Syllabus

For

Bachelor of Arts/Science Programme

in

STATISTICS

Under Choice Based Credit System(CBCS)

(2023-24 onwards)

of

NEW EDUCATION POLICY-2020

19/9/23

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Statistics

Course Structure of Four Year B.A. / B.Sc. Course in Statistics

Semester-I

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Descriptive Statistics (T)	MJC-1 (T)	4-1-0	4	100
2	Descriptive Statistics (P)	MJC-1 (P)	0-0-2	2	100
3	Introduction to Statistics (T)	MIC-1 (T)	2-1-0	2	100
4	Introduction to Statistics (P)	MIC-1 (P)	0-0-1	1	100
5	Basics of Statistics (T)	MDC-1 (T)	2-1-0	2	100
6	Basics of Statistics (P)	MDC-1 (P)	0-0-1	1	100
7	MIL (select from the basket)	AEC-1	2-1-0	2	100
8	Skill Enhancement Course (select from the basket)	SEC-1	3-0-3	3	100
9	Value Added Course (select from the basket)	VAC-1	3-0-3	3	100
Total Credit- 20					

Semester-II

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Theory of Probability (T)	MJC-2 (T)	4-1-0	4	100
2	Theory of Probability (P)	MJC-2 (P)	0-0-2	2	100
3	Probability Theory and Probability Distribution (T)	MIC-2 (T)	2-1-0	2	100
4	Probability Theory and Probability Distribution (P)	MIC-2 (P)	0-0-1	1	100
5	Introductory Probability (T)	MDC-2 (T)	2-1-0	2	100
6	Introductory Probability (P)	MDC-2 (P)	0-0-1	1	100
7	Environmental Science	AEC-2	2-1-0	2	100
8	Skill Enhancement Course (select from the basket)	SEC-2	3-0-3	3	100
9	Value Added Course (select from the basket)	VAC-2	3-0-3	3	100
Total Credit- 20					

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Semester-III

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Numerical Analysis & Sampling Distribution (T)	MJC-3 (T)	3-1-0	3	100
2	Numerical Analysis & Sampling Distribution (P)	MJC-3(P)	0-0-2	2	100
3	Real Analysis and Matrices (T)	MJC-4 (T)	3-1-0	3	100
4	Real Analysis and Matrices (P)	MJC-4 (P)	0-0-1	1	100
5	Introductory Numerical Analysis & Sampling Distribution (T)	MIC-3 (T)	2-1-0	2	100
6	Introductory Numerical Analysis & Sampling Distribution (P)	MIC-3 (P)	0-0-1	1	100
7	Basics of Sampling Distribution and Test of Significance (T)	MDC-3 (T)	2-1-0	2	100
8	Basics of Sampling Distribution and Test of Significance (P)	MDC-3 (P)	0-0-1	1	100
9	Disaster Risk Management	AEC-3	2-1-0	2	100
10	Skill Enhancement Course (select from the basket)	SEC-3	3-1-0	3	100
Total Credit- 20					

Semester-IV

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Statistical Inference (T)	MJC-5 (T)	3-1-0	3	100
2	Statistical Inference (P)	MJC-5 (P)	0-0-2	2	100
3	Non- Parametric and Sequential Analysis (T)	MJC-6 (T)	3-1-0	3	100
4	Non - Parametric and Sequential Analysis (P)	MJC-6 (P)	0-0-2	2	100
5	Demography & Vital Statistics (T)	MJC-7 (T)	3-1-0	3	100
6	Demography & Vital Statistics (P)	MJC-7 (P)	0-0-2	2	100
7	Introduction to Statistical Inference (T)	MIC-4 (T)	2-1-0	2	100
8	Introduction to Statistical Inference (P)	MIC-4 (P)	0-0-1	1	100
9	NCC/NSS/NGOs/Social Service/ Scout and Gulde/Sports	AEC-4	2-1-0	2	100
Total Credit- 20					

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Semester-V

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Survey Sampling & Indian Official Statistics (T)	MJC-8 (T)	3-1-0	3	100
2	Survey Sampling & Indian Official Statistics (P)	MJC-8 (P)	0-0-2	2	100
3	Statistical Computing using C and R (T)	MJC-9 (T)	3-1-0	3	100
4	Statistical Computing using C and R (P)	MJC-9 (P)	0-0-2	2	100
5	Introduction to Survey Sampling & Indian Official Statistics (T)	MIC-5 (T)	2-1-0	2	100
6	Introduction to Survey Sampling& Indian Official Statistics (P)	MIC-5 (P)	0-0-1	1	100
7	Introduction to Statistical Computing using C and R (T)	MIC-6 (T)	2-1-0	2	100
8	Introduction to Statistical Computing using C and R (P)	MIC-6 (P)	0-0-1	1	100
9	Internship	INT-1		4	100
Total Credit- 20					

Semester-VI

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Linear Models (T)	MJC-10 (T)	3-1-0	3	100
2	Linear Models (P)	MJC-10 (P)	0-0-1	1	100
3	Design of Experiments (T)	MJC-11 (T)	3-1-0	3	100
4	Design of Experiments (P)	MJC-11 (P)	0-0-2	2	100
5	Index number &Time Series Analysis (T)	MJC-12 (T)	3-1-0	3	100
6	Index number &Time Series Analysis (P)	MJC-12 (P)	0-0-2	2	100
7	Introduction to Design of Experiments (T)	MIC-7 (T)	2-1-0	2	100
8	Introduction to Design of Experiments (P)	MIC-7 (P)	0-0-1	1	100
9	Basics of Index number &Time Series Analysis (T)	MIC-8 (T)	2-1-0	2	100
10	Basics of Index number &Time Series Analysis (P)	MIC-8 (P)	0-0-1	1	100
Total Credit- 20					

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Semester- VII

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Statistical Quality Control (T)	MJC-13 (P)	3-1-0	3	100
2	Statistical Quality Control (P)	MJC-13 (T)	0-0-2	2	100
3	Research Methodology	MJC-14 (T)	5-1-0	5	100
4	Multivariate Analysis (T)	MJC-15	4-1-0	4	100
5	Multivariate Analysis (P)	MJC-15 (T)	0-0-2	2	100
6	Introduction to Statistical Quality Control (T)	MIC-9 (T)	3-1-0	3	100
7	Introduction to Statistical Quality Control (P)	MIC-9 (P)	0-0-1	1	100
Total Credit- 20					

Semester- VIII

Sl. No.	Name of Course	Type of Course	L-T-P (per week)	Credit	Marks
1	Operations Research (T)	MJC-16 (T)	3-1-0	3	100
2	Operations Research (P)	MJC-16 (P)	0-0-1	1	100
3	Introductory Operations Research (T)	MIC-10 (T)	3-1-0	3	100
4	Introductory Operations Research (P)	MIC-10 (P)	0-0-1	1	100
5	Research Project/ Dissertation	RP-I		12	
Total Credit- 20					

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(A) Major Core Courses

Sl. No.	SEM	Type of Course	Name of Course	Credits	Marks
1.	I	MJC-1 (T)	Descriptive Statistics (T)	4	100
		MJC-1 (P)	Descriptive Statistics (P)	2	100
2.	II	MJC-2 (T)	Theory of Probability (T)	4	100
		MJC-2 (P)	Theory of Probability (P)	2	100
3.	III	MJC-3 (T)	Numerical Analysis & Sampling Distribution (T)	3	100
		MJC-3 (P)	Numerical Analysis & Sampling Distribution (P)	2	100
4.	III	MJC-4 (T)	Real Analysis and Matrices (T)	3	100
		MJC-4 (P)	Real Analysis and Matrices (P)	1	100
5.	IV	MJC-5 (T)	Statistical Inference (T)	3	100
		MJC-5 (P)	Statistical Inference (P)	2	100
6.	IV	MJC-6 (T)	Non- Parametric and Sequential Analysis (T)	3	100
		MJC-6 (P)	Non - Parametric and Sequential Analysis (P)	2	100
7.	IV	MJC-7 (T)	Demography & Vital Statistics (T)	3	100
		MJC-7 (P)	Demography & Vital Statistics (P)	2	100
8.	V	MJC-8 (T)	Survey Sampling & Indian Official Statistics (T)	3	100
		MJC-8 (P)	Survey Sampling & Indian Official Statistics (P)	2	100
9.	V	MJC-9 (T)	Statistical Computing using C and R (T)	3	100
		MJC-9 (P)	Statistical Computing using C and R (P)	2	100
10.	VI	MJC-10 (T)	Linear Models (T)	3	100
		MJC-10 (P)	Linear Models (P)	1	100
11.	VI	MJC-11 (T)	Design of Experiments (T)	3	100
		MJC-11 (P)	Design of Experiments (P)	2	100
12.	VI	MJC-12 (T)	Index Number &Time series Analysis (T)	3	100
		MJC-12 (P)	Index Number &Time series Analysis (P)	2	100
13.	VII	MJC-13 (T)	Statistical Quality Control (T)	3	100
		MJC-13 (P)	Statistical Quality Control (P)	2	100
14.	VII	MJC-14	Research Methodology	5	100
15.	VII	MJC-15 (T)	Multivariate Analysis (T)	4	100
		MJC-15 (P)	Multivariate Analysis (P)	2	100
16.	VIII	MJC-16 (T)	Operations Research (T)	3	100
		MJC-16 (P)	Operations Research (P)	1	100

Sub Total = 80

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(B) Minor Courses to be offered by the Department for Students of other Departments of Science

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	I	MIC-1 (T)	Introduction to Statistics (T)	2	100
		MIC-1 (P)	Introduction to Statistics (P)	1	100
2.	II	MIC-2 (T)	Probability Theory and Probability Distribution (T)	2	100
		MIC-2 (P)	Probability Theory and Probability Distribution (P)	1	100
3.	III	MIC-3(T)	Introductory Numerical Analysis & Sampling Distribution (T)	2	100
		MIC-3 (P)	Introductory Numerical Analysis & Sampling Distribution (P)	1	100
4.	IV	MIC-4 (T)	Introduction to Statistical Inference (T)	2	100
		MIC-4 (P)	Introduction to Statistical Inference (P)	1	100
5.	V	MIC-5 (T)	Introduction to Survey Sampling & Indian Official Statistics (T)	2	100
		MIC-5 (P)	Introduction to Survey Sampling & Indian Official Statistics (P)	1	100
6.	V	MIC-6 (T)	Basics of Statistical Computing using C and R (T)	2	100
		MIC-6 (P)	Basics of Statistical Computing using C and R (P)	1	100
7.	VI	MIC-7 (T)	Introduction to Design of Experiments (T)	2	100
		MIC-7 (P)	Introduction to Design of Experiments (P)	1	100
8.	VI	MIC-8 (T)	Basics of Index Number & Time series Analysis (T)	2	100
		MIC-8 (P)	Basics of Index Number & Time series Analysis (P)	1	100
9.	VII	MIC-9 (T)	Introduction to Statistical Quality Control (T)	3	100
		MIC-9(P)	Introduction to Statistical Quality Control (P)	1	100
10.	VIII	MIC-10(T)	Introductory Operations research (T)	3	100
		MIC-10(P)	Introductory Operations research (P)	1	100

Sub Total = 32

(C) Multidisciplinary Courses to be offered

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	I	MDC-1	Basics of Statistics	3	100
2.	II	MDC-2	Introductory Probability	3	100
3.	III	MDC-3	Basics of Sampling Distribution and Test of Significance	3	100

Sub Total = 09

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(D) Ability Enhancement Courses to be offered

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	I	AEC-1	MIL	2	100
2.	II	AEC-2	Environmental Science	2	100
3.	III	AEC-3	Disaster Risk Management	2	100
4.	IV	AEC-4	NCC/NSS/NGOs/Social Service/ Scout and Guide/Sports	2	100

Sub Total = 08

(E) Skill Enhancement Courses to be offered

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	I	SEC-1	To be selected from the basket	3	100
2.	II	SEC-2	To be selected from the basket	3	100
3.	III	SEC-3	To be selected from the basket	3	100

Sub Total = 09

(F) Value Added Courses to be offered

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	I	VAC-1	To be selected from the basket	3	100
2.	II	VAC-2	To be selected from the basket	3	100

Sub Total = 06

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	v	INT-1	Internship	4	100

Sl. No.	Sem	Type of Course	Name of Course	Credits	Marks
1.	VIII	RP-1	Research Project/Dissertation	12	100

Grand Total = 160 Credits

(G) Basket for Multidisciplinary Courses (MDC)
To be decided by Respective Department

(H) Basket for Skill Enhancement Courses (SEC)
See at the end of structure (this booklet)

(I) Basket for Value Added Courses (VAC)
See at the end of structure (this booklet)

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SEMESTER–I

MJC-1 (T): Descriptive Statistics

Credits: 4 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of descriptive statistics including graphical representation
- To introduce theory of Attributes

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the basic problem in statistics.
- Understand the statistical data, graphical presentation and scales of measurements.
- Apply various statistical methods to analyze the statistical data.
- Use the Correlation coefficient and Rank Correlation etc.
- Apply regression analysis and fitting of different polynomials curves.
- Measure the degree of association between two variables.

UNIT I No. of hours: 09

Statistical Methods: Definition and scope of Statistics, concepts of population and sample. Data: quantitative and qualitative, variables, frequency and non frequency. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical including histogram, ogives and box plot.

UNIT II No. of hours: 11

Measures of Central Tendency: mathematical and positional, their relative merits and demerits. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation. Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

UNIT III No. of hours: 11

Bivariate data: Definition, scatter diagram, Karl Pearson product moment correlation coefficient and its properties, rank correlation, partial and multiple correlation (3 variables only). Simple linear regression, properties of regression coefficients, principle of least squares and fitting of polynomials and exponential curves.

UNIT IV No. of hours: 09

Theory of Attributes: Notations, Dichotomy, classes & class frequency, consistency of data and its conditions of independence of attributes, criterion of independence, Association of attributes, Yule's coefficient of association.

Suggested Reading:

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

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3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, Tata McGraw-Hill Pub. Co. Ltd.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.

MJC-1 (P): Descriptive Statistics

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-1 (T)

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MIC-1 (T): Introduction to Statistics

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic idea of descriptive statistics including graphical representation
- To introduce the concept of simple linear regression

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the basic problem in statistics
- Understand the statistical data, graphical presentation,
- Apply various statistical methods to analyze the statistical data,
- Use the Correlation coefficient and Rank Correlation etc.
- Apply simple linear regression analysis.

UNIT I No. of hours: 04

Statistical Methods: Definition and scope of Statistics, concepts of population and sample. Data: quantitative and qualitative, variables, frequency and non frequency. Scales of measurement- nominal, ordinal, Presentation of data: tabular and graphical including histogram, and ogives.

UNIT II No. of hours: 06

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation. Moments, skewness and kurtosis.

UNIT III No. of hours: 05

Bivariate data: Definition, scatter diagram, Karl Pearson product moment correlation coefficient and its properties, rank correlation.

UNIT IV No. of hours: 05

Simple linear regression, properties of regression coefficients, principle of least square.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, Tata McGraw-Hill Pub. Co. Ltd.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.

MIC-1 (P): Introduction to Statistics

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-1 (T)

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MDC-1 (T): Basics of Statistics

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic idea of descriptive statistics including graphical representation
- To introduce the concept of simple linear regression

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the basic problem in statistics
- Understand the statistical data, graphical presentation,
- Apply various statistical methods to analyze the statistical data
- Use the Correlation coefficient
- Apply simple linear regression analysis.

UNIT I No. of hours: 04

Definition and scope of Statistics, concepts of population and sample. Data: quantitative and qualitative, variables, frequency and non-frequency. Presentation of data: tabular and graphical including bar, line diagram and pie chart.

UNIT II No. of hours: 06

Histogram and ogives. Measures of Central Tendency: mean, median, mode, geometric and harmonic mean and their properties.

UNIT III No. of hours: 05

Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, skewness and kurtosis

UNIT IV No. of hours: 05

Bivariate data: Scatter diagram, Karl Pearson product moment correlation coefficient and its properties. Simple linear regression.

SUGGESTED READING:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, Tata McGraw-Hill Pub. Co. Ltd.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.

MDC-1 (P): Basics of Statistics

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MDC-1 (T)

SEMESTER–II

MJC-2 (T): Theory of Probability

Credits: 4 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic concept of probability and probability distribution.
- To introduce mathematical expectation and moment generating function

Course Outcomes:

After the completion of the course, the students will be able to:

- Understand the concept of probability
- Find elementary probability of an event
- Use various rules in the theory of elementary probability
- Apply Random Variables and their probability distribution
- Compute marginal and conditional distribution for two dimensional random variable,
- Use mathematical expectation and m.g.f and c.f.
- Understand special probability distributions with their properties.

UNIT I No. of hours: 09

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic., laws of addition and multiplication, independence and mutual independence of events, theorem of total probability, conditional probability, Baye's theorem and its applications.

UNIT II No. of hours: 11

Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density functions (p.d.f) and cumulative density function (c.d.f) with illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal, and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.

UNIT III No. of hours: 10

Mathematical Expectation and Generating Functions: Expectation of univariate and bivariate random variables and its properties. Moments, moment generating function (m.g.f) and characteristic function (c.f.), Uniqueness and inversion theorems (without proof) along with applications, Conditional expectations.

UNIT IV No. of hours: 10

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hyper-geometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Pearson Education, New Delhi.

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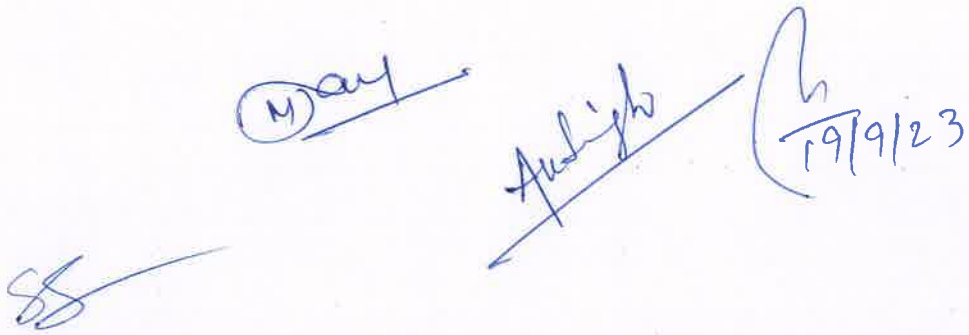
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.

MJC- 2 (P): Theory of Probability

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-2 (T)



MIC-2 (T): Probability Theory and Probability Distributions

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic concept of probability and probability distribution.
- To introduce mathematical expectation and moment generating function

Course Outcomes:

After the completion of the course, the students will be able to:

- Understand the concept of probability
- Find elementary probability of an event
- Use various rules in the theory of elementary probability
- Apply Random Variables and their probability distribution
- Understand special probability distributions with their properties.

UNIT I No. of hours: 06

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic, laws of addition and multiplication, independence and conditional probability

UNIT II No. of hours: 05

Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density functions (p.d.f), cumulative density function (c.d.f), and its properties, univariate transformations with illustrations.

UNIT III No. of hours: 04

Expectation of random variable with properties and moments, moment generating function (m.g.f) and characteristic function (c.f).

UNIT IV No. of hours: 05

Standard probability distributions: Binomial, Poisson, geometric, uniform, normal, exponential, and gamma along with their properties.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006), John E. Freund's Mathematical Statistics with Applications, Pearson Education, Asia.
3. Myer, P.L. (1970), Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.

MIC-2 (P): Probability Theory and Probability Distributions

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-2 (T)

MDC-2 (T): Introductory Probability

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic concept of probability and probability distribution.
- To introduce mathematical expectation and moment generating function

Course Outcomes:

After the completion of the course, the students will be able to:

- Understand the concept of probability
- Find elementary probability of an event
- Use various rules in the theory of elementary probability
- Apply Random Variables and their probability distribution
- Use mathematical expectation and m.g.f.
- Understand special probability distributions with their properties.

UNIT I No. of hours: 06

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic, laws of addition and multiplication, independence and conditional probability

UNIT II No. of hours: 05

Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density functions (p.d.f), cumulative density function (c.d.f), and its properties.

UNIT III No. of hours: 04

Expectation of random variable with properties and moments, moment generating function (m.g.f).

UNIT IV No. of hours: 05

Standard probability distributions: Binomial, Poisson, normal distribution and its properties.

SUGGESTED READING:

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006), John E. Freund's Mathematical Statistics with Applications, Pearson Education, Asia.
3. Myer, P.L. (1970), Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi

MDC-2 (P): Introductory Probability

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MDC-2 (T)

SEMESTER–III

MJC-3 (T): Numerical Analysis & Sampling Distribution

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of numerical analysis
- To introduce sampling Distribution

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the basic operators of finite difference.
- Understand the interpolation and extrapolation problem of real life situation .
- Understand the basics of Testing of significance
- Apply testing of hypothesis in the real life problem
- Acquire the basic sampling distributions and their properties.

UNIT I No. of hours: 07

Finite difference: Different types of operators and their properties, fundamental theorem of finite differences, missing terms (equal intervals), factorial notation. Assumptions and uses of interpolation. Gregory Newton's Forward and Backward Interpolation formula for equal intervals.

UNIT II No. of hours: 05

Interpolation with arguments at unequal intervals divided differences Δ, theorems on divided differences, Newton's divided difference formula, Lagrange's interpolation formula.

UNIT III No. of hours: 09

Parameter and statistic, sampling distribution of a statistics, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors and critical region. Large sample tests, Test of proportion, mean and standard deviation (For one and two-sample).

UNIT IV No. of hours: 09

Exact sampling distribution: Definition and derivation of p.d.f. of $\chi 2$, Student's t and Fishers F-distribution, with their mean, variance, m.g.f., and cumulant generating function, additive property and limiting form of $\chi 2$, t, F distribution. Relationship between them and their applications.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Saxena, H. C. (2010): Calculus of finite differences, S. Chand & Sons, New Delhi.
4. Sastery S.S.(2012) : Introductory Methods of Numerical Analysis, Prentice Hall of India

19/9/23

MJC-3 (P): Numerical Analysis & Sampling Distribution

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-3 (T)

19/9/23

MJC-4 (T): Real Analysis and Matrices

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of real analysis
- To introduce the Matrices theory

Course Outcomes:

After the completion of the course, the students will be able to:

- Acquire the basic knowledge of real number system and their properties.
- Understanding the basic concept of limit and continuity
- Apply the limit and continuity concept in statistical problem.
- Understand the Matrices theory and their application.

UNIT I No. of hours: 08

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhood sand limit points, Superimum and infimum, open and closed sets, sequences and their convergence. Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test.

UNIT II No. of hours: 08

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions.

UNIT III No. of hours: 07

Different types of Matrices. Algebra of Matrices. Adjoint and inverse of a Matrix, different ways of finding inverse, partitioning, characteristic equation and Calay- Hamilton theorem.

UNIT IV No. of hours: 07

Elementary row and column operations. Elementary matrices, equivalent matrices, rank of a matrix, invariance of rank through elementary row/column operations, rank of sum and product of matrices and related theorems. Solution of a system of linear equations.

Suggested Reading:

1. Malik, S. C. and Arora S. (1994): Mathematical Analysis, Wiley eastern Limited, New Age International limited, New Delhi.
2. Narayan, S.(1987): A Course of Mathematical Analysis, S. Chand & co.(Pvt.) Ltd.,New Delhi.
3. Narayan, S and Mittal, P.K. (2010): A testbook of Matrices, S. Chand & Sons, New Delhi.
4. Vasishtha, A.R., and Vasishtha A.K.(1991) : Mateices, Krishna Prakashan Media.

MJC-4 (P): Real Analysis and Matrices

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-4 (T)

MIC-3(T): Introductory Numerical Analysis & Sampling Distribution

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of numerical analysis
- To introduce sampling Distribution

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the basic operators of finite difference.
- Understand the interpolation and extrapolation problem of real life situation.
- Understand the basics of Testing of significance
- Apply testing of hypothesis in the real life problem
- Acquire the basic sampling distributions and their properties.

UNIT I No. of hours: 06

Finite difference: Forward difference operation Δ, The shift operator E, properties of operator Δ and E. Assumptions and uses of interpolation. Gregory Newton's Forward and Backward Interpolation formula for equal intervals.

UNIT II No. of hours: 04

Interpolation with arguments at unequal intervals divided differences Δ, divided differences table, Newton's divided difference formula, Lagrange's interpolation formula

UNIT III No. of hours: 05

General Quadrature Formula for equidistant ordinates, Trapezoidal Rule, Simpson's one-third rule, Simpson's three- eight rule.

UNIT IV No. of hours: 05

Exact sampling distribution: Definition of $\chi 2$, Student's t and Fishers F-distribution, mean, variance, and m.g.f., of $\chi 2$, t, F distribution.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Saxena, H. C. (2010): Calculus of finite differences, S. Chand & Sons, New Delhi.
4. Sastry S.S.(2012) : Introductory Methods of Numerical Analysis, Prentice Hall of India.

MIC-3 (P): Introductory Numerical Analysis & Sampling Distribution

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-3 (T)

MDC-3 (T): Basics of Sampling Distribution and Test of Significance

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of numerical analysis
- To introduce sampling Distribution

Course Outcomes:

After the completion of the course, the students will be able to:

- Differentiate between the population and sample
- Understand the basics of Testing of significance
- Apply testing of hypothesis in the real life problem
- Acquire the basic sampling distributions and their properties.

UNIT I No. of hours: 06

Population and Sample, Parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors and critical region.

UNIT II No. of hours: 04

Large sample tests, standard normal variate, testing of mean and proportion, testing of difference of two mean and two proportion.

UNIT III No. of hours: 04

Exact sampling distribution: $\chi 2$, Student's t and Fishers F-distribution and their mean and variance.

UNIT IV No. of hours: 06

Application of Exact sampling distributions: testing of one sample mean, two sample mean, pair t-test, testing of variance and goodness of fit.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Saxena, H. C. (2010): Calculus of finite differences, S. Chand & Sons, New Delhi.
4. Sastery S.S.(2012) : Introductory Methods of Numerical Analysis, Prentice Hall of India.

MDC-3 (P): Basics of Sampling Distribution and Test of Significance

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MDC-3 (T)

19/9/23

SEMESTER–IV

MJC-5(T): Statistical Inference

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of inferential statistics
- To learn the estimation techniques to estimate the parameters of the population
- To introduce theory behind test of significance.

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the estimation and testing problems of real life.
- develop/find best point estimators based on the desirable properties
- understand the basic principle of Bayesian estimation
- Develop / construct best/most powerful statistical tests to test hypotheses regarding unknown population parameters.

UNIT I No. of hours: 08

Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. Factorization theorem. Cramer-Rao inequality and MVB estimators (statement and applications), Minimum variance unbiased estimator (MVUE), Rao-Blackwell theorem.

UNIT II No. of hours: 06

Methods of Estimation: Method of moments, method of maximum likelihood and minimum chi square, properties of maximum likelihood estimators and minimum chi square (without proof).

UNIT III No. of hours: 08

Confidence interval: Confidence interval for mean, proportion and variance. Bayesian Estimation: Loss function, prior distribution, Bayes theorem, posterior distributions, Bayes risk, Bayes principle, Bayes estimators.

UNIT IV No. of hours: 08

Testing of hypothesis: Null and alternative hypotheses, simple and composite hypotheses. Type-I and Type-II errors, critical region, level of significance, size and power of a test, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Rohatgi V. K. and Saleh, A.K. Md. E (2009): An Introduction to Probability and Statistics, John Wiley and Sons.
4. Mood A.M, Graybill F.A. and Boes D.C,: Introduction to the Theory of Statistics, McGraw Hill.

19/9/23

MJC-5 (P): Statistical Inference

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-5 (T)

19/9/23

MJC-6(T): Non- Parametric and Sequential Analysis

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the Non-parametric test
- To introduce the sequential analysis

Course Outcomes:

After the completion of the course, the students will be able to:

- to understand the basic concept of Non-parametric
- Apply distribution free statistical tests to test hypotheses regarding unknown population parameters.

UNIT I No. of hours: 05

Nonparametric Tests: Introduction and Concept, advantages of Non-parametric tests over parametric tests. Concept of a distribution free statistic.

UNIT II No. of hours: 14

Single sample and two samples Nonparametric tests: Wald- Wolftzman Run test, Test for randomness based on total number of runs, Sign tests, Median test, Mann-Whitney U- test.

UNIT III No. of hours: 11

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

UNIT IV No. of hours: 10

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

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Rohatgi V. K. and Saleh, A.K. Md. E (2009): An Introduction to Probability and Statistics, John Wiley and Sons.
4. Mood A.M, Graybill F.A. and Boes D.C.: Introduction to the Theory of Statistics, McGraw Hil.

MJC-6(P): Non- Parametric and Sequential Analysis

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-6 (T)

19/9/23

MJC-7 (T): Demography & Vital Statistics

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

The learning objectives include:

- To collect valid Demographic data using different methods.
- To learn basic measures of Mortality, Fertility and Population Growth.
- To construct life tables.

Course Outcomes:

After the completion of the course, the students will be able to:

- Understand the fundamental of demographic data.
- Understand the Distinction between Vital Statistics and Demography.
- Interpret the demographic estimators in population studies and other related areas:

UNIT I No. of hours: 08

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

UNIT II No. of hours: 07

Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

UNIT III No. of hours: 06

Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

UNIT IV No. of hours: 09

Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, The World Press, Kolkata.
3. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
4. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.

19/9/23

MJC-7 (P): Demography & Vital Statistics

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-7 (T)

MIC-4 (T): Introduction to Statistical Inference

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic of inferential statistics
- To learn the estimation techniques to estimate the parameters of the population
- To introduce theory behind test of significance.

Course Outcomes:

After the completion of the course, the students will be able to:

- Identify the estimation and testing problems of real life.
- Understand the Different methods of finding point estimators.
- find best point and confidence estimators
- Develop / construct best/most powerful statistical tests to test hypotheses regarding unknown population parameters.

UNIT I No. of hours: 06

Introduction of Statistical inference, Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. Methods of Estimation: Method of moments, method of maximum likelihood, properties of maximum likelihood estimators (without proof).

UNIT II No. of hours: 04

Testing of hypothesis: Null and alternative hypotheses, simple and composite hypotheses, Type-I and Type-II errors, critical region, level of significance, size and power of a test, best critical region

UNIT III No. of hours: 05

Test based on t- distribution, Test of single mean, difference of two means, paired t-test, test for sample correlation coefficient. Test based on chi square- distribution and F distribution for the equality of two population variance.

UNIT IV No. of hours: 05

Non –Parametric tests: Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Rohatgi V. K. and Saleh, A.K. Md. E (2009): An Introduction to Probability and Statistics, John Wiley and Sons.
4. Mood A.M, Graybill F.A. and Boes D.C: Introduction to the Theory of Statistics, McGraw Hill.

19/9/23

MIC-4 (P): Introduction to Statistical Inference

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-4 (T)

19/9/23

SEMESTER–V

MJC-8 (T): Survey Sampling & Indian Official Statistics

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To provide tools and techniques for selecting a sample of elements from a target population keeping in mind the objectives to be fulfilled and nature of population
- To obtain estimator of the population parameter on the basis of selected sample.

Course Outcomes:

After the completion of the course, the students will have a clear understanding of

- The fundamental concepts of population and sample. (or The basic concepts of survey)
- The principles of sample survey and the steps involved in selecting a sample.
- Different sampling methods such as simple random, stratified random sampling,
- Official statistics

UNIT I No. of hours: 08

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

UNIT II No. of hours: 07

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS, Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=nxk). Comparison of systematic sampling with SRS and stratified sampling.

UNIT III No. of hours: 07

Ratio and regression method of estimation, estimate of population mean and total (of SRS of large size) and its variance. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation.

UNIT IV No. of hours: 08

Present official statistical system in India, Method of collection of official statistics, their reliability and limitations. Principle publications containing data on the topics such as population, industry and finance. Various official agencies responsible for data collection and their main function.

Suggested Reading:

1. Cochran W.G. (1984): Sampling Techniques, Wiley Eastern.
2. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics.
3. Sen Amartya (2003) : Poverty and Famines, Oxford University PLess, New Delhi.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.

MJC-8 (P): Survey Sampling & Indian Official Statistics

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-8 (T)

19/9/23

MJC-9 (T): Statistical Computing Using C and R

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the basic elements statistical computing using C and R programming.

Course Outcomes:

On successful completion of this course the students will be able to

- Describe computer Programs in C and R related to statistical data analysis
- Write computer programs in C and R related to statistical data analysis.

UNIT I No. of hours: 06

Components of C language, structure of a C program, Data types, variable declaration, Local, Global, Parametric variables, Assignment of Variables, Numeric, Character, Real and String constants, Different operators, Basic input/output.

UNIT II No. of hours: 06

Control statements: conditional statements, if - else, nesting of if - else, else if ladder, switch statements, loops in c, for, while, do - while loops, break, continue, exit ( ), goto and label declarations, One dimensional two dimensional and multidimensional arrays. Storage classes: Automatic variables, External variables, Static variables.

UNIT III No. of hours: 09

Functions: classification of functions, functions definition and declaration, assessing a function, return statement, parameter passing in functions. Pointers (concept only). Structure: Definition and declaration; structure (initialization) comparison of structure variable; Array of structures: array within structures, structures within structures, passing structures to functions; Unions accessing a union member, union of structure, initialization of a union variable, uses of union. Introduction to linked list.

UNIT IV No. of hours: 09

R language: Basics of R, naming a data object, R is a functional language, creation of data objects including vectors, factors, matrices, list and data frames. Extraction from a data object. Data Visualization: Grammar of graphics, ggplot2, scatter plot, line graphs, histograms, boxplots, bar plots, density plots. Statistics Methods and techniques in R.

Suggested Reading:

1. Balagurusamy, E. Programming in ANSI C, 6th Edition, Tata McGraw Hill.
2. Dalgaard P.. Introductory Statistics with R, Springer
3. Braun W J, and Murdoch D J: A First Course in Statistical Programming with R. Cambridge University Press. New York.

19/9/23

MJC-9 (P): Statistical Computing Using C and R

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-9 (T)

MIC-5(T): Introduction to Survey Sampling and Indian Official Statistics

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To provide tools and techniques for selecting a sample of elements from a target population keeping in mind the objectives to be fulfilled and nature of population
- To obtain estimator of the population parameter on the basis of selected sample and study its properties.

Course Outcomes:

After the completion of the course, the students will have a clear understanding of

- The fundamental concepts of population and sample. (or The basic concepts of survey)
- The principles of sample survey and the steps involved in selecting a sample.
- Different sampling methods such as simple random sampling, stratified random sampling and others
- Indian official statistical system

UNIT I No. of hours: 08

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement.

UNIT II No. of hours: 08

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations.

UNIT III No. of hours: 06

Systematic Sampling: Technique, estimates of population mean and total, Comparison of systematic sampling with SRS and stratified sampling. Cluster sampling

UNIT IV No. of hours:06

Present official statistical system in India, Method of collection of official statistics, their reliability and limitations.

Suggested Reading:

1. Cochran W.G. (1984): Sampling Techniques, Wiley Eastern.
2. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics.
3. Sen Amartya (2003) : Poverty and Famines, Oxford University PLess, New Delhi.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.

MIC 5 (P): Introduction to Survey Sampling and Indian Official Statistics

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-5 (T)

MIC-6(T): Basics of Statistical Computing Using C and R

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the basic elements statistical computing using C and R programming.

Course Outcomes:

On successful completion of this course the students will be able to

- Describe computer Programs in C/ R related to statistical data analysis
- Write computer programs in C/R related to statistical data analysis.

UNIT I No. of hours: 06

Components of C language, structure of a C program, Data types, variable declaration, Local, Global, Parametric variables, Assignment of Variables, Numeric, Character, Real and String constants, Different operators, Basic input/output.

UNIT II No. of hours: 04

Control statements: conditional statements, if - else, nesting of if – else, switch statements, loops in c, for, while, do - while loops, break, continue, exit ( ), goto and label declarations, One dimensional two dimensional.

UNIT III No. of hours: 05

Functions: classification of functions, functions definition and declaration, assessing a function, return statement. Pointers (concept only). Structure: Definition and declaration; structure (initialization) comparison of structure variable.

UNIT IV No. of hours: 05

R language: Basics of R, naming a data object, creation of data objects including vectors, matrices, list and data frames. Extraction from a data object. Data Visualization: Grammar of graphics, scatter plot, line graphs, histograms, boxplots, bar plots; Statistics Methods and techniques in R.

Suggested Reading:

1. Balagurusamy, E. Programming in ANSI C, 6th Edition, Tata McGraw Hill.
2. Dalgaard P.. Introductory Statistics with R, Springer
3. Braun W J, and Murdoch D J: A First Course in Statistical Programming with R. Cambridge University Press. New York.

MIC-6(P): Basics of Statistical Computing Using C and R

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-6 (T)

19/9/23

SEMESTER–VI

MJC-10(T): Linear Models

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the concepts of linear models.

Course Outcomes:

After the completion of the course, the students should be well versed with

- Theory and estimation of Linear Models, Gauss-Markov Theorem and its use, Simple and Multiple linear regression models and their applications
- The sound scientific interpretation of the results for applications in the fields of design of experiments and econometrics.

UNIT I No. of hours: 08

Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

UNIT II No. of hours: 06

Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

UNIT III No. of hours: 09

Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

UNIT IV No. of hours: 07

Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots, Ridge Regression.

Suggested Reading:

1. Weisberg, S. (2005): Applied Linear Regression. Wiley.
2. Wu, C. F. J. And Hamada, M. (2009): Experiments, Analysis, and Parameter Design Optimization, John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008): Linear Models in Statistics, John Wiley and Sons.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.

MJC-10 (P): Linear Models

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-10 (T)

19/9/23

MJC-11(T): Design of Experiments

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the nuances of designing, conducting, analyzing and extracting information from experimental data.

Course Outcomes:

On successful completion of this course, the students should be able to

- Analyze one way and two way classified data set in fixed and random effect model.
- Describe Split and Strip Plot Design.
- Apply these designs to various fields of applications

UNIT I No. of hours: 06

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles-Randomization, replication, local control and uniformity trials

UNIT II No. of hours: 10

Analysis of Variance for one way and Two Way Classification. Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD)–layout, model and statistical analysis and relative efficiency. Missing Plot techniques.

UNIT III No. of hours: 07

Factorial experiments: advantages, notations and concepts, 2^2, $2^3 \ldots 2^n$ factorial experiments, design and analysis. Split Plot Design and Strip Plot Design.

UNIT IV No. of hours: 07

Total and Partial confounding for 2^n ($n \leq 5$).. Analysis of covariance. Analysis of non-orthogonal data. Analysis of missing data.

Suggested Reading:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, World Press, Kolkata.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi

MJC-11 (P): Design of Experiments

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-11 (T)

19/9/23

MJC-12 (T): Index Number and Time Series Analysis

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the index number and time series analysis application in the statistics.

Course Outcomes:

On successful completion of this course the students will be able to

- apply various statistical techniques in time series data.
- Understand index number

UNIT I No. of hours: 07

Meaning of Index Numbers, Problems in the construction of index numbers, Types of index number, Different formulae, Test of Index numbers, Base shifting and splicing of index numbers, Uses of Index Numbers.

UNIT II No. of hours: 08

Introduction to times series data, application of time series to various fields, Components of a times series, Decomposition of a time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curves, and growth curves, Method of moving averages.

UNIT III No. of hours: 07

Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend, Ratio to Moving Averages, Depersonalization. Cyclic Component: Harmonic Analysis,

UNIT IV No. of hours: 08

Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations. Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods, Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, The World Press, Kolkata.
3. Kendall M.G. (1976): Time Series, Charles Griffin.
4. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.

MJC-12 (P): Index Number and Time Series Analysis

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-12 (T)

19/9/23

MIC-7 (T): Introduction to Design of Experiments

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the nuances of designing, conducting, analyzing and extracting information from experimental data.

Course Outcomes:

On successful completion of this course, the students should be able to

- Handle one way and two way classified data in design of experimental setup.
- Apply these designs to various fields of applications

UNIT I No. of hours: 06

Experimental designs: Role, historical perspective, terminology, experimental error, basic principles-Randomization, replication and local control.

UNIT II No. of hours: 04

Analysis of variance for one way and two-way analysis. Fixed and Random effect Model.

UNIT III No. of hours: 06

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD)–layout, model and statistical analysis.

UNIT IV No. of hours: 04

Factorial experiments: advantages, notations and concepts, 2^2, $2^3 \ldots 2^n$ factorial experiments, design and analysis.

Suggested Reading:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, World Press, Kolkata.
4. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.

MIC-7 (P): Introduction to Design of Experiments

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-7 (T)

19/9/23

MIC-8(T): Basics of Index Number and Time series Analysis

Credits: 2 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the time series analysis application in the statistics.

Course Outcomes:

On successful completion of this course the students will be able to

- apply various statistical techniques in time series data.
- Understand various index number

UNIT I No. of hours: 06

Meaning of Index Numbers, Problems in the construction of index numbers, Types of index number, Different formulae, Uses of Index Numbers.

UNIT II No. of hours: 04

.Introduction to times series data, application of time series to various fields, Components of a times series, Decomposition of a time series.

UNIT III No. of hours: 04

Trend: Estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curves, and growth curves

UNIT IV No. of hours:06

Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. Cyclic Component: Harmonic Analysis, Random Component: Variate component method.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Applied Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. II, The World Press, Kolkata.
3. Kendall M.G. (1976): Time Series, Charles Griffin.
4. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.

MIC-8(P): Basics of Index Number and Time series Analysis

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-8 (T)

19/9/23

SEMESTER–VII

MJC-13(T): Statistical Quality Control

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the basic elements of statistical quality control.

Course Outcomes:

On successful completion of this course the students will be able to

- Describe the various charts in SQC
- Interpretation of these charts in real life situations.

UNIT I No. of hours: 06

Quality: Definition, dimensions of quality, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts.

UNIT II No. of hours: 08

Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

UNIT III No. of hours: 08

Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables

UNIT IV No. of hours: 08

Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans. Voice of customers (VOC): Importance and VOC data collection.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, Wiley India Pvt. Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.

MJC-13 (P): Statistical Quality Control

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-13 (T)

MJC-14 (T): Research Methodology

Credits: 5 **Full Marks: ESE-70 + CIA-30 = 100**

Prepared by another committee

MJC-15 (T): Multivariate Analysis

Credits: 4 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the elementary and advanced concepts of multivariate analysis tools

Course Outcomes:

On successful completion of this course, the students will be able to

- Describe the multivariate analysis tools in relation to univariate tools
- Apply multivariate statistical methods in AI, Machine Learning applications.

UNIT I No. of hours: 10

Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions

UNIT II No. of hours: 10

Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance-covariance matrix. Multiple and partial correlation coefficient and their properties.

UNIT III No. of hours: 09

Random sampling from multivariate normal distribution, Maximum likelihood estimators of parameters, Distribution of sample mean vector.

UNIT IV No. of hours: 11

Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis

Suggested Reading:

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, John Wiley.
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972) :Multivariate Analysis, Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, Pearson & Prentice Hall.

MJC-15 (P): Multivariate Analysis

Credits: 2 **No. of hours: 20** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-15 (T)

19/9/23

MIC-9 (T): Introduction to Statistical Quality Control

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

To introduce the basic elements of statistical quality control.

Course Outcomes:

On successful completion of this course the students will be able to

- Describe the various charts in SQC
- Interpretation of these charts in real life situations.

UNIT I No. of hours: 07

Quality: Definition, dimensions of quality, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts.

UNIT II No. of hours: 08

Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart.

UNIT III No. of hours: 07

Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.

UNIT IV No. of hours: 08

Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation.

Suggested Reading:

1. Gupta, S. C. and Kapoor, V. K. (2020): Fundamentals of Mathematical Statistics, S. Chand & Sons, New Delhi.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, The World Press, Kolkata.
3. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, Wiley India Pvt. Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.

MIC-9(P): Introduction to Statistical Quality Control

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-9(T)

19/9/23

SEMESTER–VIII

MJC-16 (T): Operations Research

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic elements of Operations Research

Course Outcomes:

On successful completion of this course the students will be able to

- Understand the fundamentals of Operations Research.
- Apply the results of transportation problems, game theory, Transportation sequencing problems, etc in the real life applications.

UNIT I No. of hours: 08

Convex sets and their properties, Introduction to linear programming problem, solution by graphical method. Simplex method, optimality and unboundedness, artificial variables, two-phase method, Big-M method. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual

UNIT II No. of hours: 07

Transportation problem and its mathematical formulation, north-west-corner method, least cost method and Vogel approximation method for determination of initial basic solution, algorithm for solving transportation problem. Transportation problem as a linear programming problem.

UNIT III No. of hours: 07

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Assignment problem as a linear programming problem.

UNIT IV No. of hours: 08

Game theory: Rectangular game, pure and mixed strategies, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy.

Suggested Reading:

1. Hadley, G.,(2002): Linear Programming, Narosa Publishing House, New Delhi.
2. Taha, H.A., (2006). Operations Research, An Introduction, Prentice-Hall India.
3. Sharma, S.D., (2014): Operations Research, Theory and Application.
4. Swarup, K., Gupta, P.K. and Mohan, M.(2019): Operations Research, Sultan Chand and Sons.

MJC-16 (P): Operations Research

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MJC-16 (T)

19/9/23

MIC-10 (T): Introductory Operations research

Credits: 3 **Full Marks: ESE-70 + CIA-30 = 100**

Course Objective:

- To introduce the basic elements of Operations Research

Course Outcomes:

On successful completion of this course the students will be able to

- Understand the fundamentals of Operations Research.
- Apply the results of Linear programming, Transportation and Assignment problem in the real life applications.

UNIT I No. of hours: 08

Convex sets and their properties, Introduction to linear programming problem, solution by graphical method.

UNIT II No. of hours: 12

Simplex method, optimality and unboundednes, artificial variables, two-phase method, Big-M method.

UNIT III No. of hours: 10

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

UNIT IV No. of hours: 10

Transportation and Assignment problem and its mathematical formulation.

Suggested Reading:

1. Hadley, G.,(2002): Linear Programming, Narosa Publishing House, New Delhi.
2. Taha, H.A., (2006): Operations Research, An Introduction, Prentice-Hall India.
3. Sharma, S.D., (2014): Operations Research, Theory and Application.
4. Swarup, K., Gupta, P.K. and Mohan, M.(2019): Operations Research, Sultan Chand and Sons

MIC-10 (P): Introductory Operations research

Credits: 1 **No. of hours: 10** **Full Marks: ESE-70 + CIA-30 = 100**

Practical Based on Unit 1, 2, 3, and 4 of MIC-10 (T)

19/9/23

The question paper pattern of End Semester Exam (ESE) shall consists of three parts-

Part A- Compulsory- consisting of objective/multiple choice type- each carrying two marks. 10×2=20 marks

Part B- Short answer type- Four questions to be answered out of six questions- each carrying five marks. 04×5=20 marks

Part C- Long answer type- Three questions to be answered out of five questions- each carrying ten marks. 03×10=30 marks

19.9.23 19/9/23

To,

The Principal Secretary

Rajbhavan, Bihar,

Patna

Sub: - Regarding submission of proposed course structure and uniform syllabus of (Bachelor of Art/Science-**Statistics**) based on CBCS of 4-year undergraduate.

Ref: Letter No-BSU (UGC) 02/2023-1457 GS (I) Dated-14.09.2023

Sir,

In compliance with your letter no-BSU (UGC) 02/2023-1457 GS(I), dated-14.09.2023, followed by above mentioned letter no., we are submitting the proposed course structure and syllabus of Bachelor of Art/Science-Statistics of 4 year under graduate courses system as per UGC regulations.

Enclosed –as above

Yours faithfully,

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