BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

B.Sc. STATISTICS

CHOICE BASED CREDIT SYSTEM –

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

(NAAN MUDHALVAN SCHEME was implemented from 2nd to 6th Semester)

Sem.	Part	Course	Title	Ins. Hrs.	Credi	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Language Course – I (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – I		6	3	3	25	75	100
	III	Core Course – I (CC)	Descriptive Statistics	5	5	3	25	75	100
		Core Practical – I (CP)	Statistics Practical I	4	4	3	40	60	100
		First Allied Course – I (AC)		4	4	3	25	75	100
		First Allied Course - II (AC)		3	-	-	-	-	-
	IV	Value Education		2	2	3	25	75	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**600**
II	I	Language Course – II (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – II		4	3	3	25	75	100
	III	Core Course – II (CC)	Probability Theory	5	5	3	25	75	100
		Core Practical – II (CP)	Statistics Practical II	4	4	3	40	60	100
		First Allied Course – II (AC)		3	2	3	25	75	100
		First Allied Course – III (AC)		4	4	3	25	75	100
		Add on Course – I ##	Professional English – I	6*	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Language Proficiency for Employability - Effective English	2	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**900**

III	I	Language Course – III (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – III		6	3	3	25	75	100
	III	Core Course – III (CC)	Theoretical Discrete Distributions	5	5	3	25	75	100
		Core Practical – III (CP)	Statistics Practical III	4	4	3	40	60	100
		Second Allied Course – I (AC)		4	4	3	25	75	100
		Second Allied Practical (AP)		3	-	-	-	-	-
		Add on Course – II ##	Professional English - II	6*	4	3	25	75	100
	IV	Non-Major Elective – I @ Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level or b) Special Tamil if Tamil language was studied upto 10th & 12th std.		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Digital Skills for Employability – Microsoft Digital Skills	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
IV	I	Language Course –IV (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – IV		6	3	3	25	75	100
	III	Core Course – IV (CC)	Theoretical Continuous Distributions	5	5	3	25	75	100
		Core Practical – IV (CP)	Statistics Practical IV	4	4	3	40	60	100
		Second Allied Practical (AP)		3	2	3	40	60	100
		Second Allied Course – II (AC)		4	4	3	25	75	100
	IV	Non-Major Elective II@ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level or b) Special Tamil if Tamil language was studied up to 10th & 12th std.		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Employability Skills - Employability Skills	-	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**800**

V	III	Core Course –V (CC)	Sampling Theory	5	5	3	25	75	100
		Core Course – VI (CC)	Statistical Inference I	5	5	3	25	75	100
		Core Course – VII(CC)	Design of Experiments	5	5	3	25	75	100
		Core Practical –V (CP)	Statistics Practical V	4	4	3	40	60	100
		Major Based Elective – I (Any one)	1. Numerical Methods 2. Statistical Quality Control	5	4	3	25	75	100
	IV	Skill Based Elective I	Demography	4	2	3	25	75	100
		Soft Skills Development		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Computational Intelligence for Employability – Drone Pilot Techniques	-	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**800**
VI	III	Core Course – VIII (CC)	Statistical Inference II	6	5	3	25	75	100
		Core Course – IX (CC)	Operations Research	6	5	3	25	75	100
		Core Practical – VI(CP)	Statistics Practical VI	4	4	3	40	60	100
		Major Based Elective – II (Any one)	1. Applied Statistics 2. Regression Analysis	5	4	3	25	75	100
		Project		4	3	-	20	80	100
	IV	Skill Based Elective – II	Communication and Interpersonal Skills	4	2	3	25	75	100
	V	Extension Activities **		-	1	-	-	-	-
		Gender Studies		1	1	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Drone Application & Aerial Survey	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
GRAND TOTAL				**180**	**158**	**-**	**-**	**-**	**4700**

List of Allied Courses

First Allied Course	**Second Allied Course**
Mathematics	Computer Science

$ For those who studied Tamil up to 10th+2 (Regular Stream).

+ Syllabus for other Languages should be on par with Tamil at degree level.

Those who studied Tamil up to 10th +2 but opt for other languages in degree level under Part-I should study special Tamil in Part – IV.

The Professional English – Four Streams Course is offered in the 2nd and 3rd Semester (only for 2022-2023 Batch) in all UG Courses. It will be taught apart from the Existing hours of teaching / additional hours of teaching (1 hour /day) as a 4 credit paper as an add on course on par with Major Paper and completion of the paper is must to continue his / her studies further. (As per G.O. No. 76, Higher Education (K2) Department dated: 18.07.2020).

* The Extra 6 hrs / cycle as per the G.O. 76/2020 will be utilized for the Add on Professional English Course.

@ NCC Course is one of the Choices in Non-Major Elective Course. Only the NCC cadets are eligible to choose this course. However, NCC Course is not a Compulsory Course for the NCC Cadets.

** ExtensionActivitiesshallbeoutsideinstructionhours.

@@ Naan Mudhalvan Scheme.

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	I	Language Courses	4	12	400
2.	II	English Courses	4	12	400
3.	III	Core Courses	8	40	800
4.		Core Practical	7	29	700
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Add on Courses	2	8	200
9.		Project	1	3	100
10.	IV	Non-Major Elective Courses (Practical)	2	4	200
11.		Skill Based Elective Courses	2	4	200
12.		Soft Skills Development	1	2	100
13.		Value Education	1	2	100
14.		Environmental Studies	1	2	100
15.	V	Gender Studies	1	1	100
16.		Extension Activities	1	1	0
17.	VI	Naan Mudhalvan Scheme	5	10	500
	Total		**48**	**158**	**4700**

PROGRAMME OUTCOMES:

The Courses in the Department of Statistics will enable the student

- To develop the skills to analyze complex statistical data coming from the various fields like industry, marketing, finance, agriculture and business.
- To implement data analysis strategies to develop efficient models for various theoretical postulations.
- Understand the intricacies of statistical testing and its applications in real life problems
- To develop, design and analyze experiments in empirical research.
- To develop soft skills and practicing professional ethics.
- Analyze every large data sets in the context of real-world problems and interpret results using data analytics.
- Understand the optimization and computational techniques for the solution of the real-life problems.

COURSE OUTCOMES:

- Each course, in all the Programmes, has been designed and kept in accordance with the instructions of UGC and fulfills the requirements of the academic and industrial needs. Byopting these courses students may be able to qualify the various esteemed competitive examinations like CSIR-NET, UGC-NET, GATE, ISS, IAS, PCS and many others.
- These programmes offered by the department are highly employable and enable the students to take positions in various Institutes / Universities / Industries for research and development and serve the society.

PROGRAM SPECIFIC OUTCOME:

- The courses in the Department are designed to inculcate analytic and decision-making aptitude among the students. Having an advanced and upgraded knowledge of Statistics from both the theoretical and practical aspects, the students who pass out are well equipped in managing and analyzing various types of data. The education imparted in Statistics is aimed to inculcate statistical thinking in young minds for better future planning and welfare of society and to contribute to the society through excellence in statistical education and research.
- Students after completing these courses may be able to start their career with various Academia and Industry Interface. It may provide a platform to all the students to get experiential learning in this material world. The students may also able to develop decision making problems and suggest the best solution to attain the decision in R&D sector jobs.

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First Year | **CORE COURSE I** | **Semester I**

DESCRIPTIVE STATISTICS

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To summarize the data and to obtain its salient features from the vast mass of original data.
- To understand the concept of attributes.
- To understand the concepts of probability and its applications.
- To understand the concept of random variables, probability distributions and expectation

UNIT – I INTRODUCTION TO STATISTICS:

Meaning and definition of statistics, importance and scope of statistics, functions of statistics and limitations of statistics.

UNIT – II DIAGRAMMATIC AND GRAPHICAL REPRESENTATION:

Diagrammatic representations of data - Bar diagrams, simple, component, multiple and percentage, Pie diagrams. Graphical representations - Histogram, frequency curve, frequency polygon and Ogives (construction and uses).

UNIT – III MEASURES OF CENTRAL TENDENCY:

Measures of central tendency – Arithmetic mean, median, mode, geometric mean and harmonic mean - derivation of their properties, merits and demerits and problems.

UNIT – IV MEASURES OF DISPERSION:

Measures of dispersion - range, quartile deviation. Mean deviation, standard deviation and coefficient of variation. Skewness - concept, measures of skewness – Karl Pearson's and Bowley's coefficient of skewness. Moments – Raw and Central. Kurtosis - Concept and measures of kurtosis and problems

UNIT – V CORRELATION AND REGRESSION:

Correlation - Definitions, types and properties of correlation coefficient (statement and proof). Scatter diagrams, Karl Pearsons's co-efficient of correlation and Spearman's rank correlation. Regression lines and its properties, uses and problems.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Case study and problems relating to all the above units. Expert lectures, seminars – Webinars.

REFERENCES:

1. Gupa S.C. and Kapoor V.K (2013), Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Concepts of statistical population and sample, variables and attributes.
- Tabular and graphical representation of data based on variables.
- Conditions for the consistency' and criteria for the independence of data based on attributes.
- Measures of central tendency, dispersion, skewness and kurtosis.
- Moments and their use in studying various characteristics of data.
- Univariate transformation and expectation of random variable.

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First Year	CORE PRACTICAL I STATISTICS PRACTICAL I	Semester I
Code:	(Practical)	Credit: 4

COURSE OBJECTIVES:

The learning objectives include:

- Definition and scope of Statistics, concepts of statistical population and sample.
- Quantitative and qualitative data in attributes, variables,
- Scale of measurements in nominal, ordinal, interval and ratio.
- Tabular and graphical presentation on histogram and ogives.
- Calculation of the quartile, mean and standard deviations, skewness and correlation.

PRACTICAL PROBLEMS:

- Diagrammatic representations of data: Bar diagrams, simple, component, multiple and percentage, Pie diagrams.
- Graphical representations: Histogram, frequency curve, frequency polygon and ogives.
- Measures of Central Tendency: Arithmetic mean, median, mode, geometric mean and harmonic mean for raw and grouped data.
- Measures of Dispersion: Quartile, mean and standard deviations and their coefficients.
- Measures of Skewness: Karl Pearson's and Bowley's coefficient of skewness.
- Measures of Kurtosis: Calculation of measures of kurtosis.
- Calculation of Coefficient of Correlation: Karl Person's and Spearman's Rank.
- Finding the two regression equations X on Y and Y on X, and estimating unknown values of X and Y.

REFERENCES:

1. Gupa S.C. and Kapoor V.K (2013), Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Tabular and graphical representation of data based on variables.
- Conditions for the consistency' and criteria for the independence of data based on attributes.
- Measures of central tendency, dispersion, skewness and kurtosis.
- Moments and their use in studying various characteristics of data.

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First Year	CORE COURSE II PROBABILITY THEORY	Semester II
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

The learning objectives include:

- The purpose is to familiarize the students about the basic concepts required for further studies of advanced curriculum.
- Enable the students to understand and study random phenomena mathematically

UNIT – I INTRODUCTION TO PROBABILITY:

Concept of Random experiment – trial – sample point – sample space event, algebra of events, mutually exclusive – exhaustive events. Definition of probability, classical, statistical and axiomatic approach – Properties of probability, theorems on probability – Addition theorem of probability – Conditional probability – Multiplication theorem – Bayes' theorem – simple problems.

UNIT – II UNIVARIATE RANDOM VARIABLE:

Concept of Random variables – Discrete and continuous random variables, probability mass function - Probability density function. Distribution function – properties – simple problems.

UNIT – III BIVARIATE RANDOM VARIABLE:

Bivariate distribution – Distribution function of bivariate random variable and its properties – joint probability function and joint probability density function - marginal and conditional distributions – Independence of random variable – simple problems.

UNIT – IV MATHEMATICAL EXPECTATION:

Mathematical expectation – discrete and continuous random variables – Properties – moments – variance – properties – covariance – simple problems.

UNIT – V GENERATING FUNCTIONS:

Moment generating function – properties and uses – cumulants – characteristic functions – properties – simple examples – Inversion theorem and Uniqueness theorem – statement only.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry Expert Lecture.

REFERENCES:

1. Gupa S.C. and Kapoor V.K. (2013), Fundamental of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
2. J.N. Kapur and H.C. Saxena (1989), Mathematical Statistics, Sultan Chand & Sons, New Delhi.
3. Marek. Fisz, (1961), Probability Theory and Mathematical Statistics, John Wiley and Sons.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- After completing this course, there should be a clear understanding of:
- The fundamental concept of expectation for univariate and bivariate random variables with their distributions and properties.
- MGF, cumulant generating function and characteristic function.
- Discrete probability distributions with their properties.
- Continuous probability distributions with their properties.

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First Year	CORE PRACTICAL II STATISTICS PRACTICAL II	Semester II
Code:	(Practical)	Credit: 4

COURSE OBJECTIVES:

The learning objectives include:

- Random experiments.
- Classical and axiomatic probability problems.
- Calculation of theorem based problems in addition, multiplication and Bayes' theorems.
- Calculation of problems on discrete and continuous random variables.
- Calculation of bivariate, marginal and conditional distributions in independence of random variable and mathematical expectation.

PRACTICAL PROBLEMS:

- Random experiment: Trial, sample point and sample space event, algebra of events and mutually exclusive and exhaustive events.
- Probability Problems: Classical, statistical and axiomatic approach and its properties of probability.
- Theorems based problems: Simple problems of addition theorem of probability, conditional probability, multiplication theorem and Bayes' theorem.
- Problems on discrete and continuous random variables: Finding probabilities, distribution functions and moments.
- Simple problems of Bivariate distribution: Distribution function of random variable, joint probability function and joint probability density function -
- Simple problems of marginal and conditional distributions in independence of random variable.
- Simple problems of mathematical expectation: Discrete and continuous random variables, moments, variance and covariance.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. J.N. Kapur and H.C. Saxena (1989), Mathematical Statistics, Sultan Chand & Sons, New Delhi.
3. Marek. Fisz, (1961), Probability Theory and Mathematical Statistics, John Wiley and Sons.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- The fundamental concept of expectation for univariate and bivariate random variables with their distributions.
- Moment generating function, cumulant generating function and characteristic function.
- Discrete probability distributions.
- Continuous probability distributions.

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Second Year **CORE COURSE III** **Semester III**

THEORETICAL DISCRETE DISTRIBUTIONS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To expose the various important discrete probability models
- Real life situations where these distributions provide appropriate models

UNIT – I Binomial Distribution:

Binomial distribution – Definition, concept and derivation of moments, moment generating function, additive property, characteristic function and recurrence relation for moments. Fitting of Binomial distribution – Simple problems.

UNIT – II Poisson Distribution:

Poisson distribution – Definition, concept, derivation of moments, moment generating function, recurrence relation for moments and Poisson distribution as a limiting case of Binomial distribution, fitting of Poisson distribution – Simple problems.

UNIT – III Negative Binomial Distribution:

Negative Binomial distribution – Definition, derivation of constants and Poisson distribution as a limiting case of the Negative Binomial distribution. Logarithmic series distribution (concept only).

UNIT – IV Geometric Distribution:

Geometric distribution – Definition, moments, derivation of moment generating function and lack of memory property. Power series distribution (concept only).

UNIT – V Hyper Geometric Distribution:

Hyper Geometric distribution – Definition, derivation of mean and variance approximation to Binomial distribution and recurrence relation. Multinomial distribution (concept only).

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry Expert Lecture.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Gupta, S.P, (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Match the discrete probability distributions with real life situations
- Derive the moment generating functions of the discrete probability distributions
- Deduce the cumulate generating functions and characteristics functions of the discrete probability distributions
- Obtain the moments of DPD using recurrence relations.

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Second Year	**CORE PRACTICAL III** **STATISTICS PRACTICAL III**	**Semester III**
Code:	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- To expose the various important discrete probability models
- Real life situations where these distributions provide appropriate models.

PROBLEMS BASED ON THE FOLLOWING TOPICS

- Binomial distribution – Mean, variance, fitting and related problems.
- Poisson distribution – Mean, variance, fitting and related problems.
- Negative Binomial distribution – Mean, variance, fitting and related problems.
- Hyper Geometric distribution – Mean, variance, fitting and related problems.
- Geometric and Uniform distribution – Mean, variance, fitting and related problems.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- match the discrete probability distributions with real life situations
- derive the moment generating functions of the discrete probability distributions
- deduce the cumulate generating functions and characteristics functions of the discrete probability distributions
- Obtain the moments of DPD using recurrence relations.
- Build the DPD using recurrence probabilities.

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Second Year **CORE COURSE IV** **Semester IV**

THEORETICAL CONTINUOUS DISTRIBUTIONS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To expose the various important continuous probability models and real life situations where these distributions provide appropriate models.

UNIT – I Concepts of Normal Distribution:

Normal Distribution – Introduction, limiting form of Binomial distribution. Characteristics of normal distribution, and its curve. Derivation of mean, mode, median, moments and moment generating function.

UNIT – II Advances in Normal Distribution:

Derivation of cumulant generating function, additive property of normal distribution, mean deviation about mean, and points of inflection of normal curve, importance of normal distribution – Fitting of normal distribution – simple problems.

UNIT – III Gamma and Beta Distribution:

Beta distribution of first and second kind – Derivation of moments, $\beta 1$, $\beta 2$ and Harmonic mean. Gamma distribution – Definition and derivation of moment generating function, cumulant generating function, moments and additive property of Gamma distribution.

UNIT – IV Rectangular and Exponential Distribution:

Rectangular distribution - Introduction and derivation of moments, moment generating function and mean deviation about mean**.** Exponential distribution – Definition, derivation of moment generating function and lack of memory property. Concept of Weibul distribution, Cauchy distribution and Bivariate Normal distribution.

UNIT – V Sampling Distribution:

Sampling distribution - Concept of t, chi-squre and F distribution – Derivation of these distributions, constants and moment generating function – Relationship between t, chi-squre and F distribution.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry Expert Lecture.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Johnson N.L. and Kotz S. (1969), Distributions in Statistics - Discrete Distributions. John Wiley & Sons, New York

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Learn the characteristics of Normal distributions.
- Learn the relationship between beta and Gamma distribution.
- Know the memory less property of Exponential distribution.
- Obtain the difference of two sample tests.
- Understand the relationship between t and F distributions.
- Understand why Exponential distribution possesses memory less property.

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Second Year	**CORE PRACTICAL IV**	**Semester IV**
	STATISTICS PRACTICAL IV	
Code:	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- To expose the various important continuous probability models
- Real life situations where these distributions provide appropriate models.

PROBLEMS BASED ON THE FOLLOWING TOPICS

- Normal distribution – Mean, variance, fitting and related problems.
- Beta distribution – Mean, variance, fitting and related problems.
- Rectangular distribution – Mean, variance, fitting and related problems.
- Exponential distribution – Mean, variance, fitting and related problems.
- Gamma distribution – Mean, Variance, fitting and related problems.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Learn the characteristics of Normal distributions.
- Learn the relationship between beta and Gamma distribution.
- Know the memory less property of Exponential distribution.
- Obtain the difference of two sample tests.
- Understand the relationship between t and F distributions.
- Understand why Exponential distribution possesses memory less property.

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Third Year	**CORE COURSE V**	**Semester V**
	SAMPLING THEORY	
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To understand the concept of sampling distributions and their applications in statistical inference and the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.
- To amalgamate the intellectual facts of the sampling techniques to implement in projects and to motivate the students in carrying out the field projects in scientific manner and statistical skills.
- To convey some extended concepts in sampling to encourage the students in industrial and research aspects.

UNIT – I Introduction to Sampling Theory:

Basic concept of sample survey - Introduction, definitions and preliminaries, fields of application of sampling techniques and limitations, Census and sample surveys, their advantages and disadvantages, principles of sampling theory, principal steps in a sample survey. Probability and non-probability sampling, sampling unit, sampling frame, sampling and non-sampling errors.

UNIT – II Simple random sampling:

Simple random sampling, procedures of selecting a random sample, estimation of population parameters, estimation of population proportion, Estimation of sample size.

UNIT – III Stratified random sampling:

Stratified random sampling – Introduction, principles of stratification, advantages of stratification, Estimation of population mean and its variance. Estimation of variance, allocation of sample size in different strata - Equal allocation, Neyman allocation, optimum allocation and proportional allocation. Relative precision of stratified random sampling with simple random sampling.

UNIT – IV Systematic sampling:

Systematic sampling – Introduction, sample selection procedures, advantages and disadvantages, estimation of mean and its sampling variance, comparison of simple random sampling and stratified random sampling with systematic sampling.

UNIT – V Ratio and Regression estimators:

Ratio estimators - Introduction, definitions and notations, bias of ratio estimators, comparison of the ratio estimate with the mean per unit. Regression estimators – Introduction, difference estimator, regression estimator, comparison with the mean per unit and ratio estimators.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Research and Analytical problems on various applications of the industrial issues.

REFERENCES:

1. Daroga Singh and Choudry F.S. (1986), Theory and Analysis of Sample Survey Design, Wiley Eastern Ltd., New Delhi.
2. Murthy M.N. (1976), Sampling theory and methods- statistical publishing society, Calcutta.
3. Cochran W.G. (1984), Sampling Techniques, Wiley Eastern Ltd.
4. Des Raj (1976), Sampling Theory, Tata-McGraw Hill.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- The students will accomplish research oriented concepts given for sampling techniques.
- The students will have ideas of usage of sampling techniques in projects.
- The students will be motivated to use sampling techniques in industrial use.
- The content of syllabus also avails them to fetch the background concepts of Statistical quality control.
- The students will be motivated to do research work.
- The content of syllabus also avails them to face central government examination like Indian Statistical Service and other competitive examinations.

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Third Year | **CORE COURSE VI** | **Semester V**

STATISTICAL INFERENCE I

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- Drawing inference about the unknown population parameters based on random samples.
- Validating our estimation / inference about the population using hypothesis testing.

UNIT – I Introduction to Estimation:

Introduction to estimation theory – definition of parameter space, estimate and estimator.Characteristics of estimator – unbiasedness – definition and simple problems. Consistency – definition, problem based on Normal and Poisson distribution. Invariance property of consistency, sufficient condition for consistency.

UNIT – II Efficiency and Sufficiency:

Efficient estimators – definition of efficiency, most efficient estimator, minimum variance unbiased estimator. Sufficiency – definition, Rao-Blackwell theorem, Crammer-Rao inequality, statement of Neymann factorization theorem, Invariance property of sufficient estimator (simple problems).

UNIT – III Methods of Estimation:

Methods of estimation : Method of Maximum likelihood estimation – definition of likelihood function and M.L.E., properties of M.L.E (simple problems). Statement of Crammer-Rao theorem and Hazoor Bazar's theorem.

UNIT – IV Methods of Moments:

Methods of minimum variance, methods of moments and methods of least squares - simple problems.

UNIT – V Interval Estimation:

Interval estimation – definition of confidence limits, confidence co-efficient, confidence interval and confidence intervals for large samples (simple problems).

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Research and development problems related to various fields of inferential statistics with practical knowledge of computer software.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.
2. Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited.
3. Lehmann E.L. (1986), Testing of Statistical Hypothesis, John Wiley.
4. Gibbons J.D. (2010), Non–Parametric Statistical Inference, Duxbury.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Different methods of finding point estimators for unknown population parameters, their advantages and disadvantages:
- Maximum Likelihood Estimation
- Method of moments
- Method of minimum chi-square and modified minimum chi-square
- Desirable properties of point estimators based on which estimators can be compared: unbiasedness ,consistency, efficiency, sufficiency
- Methods to develop/find best point estimators based on the desirable properties (Using Cramer-Rao inequality, Rao-Blackwell theorem, and Lehmann-Scheffe theorem).
- General methods of constructing interval estimators (confidence intervals) for unknown population parameters.
- Basic principle of Bayesian estimation (finding posterior distributions of unknown population parameters).
- Developing/ constructing best/most powerful statistical tests to test hypotheses regarding unknown population parameters (using Neyman-Pearson Lemma and Likelihood Ratio tests).
- Practical applications of estimation theory and hypothesis testing pertaining to all discussed methods.

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Third Year | **CORE COURSE VII** | **Semester V**

DESIGN OF EXPERIMENTS

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To design and conduct experiments.
- To analyze and interpret data.

UNIT – I Analysis of Variance:

Analysis of Variance: Definition and assumptions. Cochran's theorems (statement only) ANOVA - One way and Two way classifications (with one observation per cell). Experimental error.

UNIT – II Design of Experiment:

Design of Experiment: Need, terminology, randomization, replication and local control; Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) - Estimation of missing values in RBD and LSD (one and two).

UNIT – III Factorial Experiment:

Factorial experiment - main effects and interactions; definitions of contrast and orthogonal contrast - Analysis of 2^2 and 2^3 experiments.

UNIT – IV Confounding:

Confounding in factorial design – Total Confounding and Partial confounding in 2^3 experiments.

UNIT – V ANACOVA:

Analysis of co-variance for a one way layout with one concomitant variable and RBD with one concomitant variable.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry Expert Lectures on - how abstract ideas and rigorous methods in mathematical analysis can be applied to practical problems arising in science and Technology.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
2. Douglas C. Montgomery (2010), Design and Analysis of Experiment, Wiley International Edition, India.

3. Cochran W.G. and G.M. Cox (1957), Experimental designs, Wiley International edition, India.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- The fundamental concepts of design of experiments.
- Introduction to planning valid and economical experiments within given resources. Completely randomized design.
- Randomized block design. Latin square design.
- Balanced incomplete block design.
- Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.

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Third Year	**CORE PRACTICAL V**	**Semester V**
	STATISTICS PRACTICAL V	
Code:	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps,
- Choice of size and shape of plots and blocks.
- Missing plot technique (for both RBD and LSD) for one missing observation only, variance of the difference between two estimated treatment effects out of which one has the missing observation (for both RBD and LSD). Practical work.

PROBLEMS BASED ON THE FOLLOWING TOPICS

- Simple Random Sampling.
- Stratified Random Sampling with proportional allocation and optimum allocation.
- Systematic Random Sampling.
- Completely Randomized Design (CRD).
- Randomized Block Design (RBD).
- Latin Square Design (LSD).
- Estimation of missing values in RBD and LSD (one and two).
- Factorial Experiment - Analysis of 2^2 and 2^3 experiments.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
2. Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited.
3. Daroga Singh and Choudry F.S. (1986), Theory and Analysis of Sample Survey Design, Wiley Eastern Ltd, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Understanding of fundamentals and design and analysis of basic Design.
- Fractional factorial designs with two levels.
- Understanding of BIBD, full and confounded.
- Factorial and Fractional factorial designs.
- Practical work based on the design and analysis.

Third Year **MAJOR BASED ELECTIVE I** **Semester V**

1. NUMERICAL METHODS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- To tackle the practical situations demands the use of interpolation and extrapolation.
- To solve Mathematical calculus problems, whenever the classical approach fails

UNIT – I Introduction Numerical Methods:

Solution of algebraic and transecendental equations - Bisection method, Newton's Raphson method. Finite differences - Newton's forward and backward interpolation formula (problems only)

UNIT – II Interpolation:

Central differences interpolation formulae – Gauss forward, Gauss Backward, Stirlings formula and Bessel's formula (problems only).

UNIT – III Numerical differentiation:

Numerical differentiation - Newton's forward and Newton's backward formulae (up to 2^{nd} order) - (problems only).

UNIT – IV Numerical integration:

Numerical integration – Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule (problems only).

UNIT – V Numerical solution:

Numerical solution of ordinary differential equation – Taylor series method, Modified Euler's method and second and fourth order Runge-Kutta method (problems only).

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Expert lecture on introduction to wavelets.

REFERENCES:

1. A. Singaravel (2020), Numerical Methods, Meenakshi publications, Chennai.
2. S.S. Sastry (2000), Introduction to methods of Numerical Analysis, Prentice-Hall of India Pvt. India III Editions.

3. P. Kandasamy, K. Thilagavathy, and K. Gunavathy (2005), Numerical Methods.
4. E. Balagurusamy (2004), Numerical Methods, Tata McGraw Hill Publishing Company Limited, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Understand the uses of interpolation in various fields.
- Learn the usage of numerical differentiation and integration.
- Learn the importance of Newton's problem in interpolation.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

2. STATISTICAL QUALITY CONTROL

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- This course will help students to learn techniques and approach of SQC being used in industry to manufacture goods and services of high quality at low cost.
- This course will also give exposure to six sigma and Index Numbers.

UNIT – I Introduction to SQC:

Introduction to SQC – Chance and assignable causes of variation – Benefits of SQC – Process and product control – Tools for SQC - Control chart for variables – X-Bar and R charts.

UNIT – II Process Control:

Control chart for attributes – Control chart for fraction defective (p-chart) – Control chart for number of defectives (d-chart, for fixed and variable sample size) – Control chart for number of defects per unit (c-chart) – Natural tolerance limit and specification limits.

UNIT – III Product Control:

Acceptance sampling by Attributes – Acceptance Quality Level (A.Q.L) – Lot Tolerance Proportion or Percent Defective (LTPD) – Process Average Fraction Defective (p) – Consumer's Risk(β) – Producer's Risk(α) – Rectifying Inspection Plan – Average Outgoing Quality Level (AOQL)

UNIT – IV Sampling Plans:

Operating Characteristic Curve (OC-curve) – Average Sample Number (ASN) – Average Amount of Total Inspection (ATI) – Single sampling plan – Determination of 'n' and 'c', AOQL, OC-curve – Double sampling plan – ASN and ATI of double sampling plan – Single sampling Vs double sampling plan.

UNIT – V Sequential Sampling:

Sequential Sampling – Sequential Probability Ratio Test (SPRT) – ASN Function of sequential sampling plan.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Traditional quality inspection activities in industry, e receiving inspection, process inspection in industrial applications.

REFERENCES:

1. Gupta S.C. and Kapoor V.K. (2014), Fundamentals of Applied Statistics, 4th Edition, Sultan Chand & Sons, New Delhi.
2. Ehrlich H.B. (2002), Transactional Six Sigma and Lean Servicing, 2nd Ed., St. Lucie Press.
3. Goon A.M., Gupta M.K. and Dasgupta B. (2002), Fundamentals of Statistics, Vol. I & II, 8th Ed., The World Press, Kolkata.
4. David H. (1995), ISO Quality Systems Handbook, 2nd Ed., Butterworth Heinemann Publication.
5. Montogomery D.C. (2009), Introduction to Statistical Quality Control, 6th Ed., Wiley India Pvt. Ltd.
6. Mahajan M. (2010), Statistical Quality Control, Dhanpat Rai & Co.

COURSE OUTCOMES:

- Upon successful completion of this course the students would be able:
- Statistical process control tools- Control charts for variables, attributes.
- Statistical product control tools- Sampling inspection plans.
- Control Charts, OC- Curve

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Third Year **SKILL BASED ELECTIVE I DEMOGRAPHY** **Semester V**

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The learning objectives include:

- This course will help students to learn the basics of demography and the sources of demographic data.
- To explain the concept fertility and calculate its measures CBR, GFR, TFR, ASFR, GRR and NRR.

UNIT – I Demography:

Definition - importance of demographic data – sources of demographic data - population census – uses - registration method - vital registration - population register - records - sample surveys - international publications - demography in sociology, economics and health planning.

UNIT – II Fertility measurements:

Mortality – Mortality measures - Crude Death Rate (CDR), age, sex and cause specific death rates - Standardized death rate - Infant mortality rate - Simple problems.

UNIT – III Mortality Measurements:

Small sample test – student's 't' test – test for single mean, difference between means, paired 't' test and observed sample correlation co-efficient.

UNIT – IV Life Table and Migration:

Life Table - Assumptions - Description of various columns of a Life table – Relationship between life table functions - Construction of a Life table - Uses of a Life table - Simple Problems. Migration - Definition - Types of Migration - Effects of Migration.

UNIT – V Population Projection:

Types - Methods of population projection – Importance - limitations – Population estimates and projection – Mathematical Method – Arithmetic Method and Geometric Method - Growth Component Method – Logistic curve – Basic ideas of Stationary and Stable population.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Research and development problems related to various fields of demographical data with practical knowledge of computer software.

REFERENCES:

1. Mishra D.E (2001). An Introduction to the Study of Population, South India publishers, Madras.
2. Goon, A.M, Gupta, M.K and Das Gupta (2009). Fundamentals of Statistics, Vol II (World Press).
3. https://nptel.ac.in/courses/109/104/109104045/ 2
4. https://swayam.gov.in/nd1_noc19_hs39/preview 3
5. https://nptel.ac.in/courses/109/104/109104150/ 4
6. http://www.ru.ac.bd/wpontent/uploads/sites/25/2019/03/402_10_00_Lundquist_Demography.pdf

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Students will be able to summarize the concept mortality and calculate its measures CDR, ASDR, SDR and IMR.
- Students will be able to describe various types, importance and methods for estimation of population projection.

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Third Year **CORE COURSE VIII** **Semester VI**

STATISTICAL INFERENCE II

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- Drawing inference about the unknown population parameters based on random samples.
- Validating our inference about the population using hypothesis testing

UNIT – I Introduction to Hypothesis:

Statistical hypothesis – simple and composite, null and alternative hypothesis, critical region, level of significance, type of errors and power of test (simple problems). Steps involved in testing of hypothesis. Neymann Pearson Lemma (statement and proof).

UNIT – II Large sample test:

Large sample test – Test for single proportion, difference between proportions, single mean, difference between means and difference between standard deviation.

UNIT – III Small sample test:

Small sample test – student's 't' test – test for single mean, difference between means, paired 't' test and observed sample correlation co-efficient.

UNIT – IV Testing of Significance (F-test):

Snedecor's F test – Test for equality of two population variance – Testing the significance of an observed multiple correlation co-efficient, observed sample correlation ratio and linearity of regression (concepts only).

UNIT – V Non-parametric tests:

Non-parametric test - Chi-square test - Independence of attributes and goodness of fit. One sample tests – Sign test and Run test for randomness, Two sample tests – Sign, median and Mann-Whitney U test – Simple problems.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Research and development problems related to various fields of inferential statistics with practical knowledge of computer software.

REFERENCES:

1. S.C. Gupta and V.K. Kapoor (2013), Fundamentals of Mathematical Statistics, Sultan Chand and Sons Publications, New Delhi.

2. Rohatgi V.L. (1979), An introduction to probability theory and Mathematical Statistics, Wiley Eastern limited.
3. Lehmann E.L. (1986), Testing of Statistical Hypothesis, John Wiley.
4. Gibbons J.D. (2021), Non–Parametric Statistical Inference, 6th ed., Duxbury.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Students will be able to identify the appropriate null and alternative hypotheses, including one or two sided, simple or composite for a given study objective.
- Identify correctly what the type I and type II errors would be when presented with the results of a statistical study.

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Third Year	**CORE COURSE IX**	**Semester VI**
	OPERATIONS RESEARCH	
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

The learning objectives include:

- To study various operational research techniques and models.

UNIT – I Introduction to Operations Research:

Operations Research – Meaning, nature, history, scope and limitations. Linear Programming Problem (LPP) – General form, standard form and canonical form, basic solution, basic feasible solution, optimum solution. Assumption and mathematical formulation of LPP. Graphical solution of LPP – Unique and special cases – Simplex method and Big-M method.

UNIT – II Transportation Problem and Assignment Problem:

Transportation Problem (T.P.) – Meaning, balanced and unbalanced transportation problem. Initial basic feasible solution (IBFS) – North-West Corner Rule (NWC), Least Cost Method (LCM) and Vogel's Approximation Method (VAM) and MODI method to solve an Transportation problem. Maximization case in Transportation problem. Assignment problem (A.P.) – Meaning, Balanced and Unbalanced Assignment problem – Hungarian method to solve an Assignment problem. Maximization case in Assignment problem.

UNIT – III Game Theory:

Theory of Games – Basic definition – Maximin and Minimax criterion – Solution of games with saddle points – Two–by–Two (2x2) Games without saddle point – principle of dominance – problems based on dominance rule – Graphical method for (2xn) and (mx2) games.

UNIT – IV Sequencing Problem:

Sequencing problem – Meaning, procedure for solving sequencing problems - Processing 'n' jobs through two machines, Processing 'n' jobs through 'm' machines and processing of two jobs through 'm' machines.

UNIT – V Network Analysis by PERT/CPM:

Network analysis by CPM/PERT : Basic Concept – Constraints in network – Construction of the network – Time calculations – Concept of slack and float in Network analysis – Network crashing – Finding optimum project duration and minimum project cost.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Research and analytical problems on various applications of the industrial issues.

REFERENCES:

1. Kanti Swarup, Gupta P.K. and Manmohan (2020), Operations Research, Sultan Chand & Sons, New Delhi.
2. Taha H.A. (1992), An Introduction to Operations Research, Colliat Macmillan.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- The fundamental concepts of operational research techniques.
- Linear programming.
- Transportation and assignment problems, sequencing problem.

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Third Year | **CORE PRACTICAL VI** | **Semester VI**

STATISTICS PRACTICAL VI

(Using R Programming)

Code: | **(Practical)** | **Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- To impart the analytical skills compassing the statistical methods, predictive analytics, data mining, and machine learning using software and its implications in data science.
- To give adequate acquaintance with the technical world to elevate the job competency.

PROBLEMS BASED ON THE FOLLOWING TOPICS

- Classification and tabulation of data.
- Diagrammatic representation.
- Measures of central tendency.
- Measures of dispersion.
- Measures of skewness and kurtosis.
- Simple correlation.
- Simple regression.
- Fitting of Binomial, Poisson, Normal distributions.
- Test of significance (t, F, Chi-square tests).
- Test of significance (Z test)
- One way ANOVA and Two way ANOVA

REFERENCES:

1. Alan Agresti (2002), Categorical Data Analysis. John Wiley & Sons.
2. Gardener (2017), Beginning R - The Statistical Programming Language, 1st edition, Wiley India Pvt ltd.
3. *https://cran.r-project.org/doc/contrib/Faraway-PRA.pdf*

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Students will gain the statistical software knowledge along with machine learning which is essential required for projects in all disciplines.
- The content develops research oriented concepts and skills in students about data science required for data analytics, data scientist job in IT sectors will be enriched.
- The content of the syllabus includes the statistical techniques used in market analytics, research analytics and financial analytics.
- The students will be motivated to do research work.
- The students will get the insights of theory as to use the applications of theory in real time problems through software and summarize the results.

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

1. APPLIED STATISTICS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- This course will help students to know the applications of statistics and learn and apply these techniques in the core course of their study.
- This course will give exposure to four applied fields of statistics viz. Time series and index numbers.
- They will be having hands on practice of working on the data related to above mentioned fields.

UNIT – I Secular Trend:

Analysis of Time Series – Its definition and uses, additive and multiplicative models in time series, components of time series - secular trend, seasonal variation, cyclic variations and irregular fluctuations - Definition and concepts. Measurement of trend – graphic method, method of semi-averages, method of moving averages and method of least squares. fitting of straight line trend.

UNIT – II Seasonal Variations:

Measurement of Seasonal Variations – Method of Simple Averages, Ratio to Moving Average method by additive and multiplicative model , Ratio to Trend Method and Link Relative Method - Simple Problems.

UNIT – III Introduction to Index Numbers:

Index Numbers – Definition and uses, types of index numbers, problems involved in the construction of index numbers. Construction of simple index numbers – Simple aggregate method and simple average of price relatives using A.M. & G.M. Construction of weighted index numbers – Laspeyre's, Paasche's, Dorbish-Bowley, Marshall-Edgeworth and Fisher's ideal index numbers - Simple problems.

UNIT – IV Testing of Index Number:

Definition of deflation, splicing, inflation, and real wages. Construction of weighted average of price relatives index numbers using A.M. & G.M. Fixed base index numbers and chain base index numbers. Tests of adequacy of a good Index number – Time reversal test, factor reversal test, unit test and cyclic test - Simple problems.

UNIT – V Demand Analysis:

Demand Analysis: Introduction - Definition of demand and supply - Laws of demand and supply - Equilibrium Price-Giffen's paradox. Price elasticity of demand and supply: Definition, interpretation and simple problems.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry expert lectures - predictive modelling in data analytics and demographical analysis of real time problems.

REFERENCES:

1. Gupta S.C. and Kapoor V.K (1993), Fundamental of Applied Statistics. Sultan Chand & Sons, New Delhi.
2. Gupta S.P. (1995), Statistical Methods, Sultan Chand & Sons, New Delhi.
3. Goon A.M., Gupta M.A. and Das Gupta (1987), Fundamentals of Statistics, Sultan Chand & Sons, New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Understand and identify the problems in the construction of various types of index numbers.
- Appreciate various tests of adequacy and the uses of index numbers.
- Understand the concept of consumer price index and identify the limitations of index numbers.
- Understand and apply the concepts and methods underlying the analysis of univariate time series and the context for interpretation of results.
- Decompose a time series into trend, seasonal, cyclical and irregular components.
- Understand the theoretical basis of different methods of time series analysis including decomposition.
- Define supply and demand analysis and explain the associated functions.
- Explain how supply and demand are related.

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

2. REGRESSION ANALYSIS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The learning objectives include:

- This course will help students to know the linear regression and least square analysis.
- This course will give exposure to test for lack of fit, multicollinearity and non-linear regression.

UNIT – I Simple Linear Regression:

Simple linear regression - Assumptions, estimation of model parameters, standard error of estimators, testing of hypotheses on slope and intercept (β's), interval estimation of model parameters, prediction interval of a new observation, coefficient of determination, regression through origin.

UNIT – II Least Square Analysis and Test of Hypothesis:

Standard Gauss Markov setup, least square estimation of model parameters, variance covariance of least squares estimators, estimation of error variance. Tests of hypotheses – Significance of regression (ANOVA, R^2 and adjusted R^2), general linear hypotheses - Confidence intervals and regions, prediction intervals, detecting hidden interpolation.

UNIT – III Test for lack of fit:

Test for Lack of fit of the model. Durbin-Watson test for autocorrelation. Analytical methods for selecting a transformation generalized and weighted least squares - Detection of influential observations - Cooks statistic, DFFITS, DFBETAS.

UNIT – IV Multicollinearity:

Multicollinearity – sources, effects, diagnostics, Methods of dealing with multicollinearity (collection of additional data, model respecification, Ridge regression). Selection of variables – forward selection, backward elimination and stepwise regression (algorithms only).

UNIT – V Non-linear Regression:

Non-linear regression - transformation to a linear model, their use and limitations, initial estimates (starting values), parameter estimation using iterative procedures - Gauss-Newton, steepest Descent, Marquardt's compromise. Count data - Poisson regression – variables selection - Non-parametric regression.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Industry expert lectures - predictive modelling in linear and non-linear regression analysis of real time problems.

REFERENCES:

1. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining (2021), Introduction to Linear Regression Analysis, 6th edition, Wiley.

2. Norman R. Draper, Harry Smith (1998), Applied Regression Analysis - Wiley.
3. John F. Monahan, (2008), A Primer on Linear Models - CRC Press.
4. Andre I. Khuri, (2009), Linear Model Methodology - CRC Press.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able:

- Understand and identify the problems in linear and non-linear regression models.
- Understand the concept of methods of dealing with multicollinearity.
- Understand the concept of test of hypothesis and lack of fit.

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Third Year **PROJECT** **Semester-VI**

Code: **Credit: 3**

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-Voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Third Year **SKILL BASED ELECTIVE II** **Semester VI**

COMMUNICATION AND INTERPERSONAL SKILLS

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The learning objectives include:

- Importance and different types of business communication.
- Business communication methods, business communication functions.

UNIT – I Basic Communication:

Communication – meaning and definition – medium of communication – barriers to communication.

UNIT – II Listening:

Needs and advantages of listening – active – elements of active listening with reading - coherence of listening with reading and speaking.

UNIT – III Speaking:

Features of effective speech – role play - conversation building – topic presentation – group discussions.

UNIT – IV Reading

Comprehensive of technical and non-technical material – skimming scanning – inferring guessing.

UNIT – V Writing:

Writing effective sentences – cohesive writing – clarity and conciseness in writing – resumes and job applications.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Interview skills placement / job interview activity: Mock interview, conflict management and decision making activity: case analysis of a challenging scenario.

REFERENCES:

1. Basic Communication Skills by P. Kiranmani Dutt and Geetha Rajeevan
2. Business Scenarios by Heidi Schuttz
3. Business Communication by Asha Kaul – PHI.
4. Business Communication by Sathya Swaroop Debasish and Bhagaban Das – PHI
5. Business Communication by NS Raghunathan and Santhanam – Marghum.

COURSE OUTCOMES:

- Business Communications Jobs and accelerate your career.
- Internal upward communication. Internal upward business communication is communication that comes from a subordinate to a manager or an individual up the organizational hierarchy.

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