An Introduction Using* R (English)

2. Dalgaard, P. (2008):*Introductory Statistics with R*. New York: Springer-Verlag.

3. Fox, J. (2002): *An R and S-Plus Companion to Applied Regression*. Thousand Oaks, CA: Sage.

4. HothormTorsten and Everitt Brain S.(2014): *A Handbook of Statistical Analyses using R*, CRC press.

EIGHT SEMESTERS

DISCIPLINARY MAJOR

STAT 406: Discrete Data Analysis

Full Marks: 100   (4 Credits)

Course Outcome: Students will know Categorical response dataand their probability distribution and contingency table logistic and Poisson regression models and model adequacy checking.

Unit-1

Categorical response data, Probability distribution for categorical data, The binomial distribution, The multinomial distribution, The Poisson distribution, Statistical inference for a proportion, More on statistical inference for discrete data, Wald, likelihood- ratio, and score inference, Small-sample binomial inference.

Unit-2

2×2 contingency table and its probability structures (joint, marginal, and conditional probabilities). comparing proportions in two-by-two contingency tables using proportions, Odds ratio and relative risk approaches. Analysis of $\square \times \square$ contingency tables: analysis of Chi-square tests of independence, Likelihood- ratio statistic, testing for independence for ordinal data. Analysis of three-way and multi-way contingency tables.

Unit-3

The logistic regression model and its inference. Building and checking model adequacy in logistic regression. Logit models for nominal responses and cumulative logit models for ordinal responses.

Unit-4

Poisson regression model and its inference. Forward and backward procedures. Negative binomial regression.

Textbook: Agresti, A. (2007):*An Introduction to Categorical Data Analysis* (2nd edition). Wiley, New Jersey.

References

1. Christensen, R. (1997):*Log-linear models and logistic regression*, second edition, Springer, New York.

2. Agresti A. (2002):*Categorical Data Analysis*. (2nd ed.), Wiley, New York.

3. Chap, T. L. (1998):*Applied Categorical Data Analysis*. John Wiley and Sons, New York.

4. Collett, D. (2003):*Modelling Binary data* , 2nd ed, Chapman -Hall, London.

5. Hosmer, D. W and Lemeshow S. (2000):*Applied Logistic Regression* (2nd Edition)., Wiley, New York.

6. Lloyd, C. J. (1999): *Statistical Analysis of Categorical Data*. Wiley, New York.

7. Simonoff, J. S. (2003):*Analyzing Categorical Data*. Springer, New York.

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EIGHT SEMESTER

DISCIPLINARY MAJOR

STAT 407: Multivariate Analysis

Full Marks: 100   (4 Credits)

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Course Outcome: Students will able to analyze the multivariate data using matrix theory, predict the model for multivariate variable, Analyze multiple dependent variables with independent variables, Predict and classification of data.

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Unit – 1

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Multivariate normal distribution and its properties. Random sampling from multivariatenormal distribution. Maximum likelihood estimators of parameters, distribution of samplemean vector.

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Unit – 2

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Wishart matrix – its distribution and properties, distribution of sample generalized variance,null and non-null distribution of multiple correlation coefficients.

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Unit – 3

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Hotelling's $T^2$and its sampling distribution, Classification problem- Standards of goodclassification, procedure of classification based on multivariate normal distributions.

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Unit – 4

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

Books for references:

1. T.W. Anderson (1983):*An Introduction to Multivariate Statistical Analysis*, 2nd Ed., Willey.

2. N.C. Giri (1977):*Multivariate Statistical Inference*, Academic Press.

3. A.M. Kshirsagar (1972):*Multivariate Analysis*, Marcel Dekker.

4. D.F. Morrison (1976):*Multivariate Statistical Methods*, 2nd Ed. McGraw Hill.

5. R.J. Muirhead (1982): *Aspects of Multivariate Statistical Theory*, J. Wiley.

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EIGHT SEMESTER

DISCIPLINARY MAJOR

STAT 408: Research Project

Full Marks: 100(12 Credits)

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Course Outcomes: Through a supervised project, a student will get exposure to one of the areas of research, preferably of his own choice. During the Project Work, the student will learn about the literature survey, identification of the research problem and then work on the problem during the project duration. The student will get the feel and methodology of the research work and rigorously do focused work in the area of the topic of the major research project chosen. The endeavour will be to prepare the student research- ready in the fourth year of graduation, as the student will have the opportunity to directly enter into the Ph.D. programme immediately after the B.Sc. degree with research. The student will learn to focus and complete desired task within a specified time frame.

Course Objectives:

a) To provide student with skill and knowledge in conducting research in fundamental and application aspects of Statistics.

 b) To train students in developing analytical as well as argumentative skill.

MARK DISTRIBUTION FOR PROJECT WORK:

Total marks allotted: 100

Distribution of Marks component wise: Internal Assessment (C1+C2) : 25

As per CCFUP guidelines of MZU(NEP2020)

End Semester Examination : 75

Criteria for End Semester Examination:

Sl. No.	Criteria	Marks
1	Originality and relevance The research is carried out with sufficient originality and creativity	5
2	Purpose and Objective The research problems, questions and objectives are well defined	5
3	Literature Evidence of appropriate selection and discussion of relevant literature	5
4	Methodology Appropriateness and justification of the methodology to achieve the research objectives	10
5	Discussion of findings Discussion of findings reflect learning from analysis and understanding of the implications	10
6	Presentation, Structure & Language The research is presented in an academic style Language used is good and easy to understand Use of appropriate graphics, illustrations and accurate referencing. Well structured, logical and coherent, use appropriate chapter headings.	10
7	Conclusion Conclusions add new insight to the topic of the dissertation and identify clear and practical recommendations/opportunities for further development	10
8	Contribution to knowledge The research produces new results. The results are of interest to academia or industry or otherwise relevant to professionals in the field.	5
9	Viva-Voce Presentation skills (style of presentation, language, structure, completeness and uses of time etc.) Ability to clarify questions	15
	Total	**75**

Evaluation of the Dissertation: The Project Work shall be evaluated by a Board of Examiners consisting of Supervisor, Head of concerned Department and an External Examiner approved by COE as per CCFUP guidelines of Mizoram University. The evaluation of the Project Work shall be completed before the commencement of 4th Semester Theory Examinations. The Project Work as evaluated by this Board will be final. It is to be noted that copy and pasting of articles from internet without proper permission, copying from dissertation or thesis without quoting proper references will not be accepted. If any kind of plagiarism is practiced by the student, his/her Project Work shall be liable to be rejected.

Presentation & Viva-Voce: The presentation of the Project Work will be conducted by the Board of Examiners. Other members of the faculty and students may be present. It will be presentation of 15 minutes duration and 5 minutes for Viva Voce. The logic, analysis and conclusion relevant to the Project Work mentioned under assessment would be the main subject matter for the Viva Voce.

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