Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure and Syllabus for T. Y. B. Sc. STATISTICS
(Semester- V and Semester- VI)
(w. e. from June, 2021)

Semester	Paper Code	Title of Paper	No. of Credits
V	STAT3501	Distribution Theory	3
	STAT3502	Statistical Inference- I	3
	STAT3503	Sampling Methods	3
	STAT3504	Design of Experiments	3
	STAT3505	C- Programming	3
	STAT3506(A) STAT3506(B)	Introduction to Stochastic Processes Or Biostatistics	3
	STAT3507	Statistics Practical- V	2
	STAT3508	Statistics Practical- VI	2
	STAT3509	Statistics Practical- VII	2
	CC	Certificate Course	2
VI	STAT3601	Introduction to Regression Analysis	3
	STAT3602	Statistical Inference- II	3
	STAT3603	Statistical Quality Control and Reliability	3
	STAT3604	Operations Research	3
	STAT3605	Statistical Computing Using R- Software	3
	STAT3606(A) STAT3606(B)	Official Statistics Or Actuarial Statistics	3
	STAT3607	Statistics Practical- VIII	2
	STAT3608	Statistics Practical- IX	2
	STAT3609	Project	2

Note:

Paper Code	Title of Paper	Practical Based on Paper
STAT3507	Statistics Practical- V	Design of Experiments
STAT3508	Statistics Practical- VI	Distribution Theory, Statistical Inference- I and Sampling Methods
STAT3509	Statistics Practical- VII	C- Programming
STAT3607	Statistics Practical- VIII	Introduction to Regression Analysis and Operations Research
STAT3608	Statistics Practical- IX	Statistical Inference- II and Statistical Quality Control and Reliability

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3501
Paper : I   Title of Paper : Distribution Theory
Credit : 3 credits   No. of lectures : 48

A) Learning Objectives:

1. To learn how to apply continuous probability distribution to various business problems.
2. To provide a through theoretical grounding in different type of distributions.
3. To train students with essential tools for statistical analysis understanding through real-world of statistical applications.
4. To present the general theory of statistical distributions as well as the standard distributions found in statistical practice.
5. To learn general strategies for problems about order statistics and applications of order statistics.

B) Learning Outcome:

Students should be able to:

1. Develop problem solving techniques needed to calculate probabilities.
2. Understand the most common continuous probability distributions and their real-life applications.
3. Understanding of distribution helps to understand the nature of data and to perform appropriate analysis.
4. The paper shall expose the students to different aspects of distribution theory. On studying this paper students can get to learn the theory underlying the construction of these distributions.
5. Thoroughly understanding the procedures of probability distributions students can apply these distributions to model random events.
6. On studying the theory of order statistics students can learn how to model product failure, droughts, floods and other extreme occurrences.

TOPICS/CONTENTS:

Unit - 1. Beta Distribution (9 L)

1.1 Beta distribution of first kind: p.d.f

$$f(x) = \frac{1}{B(m,n)} x^{m-1}(1-x)^{n-1}, \qquad 0 \leq x \leq 1, \qquad m, n > 0$$

$$= 0, \qquad\qquad\qquad elsewhere$$

Notation: $X \sim \beta_1(m,n)$, Nature of probability curve, Derivation of mean, variance, r^{th} raw moment, harmonic mean, mode, symmetry of the distribution.

1.2 Relation with U (0, 1), probability distributions of $\frac{1}{X}, X + Y, X - Y, XY, \frac{X}{Y}$, where X and Y are iid $\beta_1(1,1)$

1.3 Beta distribution of second kind: p.d.f. $f(x) = \frac{1}{B(m,n)} \frac{x^{m-1}}{(1-x)^{m+n}}$; $x \geq 0, \ m, n > 0$

$$= 0 \qquad\qquad ; elsewhere$$

Notation: $X \sim \beta_2(m,n)$, Nature of probability curve, Derivation of mean, variance, r^{th} raw moment, harmonic mean, mode, symmetry of the distribution.

1.4 Derivation of interrelation between $\beta_1(m,n)$ and $\beta_2(m,n)$

1.5 Derivation of distribution of $\frac{X}{Y}, \frac{X}{X+Y}$, where X and Y are independent gamma variates.

1.6 Statement of relation between distribution function of $\beta_1(m,n)$ and binomial distribution.

1.7 Illustrative examples.

Unit – 2 Weibull Distribution (4 L)

2.1 p.d.f . $f(x) = \frac{\beta}{\alpha} \left(\frac{x}{\alpha}\right)^{\beta-1} exp\left\{-\left(\frac{x}{\alpha}\right)^{\beta}\right\}$; $x \geq 0, \alpha, \beta > 0$

$$= 0 \qquad\qquad ; elsewhere$$

Notation X ~ W (α, β)

2.2 Probability curve, location parameter, shape parameter, scale parameter. Derivation of distribution function, quartiles, mean and variance, coefficient of variation, relationship with gamma and exponential distribution.

2.3 Illustrative examples.

Unit – 3 Pareto Distribution (4 L)

3.1 p.d.f. with parameters (α, β) $f(x) = \frac{\alpha \beta^{\alpha}}{x^{\alpha+1}}$; $x \geq \beta \ and \ \alpha, \beta > 0$,

$$= 0 \qquad ; elsewhere$$

Notation X ~ Pareto (α, β)

3.2 Probability curve, shape parameter, scale parameter.

3.3 Derivation of distribution function, quartiles, mean, variance, mode, skewness.

3.4 Relationship with exponential distribution, applications.

3.5 Illustrative examples.

Unit – 4 Order Statistics   (5 L)

4.1 Order Statistics for a random sample of size n from a continuous distribution, definition, derivation of distribution function and density function of the ith order statistics $X_{(i)}$, particular cases for $X_{(1)}$ and $X_{(n)}$.

4.2 Distribution of $X_{(i)}$ for a random sample from uniform and exponential distribution.

4.3 Joint distribution of rth and s^{th} order statistic $(X_{(r)}, X_{(s)})$ for a random sample from uniform and exponential distribution.

4.3 Distribution of sample median for a random sample from uniform distribution.

4.4 Distribution of sample range

4.5 Illustrative examples.

Unit – 5 Cauchy Distribution   (5 L)

5.1 p.d.f. $f(x) = \frac{\lambda}{\pi} \frac{1}{\lambda^2 + (x-\mu)^2}$; $-\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0$.

$\qquad\qquad = 0 \qquad\qquad ; elsewhere$

Notation: $X \sim C(\mu, \lambda)$

5.2 Nature of the probability curve, comparison with tails of normal distribution.

5.3 Derivation of distribution function, quartiles, non – existence of moments, statement of distribution of $aX + b$, derivation of distribution of i) $\frac{1}{x}$ ii) X^2 where $X \sim C(0,1)$, problems based on these results.

5.4 Statement of additive property for two independent Cauchy variates, statement of distribution of the sample mean, comment on limiting distribution of X.

5.5 Statement of relationship with uniform, Student's t and normal distributions.

5.6 Illustrative examples.

Unit – 6 Laplace (Double Exponential) Distribution   (5 L)

6.1 p.d.f. $f(x) = \frac{\lambda}{2} exp(-\lambda|x - \mu|)$; $-\infty < x < \infty, -\infty < \mu < \infty, \lambda > 0$.

$\qquad\qquad = 0 \qquad\qquad\qquad ; elsewhere$

Notation: $X \sim L(\mu, \lambda)$

6.2 Nature of the probability curve.

6.3 Derivation of distribution function, quartiles.

6.4 MGF, CGF, Moments and cumulants, skewness and kurtosis.

6.5 Derivation of Laplace distribution as the distribution of the difference of two i.i.d. exponential random variables with mean $\frac{1}{\lambda}$.

6.6 Illustrative examples.

Unit –7. **Lognormal Distribution** (7 L)

7.1 p.d.f. $f(x) = \frac{1}{(x-a)\sigma\sqrt{2\pi}} exp\left\{\frac{-1}{2\sigma}[log_e(x-a)-\mu]^2\right\}$ $;x>a, -\infty < \mu < \infty, \sigma > 0,$

$= 0$ $; elsewhere$

Notation: $X \sim LN\ (a, \mu, \sigma^2)$

7.2 Derivation of relation with N (μ, σ^2) distribution

7.3 Nature of the probability curve.

7.4 Derivation of moments (r-th moment of X-a), mean, variance, quartile, mode, Karl Pearson's and Bowley's coefficient of skewness and kurtosis, derivation of quartiles and mode.

7.5 Distribution of ($\prod x_i$), when X$_i$'s independent lognormal random variables.

7.6 Illustrative examples.

Unit – 8. **Bivariate Normal Distribution.** (9L)

8.1 p.d.f of a bivariate normal distribution.

$$f(x) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}}\ exp\left\{\frac{-1}{2(1-\rho^2)}\left[\left(\frac{x-\mu_1}{\sigma_1}\right)^2 + \left(\frac{y-\mu_2}{\sigma_2}\right)^2 - 2\rho\left(\frac{x-\mu_1}{\sigma_1}\right)\left(\frac{y-\mu_2}{\sigma_2}\right)\right]\right\} ;$$

$$; -\infty < x, y < \infty,$$
$$-\infty < \mu_1, \mu_2 < \infty$$
$$\sigma_1, \sigma_2 > 0, -1 < \rho < 1$$

Notation (X, Y) $\sim BN\ (\mu_1, \mu_2, \sigma_1, \sigma_2, \rho)$

8.2 Nature of surface of p.d.f., marginal and conditional distributions, identification of parameters, regression of Y on X, independence and uncorrelatedness, Derivation of MGF and moments. Statement of distribution of aX+ bY+ c and distribution of $\frac{X}{Y}$.

8.3 Illustrative examples.

Books Recommended

1. Arora Sanjay and Bansi Lal (1989). Mathematical Statistics (1st Edition), Satya Prakashan 16/17698, New Delhi.

2. Cramer H.: (1962) Mathematical Method of Statistics, Asia Publishing House, Mumbai

3. Gupta S. C. and Kapoor V. K.: (2006). Fundamental Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi.

4. Hogg, R.V. and Craig A. T. (1970). Introduction Mathematical Statistics (IIIrd Edition), Macmillan Publishing Company. Inc. New York

5. Lindgren B.W.: (1976) Statistical Theory (IIIrd Edition) Collier Macmillan international Edition, Macmillan Publishing Co. Inc. New York.

6. Mood. A.M., Graybill, F. Bose, D. C.: (1974) Introduction to theory of Statistics. (IIIrd Edition) Mc- Graw Hill Series.

7. Mukhopdhyay, P (1996). Mathematical Statistics, New Central Book Agency.

8. Rohatgi, V. K. (1975) An Introduction to probability Theory and Mathematical Statistics, Wiley Eastern Ltd. New Delhi

9. Feller, W.: An introduction of Probability Theory and its applications, Wiley Eastern Ltd. Mumbai.

10. Jhonson and Kotz: Continuous Univariate Distributions I and II: Discrete distributions.

11. Bhat B. R.: Modern Probability Theory, New Age International.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT- 3502
Paper   : II   Title of Paper   : Statistical Inference- I
Credit   : 3 credits   No. of lectures : 48

A) Learning Objectives:

The main objective of this course is to get knowledge about

1. The concept of estimation of parameters.

2. Notion of parameter and estimator.

3. Applying various methods of estimation.

4. Important inferential aspects such as point estimation and interval estimation.

5. Properties of a good estimator.

6. Efficient estimator through relative efficiency, MVUE, UMVUE and MVBUE.

B) Learning Outcome:

After completing this course, students will possess skills concerning:

1. Estimation, Parameter, statistic, standard error, sampling distribution of a statistic,

2. Characteristics of a good estimator

3. Different methods of estimation

TOPICS/CONTENTS:

Unit 1: Point Estimation   (4 L)

    1.1 Notion of a parameter, parameter space, sample space as a set of all possible values of $(X_1, X_2, . . , X_n)$, general problem of estimating an unknown parameter by point and interval estimation.

    1.2 Point Estimation: Definition of an estimator, distinction between estimator and estimate, illustrative examples.

    1.3 Mean Square Error (MSE) of an estimator.

Unit 2: Methods of Estimation   (10 L)

    2.1 Method of moments: Derivation of moment estimators for standard distributions. Illustrations of situations where M.L.E. and moment estimators are distinct and their comparison using mean square error. Examples and problems.

    2.2 Method of maximum likelihood:

        2.2.1: Definition of likelihood as a function of unknown parameter, for a

random sample from i) discrete distribution ii) continuous distribution. Examples and problems.

2.2.2: Derivation of maximum likelihood estimator (M.L.E.) for parameters of only standard distributions (case of two unknown parameters only for normal distribution).

2.2.3: M.L.E. of θ in uniform distribution over i) $(0, \theta)$ ii) $(-\theta, \theta)$ iii) $(m\theta, n\theta)$ $(m < n)$

2.2.4: M.L.E. of θ in $f(x ; \theta)= \text{Exp} \{-(x- \theta)\}, x > \theta$.

2.2.5: M.L.E. of location parameter in Laplace distribution.

2.2.6: Invariance property of M.L.E.

Unit 3: Properties of Estimators

3.1 Unbiasedness (4 L)

Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples. Proofs of the following results regarding unbiased estimators:

(a) Two distinct unbiased estimators of θ give rise to infinitely many estimators.

(b) If T is an unbiased estimator of θ, then $\phi(T)$ is unbiased estimator of $\phi(\theta)$ provided $\phi(.)$ is a linear function.

3.2 Efficiency (4 L)

Relative efficiency of unbiased estimator T_1 with respect to another unbiased estimator T_2, use of mean square error to define relative efficiency of biased estimators, Notion of the Best Linear Unbiased Estimator and Uniformly Minimum Variance Unbiased Estimator (UMVUE), uniqueness of UMVUE whenever it exists, Examples and problems.

3.3 Sufficiency (7 L)

Concept and definition of sufficiency, statement of the Fisher-Neyman factorization theorem with proof for discrete probability distribution. Pitmann – Koopman form and sufficient statistic; Exponential family of probability distributions and sufficient statistic. Examples and problems. Proofs of the following properties of sufficient statistics:

(a) If T is sufficient for θ, then $\emptyset(T)$ is also sufficient for θ provided $\emptyset$ is a one to one and onto function.

(b) If T is sufficient for θ then T is also sufficient for ø (θ).

(c) M.L.E. is a function of sufficient statistic.

3.4 Asymptotic Behavior of an Estimator (6 L)

Chebychev's inequality for discrete and continuous distributions. Consistency: Definition. Proof of the following theorems:

(a) An estimator is consistent if its bias and variance both tend to zero as the sample size tends to infinity.

(b) If T is consistent estimator of θ and ø (.) is a continuous function, then ø (T) is a consistent estimator of ø (θ)

Examples and problems.

Unit 4: Cramer- Rao Inequality (7 L)

4.1 Fisher information function: Amount of information contained in statistic $T = T(X_1, X_2, \ldots, X_n)$. Statement regarding information in sample and in a sufficient statistic T.

4.2 Cramer- Rao Inequality

4.2.1: Statement and proof of Cramer - Rao inequality, Cramer – Rao Lower Bound (CRLB), definition of minimum variance bound unbiased estimator (MVBUE) of ø (θ). Examples and problems.

4.2.2: Proofs of following results:

(a) If MVBUE exists for θ then MVBUE exists for ø (θ) where ø (.) is a linear function.

(b) If T is MVBUE for θ then T is sufficient for θ.

4.2.3: Comparison of variance with CRLB, relative efficiency of T_1 w. r. t. T_2 for (i) unbiased (ii) biased estimators. Efficiency of unbiased estimator T w. r. t. CRLB.

Unit 5: Interval Estimation (6 L)

5.1 Notion of interval estimation, definition of confidence interval (C.I), length of C.I., Confidence bounds, confidence coefficient. Definition of pivotal quantity and its use in obtaining confidence intervals.

5.2 Interval estimation for the following cases:

i) Mean (μ) of normal distribution (when σ^2 known and σ^2 unknown).

ii) Variance (σ^2) of normal distribution (when μ known and μ unknown).

iii) Median, quartiles using order statistics.

Books Recommended

1. Kale B. K. and Murlidharan K. (2015) Introduction to Parametric Inference, Narosa Publication House, New Delhi.

2. Rohatagi, V. K. (1975) An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.

3. Lehman E. L. (1988) Theory of point estimation (John Wiley)

4. Dudeweitz, E. J. and Mishra, S. N. (1988) Modern Mathematical Statistics, John Wiley and Sons, Inc.

5. Hoel, P. G. Port, S. and Stone, C. (1972) Introduction to Statistical Theory, Houghton Mifflin Company (International) Dolphin Edition.

6. Hogg, R. V. and Craig, A. T. (1978) Introduction to Mathematical Statistics (fourth edition), Collier Macmillan International Edition, Macmillan Publishing Co. Inc., New York

7. Kendall, M. and Stuart, A. (1943) The advanced Theory of Statistics, Vol- 1, Charles and Company Ltd., London

8. Lindgren, B. W. (1976) Statistical Theory (third edition) Collier Macmillan International Edition, Macmillan Publishing Co., Inc. New York

9. Mood, A. M., Graybill, F. and Bose, D. C. (1974). Introduction to the theory of Statistics (third edition) International Student Edition, McGraw Hill.

10. Ramchandran, K. M. and Tsokos C. P. (2009). Mathematical Statistics with Applications, Academic Press.

11. Casella G. and Berger R. L. (2001) Statistical Inference, 2nd edition, Duxbury press.

12. Mukhopadhyay, N. (2020) Probability and Statistical inference. CRC Press.

13. Dixit, U. J. (2016) Examples in Parametric Inference with R. Singapore: Springer.

14. Fergusson T. S. (1996) Mathematical Statistics.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3503
Paper   : III   Title of Paper   : Sampling Methods
Credit   : 3 credits   No. of lectures : 48

A) Learning Objectives:

1. Describe the situations where and how to use probability sampling methods

2. Estimating population parameters using sampling distribution of estimator and obtaining estimators of standard error in estimation under various sampling procedures.

3. Determining adequate sample size for various sampling procedures.

4. Describe the concept of sampling error and non-sampling error.

5. Explain when non-probability sampling methods may be preferred.

B) Learning Outcomes:

1. Identify and recognize the appropriate sample survey design for related problems.

2. Understand the importance of sampling and how results from samples can be used to provide estimates of population characteristics such as the population mean, the population standard deviation and / or the population proportion.

3. Estimates the convenient sample size for Simple random sampling and stratified random sampling.

4. Have an appreciation of the practical issues arising in sampling studies.

TOPICS/CONTENTS:

Unit-1. Sampling   (8 L)

1.1 Concept of distinguishable elementary units, sampling units, sampling frame, random sample, requisites of a good sample. Simple random sampling from finite population of size (N) (i) with replacement (SRSWR) ii) without replacement (SRSWOR) definitions, population mean and population total as parameters, inclusion probabilities.

1.2 (a) Sample mean $\bar{y}$ as an estimator of population mean, derivation of expectation and standard error of $\bar{y}$, confidence interval for population mean, population total standard error.

(b) $N\bar{y}$ as an estimator of population total, derivation of expectation and standard error of $N\bar{y}$ (c) Estimator of above standard errors, both in case of SRSWR and SRSWOR.

1.3 Sampling for proportion as an application of a simple random sampling with X_i as zero or one.

(a) sample proportion as an estimator of population proportion of units possessing a certain attribute, derivation of expectation and standard error of (p).

(b) N_p as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of N_p

(c) Estimator of above standard error both in case of SRSWR and SRSWOR.

Unit-2. Determination of Sample Size (in case of SRS) (4 L)

2.1 Determination of the sample size for the given:

(a) Margin of error and confidence coefficient.

(b) Coefficient of variation of the estimator and confidence coefficient.

Unit-3. Stratified Random Sampling (12 L)

3.1 Stratification, basis of stratification, real life situation where stratification can be used.

3.2 Stratified random sampling as a sample drawn from individual strata using SRSWOR in each stratum.

3.3 (a) $\overline{y_{st}} = \frac{\sum N_i \bar{y}_i}{N}$ as an estimator of population mean ($\bar{Y}$), Derivation of expectation

and standard error of $\overline{y_{st}}$.

(b) $N\overline{y_{st}}$ as an estimator of population total, derivation of expectation and standard error of $N\overline{y_{st}}$.

(c) Estimator of above standard errors.

3.4 Problem of allocation, proportional allocation, Neyman's allocation, derivation of the expressions for the standard errors of the above estimators when these allocations are used.

3.5 Gain in precision due to stratification, comparison amongst SRSWOR, stratification with proportional allocation and stratification with Neyman's allocation.

3.6 Cost and variance analysis in stratified random sampling, minimization of variance for fixed cost, minimization of cost for fixed variance, optimum allocation, Neyman's allocation as a particular case of optimum allocation in cost and variance analysis.

Unit-4. Ratio and Regression Methods of Estimation for SRSWOR (Sampling Methods using Auxiliary variables) **(6 L)**

    4.1 Rationale behind using auxiliary variates in estimation.

    4.2 Situations where (a) ratio method is appropriate, (b) regression method is appropriate.

    4.3 Ratio and regression estimators of the population mean and population total.

    4.4 Comments regarding bias, statement of standard errors of ratio and regression estimators relative efficiency of these estimators, with respect to SRSWOR. (Derivations are not expected).

Unit-5. Systematic Sampling (Linear Systematic Sampling) **(6 L)**

    5.1 Real life situations where systematic sampling is appropriate. Techniques of drawing a sample using systematic sampling.

    5.2 Estimation of the population mean and population total, standard error of these estimators.

    5.3 Comparison of systematic sampling with SRSWOR.

    5.4 Comparison of systematic sampling with SRSWOR and stratified sampling in the presence of linear trend.

Unit-6. Role of Sample Surveys in Research Methodology **(8 L)**

    6.1 Objectives of a sample survey.

    6.2 Designing a questionnaire, characteristics of a good questionnaire (Questions with codes & scores are to be discussed). Reliability and validity testing by using

        (a) Test – Retest method

        (b) Internal Consistency: (i) Kuder Rechardson Coefficient (KR-20)

                           (ii) Cronbach's Coefficient Alpha

    6.3 Planning, execution and analysis of a sample survey, practical problems at each of these stages.

    6.4 Sampling and non-sampling errors with illustrations.

    6.5 Study of some surveys illustrating the above ideas, rounds conducted by National Sample Surveys organization.

Unit-7. Non-probability sampling techniques **(4 L)**

    7.1 Quota sampling, Convenience sampling, Purposive sampling and snowball sampling.

Books Recommended

1) Cochran, W. G. (1977) Sampling Techniques, third Edition Wiley Eastern Ltd., New Delhi.

2) Malhotra N. (2008) Marketing Research and Applied Orientation (third edition), Prentice Hall of India.

3) Mukhopadhyay P (2008) Sampling theory and methods of survey sampling. Prentice-Hall of India, New Delhi.

4) Murthy, M. N. (1967) Sampling methods, Indian Statistical Institute, Kolkata.

5) Singh, D. and Chaudhary, F. S. (1986) Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.

6) Sukhatme, P. V., Sukhatme, B. V. (1984) Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3504
Paper   : IV   Title of Paper : Design of Experiments
Credit   : 3 credits   No. of lectures : 48

A) Learning Objectives:

1. The main objective of this course is to learn and understand various designs of experiments.

2. Students should be able to identify the design, carryout various experiments and analyze the data.

3. Students should be able to apply appropriate design in real life situation.

B) Learning Outcomes:

1. Students will be able to understand basic principles and various terms of Design of Experiments.

2. Students will be able to apply Factorial design, confounding in real life problems.

3. Students should be able to analyze the data of various experimental design.

TOPICS/CONTENTS:

Unit-1 Introduction   (4 L)

1.1 Concept of Design of Experiment (DOE), Introduction to basic terms of Design of Experiments, Experimental unit, treatments, layout of an experiment, factor, level, run of experiment, control experiment, test experiment.

1.2 Basic principles of Design of Experiments, Randomization, Replication and Local control. 1.3 Uniformity trials.

1.4 Choice of size and shape of a plot.

1.5 The empirical formula for the variance per unit area of plots.

Unit-2 Standard Designs of Experiments   (15 L)

2.1 Completely Randomized Design (CRD): Application of the principles of design of experiment in CRD, Layout of CRD, Model: $X_{ij} = \mu + \alpha_i + \varepsilon_{ij}$ i = 1, 2, …, t; j = 1, 2, …., n_i assumptions and interpretations. Testing normality graphically. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of

(ANOVA) table, testing equality of treatment effects, Hypothesis to be tested $H_0 : \alpha_1 = \alpha_2 = \ldots = \alpha_t = 0$. Comparison of treatment means using box plot techniques. Statement of Cochran's theorem. F test for testing H_0 with justification (independence of chi-square is to be assumed), test for equality of two specified treatment effects using critical difference (C.D). Merits and demerits of CRD.

2.2 **Randomized Block Design (RBD):** Application of the principles of design of experiments in RBD, layout of RBD, Model: $X_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$ i = 1, 2, …, t; j = 1, 2, …, b, Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table, Hypotheses to be tested $H_{01} : \alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_t = 0$; $H_{02} : \beta_1 = \beta_2 = \beta_3 = \ldots = \beta_b = 0$. F test for testing H_{01} and H_{02} with justification (independence of chi-squares is to be assumed), test for equality of two specified treatment effects using critical difference (CD). Merits and demerits of RBD.

2.3 **Latin Square Design (LSD):** Application of the principles of design of experiments in LSD, layout of LSD, Model: $X_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ijk}$ i = 1, 2, ⋯, m; j = 1, 2, ⋯, m; k = 1, 2, ⋯, m. Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table, hypotheses to be tested. $H_{01} : \alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_m = 0$; $H_{02} : \beta_1 = \beta_2 = \beta_3 = \ldots = \beta_m = 0$; $H_{03} : \gamma_1 = \gamma_2 = \cdots = \gamma_m = 0$ and their interpretation. Justification of F test for H_{01}, H_{02} and H_{03} (independence of chi-square is to be assumed). Preparation of ANOVA table and F test for H_{01}, H_{02} and H_{03} testing for equality of two specified treatment effects, comparison of treatment effects using critical difference, linear treatment contrast and testing its significance. Merits and demerits of LSD.

2.4 Linear treatment contrasts, orthogonal contrasts. Scheffe's method for comparing contrasts, Tuckey's procedure for comparing pairs of treatment means (applicable to C.R.D., R.B.D. and L.S.D.)

2.5 Identification of real-life situations where the above designs are useful.

Unit-3 Analysis of non- normal data using (5 L)

3.1 Square root transformation for counts.

3.2 Sin^{-1} (.) transformation for proportions.

3.3 Kruskal Wallis test.

Unit-4 Efficiency of a Design **(5 L)**

    4.1 Concept and definition of efficiency of a design.

    4.2 Efficiency of RBD over CRD.

    4.3 Efficiency LSD over CRD.

    4.4 Efficiency LSD over RBD taking

        i)   Row as a Block.

        ii) Column as a Block.

    4.5 Simple numerical problems.

Unit-5 Analysis of Covariance (ANOCOVA) **(7 L)**

    5.1 Situations where analysis of covariance is applicable.

    5.2 Model for ANOCOVA in CRD and RBD with One Concomitant Variable. Estimation of parameters (derivations are not expected)

    5.3 Preparation of analysis of variance – covariance table, test for $\beta = 0$, test for equality of treatment effects (computational technique only).

Unit-6 Factorial Experiments **(12 L)**

    6.1 General description of m $\times$ n factorial experiment, 2^2 and 2^3 factorial experiments arranged in RBD.

    6.2 Definitions of main effects and interaction effects in 2^2 and 2^3 factorial experiments.

    6.3 Yate's procedure, preparation of ANOVA table, test for main effects and interaction effects.

    6.4 General idea of confounding in factorial experiments.

    6.5 Construction of layouts in total confounding and partial confounding in 2^2 and 2^3 factorial experiments.

    6.6 Total confounding (confounding only one interaction) ANOVA table, testing main effects and interaction effects.

    6.7 Partial confounding (confounding only one interaction per replicate); ANOVA table, testing main effects and interaction effects.

    6.8 Construction of layouts in total confounding and partial confounding for 2^2, 2^3 factorial experiments.

Books Recommended

   1. Cochran W. G. and Cox, C. M. (1968) Experimental Design, John Wiley and Sons, Inc., New York.

2. Dass, M. N. and Giri, N. C. (1986) Design and Analysis of Experiments, II Edition Wiley Eastern Ltd., New Delhi

3. Federer W. T. (1967) Experimental Design: Oxford and IBH Publishing Co., New Delhi

4. Goon, A.M., Gupta, M. K. and Dasgupta, B. (1998). Fundamentals of Statistics, Vol. II, The world Press Pvt. Ltd. Kolkatta

5. Gupta S. C. and Kapoor V. K. (2006). Fundamentals of Applied Statistics, S. Chand Sons, New Delhi

6. Johnson, R. A., Miller, I. and Freund, J. (2010). Probability and Statistics for engineers, Prentice Hall, India.

7. Kempthorne, O. (1952). Design of Experiments, Wiley Eastern Ltd., New Delhi.

8. Montgomery, D. C. (2001). Design and Analysis of Experiments, John Wiley and sons Inc., New Delhi.

9. Snedecor, G. W. and Cochran, W. G. (1994). Statistical Methods, 8th edition, Affiliated East – West Press, New Delhi

10. Wu, C. F. J. and Hamda, M. (2009). Experiments, Planning, Analysis and Parameter Design Optimization, John Wiley & Sons, Inc., Hoboken, New Jersey.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS (With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3505

Paper   : V   Title of Paper   : C- Programming

Credit   : 3 credits   No. of lectures : 48

A) Learning Objectives:

Students successfully completing this course will be able:

1. The course realizes and design algorithm for problem solving.

2. The objective of the course is to develop problem solving abilities using computers.

3. The student will develop skills for writing programs using C.

B) Learning Outcome:

1. Student will be solved to problems using programming capability.

2. Student will be exploring their algorithmic approaches to problem solving.

3. Student will be developed modular programs using control structures, pointers, arrays, strings and functions.

TOPIC CONTENT

Unit 1: C Fundamental (12 L)

1.1 History of 'C' language, Application areas, Structure of a 'C' program, 'C' Program development life cycle, Function as building blocks,

1.2 'C' tokens: Character set, Keywords, Identifiers, Variables, Constants (character, integer, float, string, escape sequences, enumeration constant),

1.3 Data Types: Numeric and character data types, Numeric and character constants, string constants, symbolic constants.

1.4 Operators, Types of operators: arithmetic, relational, logical, assignment, bitwise, conditional. Expressions, types of operators, Operator precedence and Order of evaluation.

1.5 Character input and output, String input and output, Formatted input and output.

Unit 2: Control Structure (10 L)

Decision making structures: - if, if-else, switch and conditional operator, Loop control structures: - while, do while, for, use of break and continue, Nested structures, Unconditional branching (goto statement)

Unit 3: Array (10 L)

Concept, declaration, definition, initialization of array, problem using arrays, passing to function.

List of programs using arrays.

3.1 To find mean, median, variance and coefficient of variation of frequency distribution.

3.2 To find correlation coefficient and least square regression line of Y on X for a given bivariate data.

3.3 To arrange the given data in increasing/decreasing order of magnitude.

3.4 To obtain median of given n observations.

3.5 To obtain addition of two matrices, multiplication of two matrices.

Unit 4: String (4 L)

String Literals, string variables, declaration, definition, initialization, Syntax and string operations, use of predefined string functions, string functions like strcpy(), strcat(), strlen(), strcmp(), strrev(). Array of strings.

Unit 5: Function (8 L)

Concept of function, Standard library functions, User defined functions: - declaration, definition, function call, parameter passing (by value), calling a function by reference and by value, return statement. Recursive functions, Scope of variables. local and global variables.

List of writing functions:

1. To find factorial of integer number (both recursive and non-recursive)

2. To find the value of Xn where n is integer. (both recursive and non-recursive)

3. To find GCD of two integer numbers (both recursive and non-recursive)

4. To find maximum/minimum of n numbers. (non-recursive)

Unit 6: Pointer (4 L)

Introduction to Pointers. Declaration, definition, initialization, dereferencing. Pointer arithmetic. Relationship between Arrays & Pointers- Pointer to array, Array of pointers.

List of Simple Programs (short programs)

1. Converting °C temperature to °F.

2. To carry out arithmetic calculations.

3. To check whether given number is odd or even.

4. To check whether given number m is divisible by n or not.

5. To find maximum of 2 numbers or 3 numbers.

6. To find area of triangle and circle.

7. To find roots of quadratic equation.

8. To check whether integer is prime or not.

9. To find mean, Geometric mean and Harmonic Mean of n numbers.

10. To prepare multiplication table.

11. To find sum of digits of a number.

12. To solve simultaneous linear equations. (two equations in two variables)

13. To evaluate simple and compound interest

14. To evaluate exp(x), sin (x), log (x) etc. using Taylor"s series expansion.

15. To convert decimal number to equivalent binary number.

16. To generate Fibonacci series like 0, 1, 1,2,3,5…

17. To test palindrome string using string function.

18. To sort a string using string function.

19. To search string using string function.

20. To combine given two strings using string function.

List of programs (long programs)

21. Program in C to prepare a frequency distribution with given class interval from raw data.

22. Program in C to find mean, variance, standard deviation and quartiles for given n observations and frequency distribution.

23. Program in C to fit a Binomial distribution to given data.

Books Recommended:

1. How to Solve it by Computer, R.G. Dromey, Pearson Education.

2. Problem Solving and Programming Concept, Maureen Sprankle,7th Edition, Pearson Publication.

3. C: the Complete Reference, Schildt Herbert, 4 th edition, McGraw Hill

4. A Structured Programming Approach Using C, Behrouz A. Forouzan, Richard F. Gilberg, Cengage Learning India

5. The 'C' programming language, Brian Kernighan, Dennis Ritchie, PHI

6. Programming in C, A Practical Approach, Ajay Mittal, Pearson

7. Programming with C, B. Gottfried, 3rd edition, Schaum's outline Series, Tata McGraw Hill. 8. Programming in ANSI C, E. Balagurusamy, 7th Edition, McGraw Hil.

8. Let us C, Kanitkar, Y (2008) BFB publishers, New Delhi.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3506 (A)

Paper   : VI (A)   Title of Paper   : Introduction To Stochastic Processes

Credit   : 3 credits   No. of lectures : 48

A) Learning objectives:

1. To provide the students with a fundamental understanding of the stochastic processes and Markov chains.

2. Students should be able to construct transition probability matrix (tpm), find the n-step transition probabilities and classify its states.

B) Learning outcomes:

1. Students will be able to formulate tpm, n-step transition probabilities

2. Students will be able to classify of states.

3. Students will become familiar with Poisson process.

TOPICS/CONTENTS:

UNIT 1: Introduction (18 L)

Definition of a Stochastic process, state space ,parameter space, types of stochastic processes, Markov Chains (MC) $\{X_n, n \geq 0\}$, finite MC, time homogeneous MC one step transition probabilities, and transition probability matrix (t.p.m.), stochastic matrix, Chapman Kolmogorov equation, n-step transition probability matrix, initial distribution, joint distribution function of $\{X_0, X_1, \ldots, X_n\}$, partial sum of independent and identically distributed random variables as Markov Chain, illustrations such as random walk, Gambler's ruin problem, Ehrenfest chain.

UNIT 2: Classification of States (12 L)

Classification of states: Communicating states, first return probability, probability of ever return Classification of states, as persistent and transient states. Decomposition of state space, closed set of states, irreducible set of states, irreducible MC, periodicity of M.C. aperiodic M.C. ergodic M. C.

UNIT 3: Stationary distribution (6 L)

Stationary distribution for an irreducible ergodic finite Long run behaviour of a MC

UNIT 4: Poisson Process (12L)

Poisson process: Postulates and properties of Poisson process, probability distribution of N(t), the number of occurrences of the event in (0, t], Poisson process and probability

distribution of inter-arrival time, mean, variance and covariance functions. Definition of compound Poisson

Books Recommended:

1. Medhi J. (1982) Stochastic processes (Wiley Eastern)
2. Ross, S. (1996) Stochastic processes (John Wiley)
3. Ross, S. (2000) Introduction to probability models, 7th edition (Academic Press)
4. Hoel , P.G.,Port, S.C. ,Stone, C.J. (1972) : Introduction to stochastic processes
5. Bhat, B.R. (2000) stochastic models: Analysis and applications (New Age International)
6. Adke, S.R., Manjunath, S.M. (1984) An introduction to finite Markov processes (Wiley Eastern)
7. Taylor, H N and Karlin, S. (1984) An introduction to stochastic modeling(Academic Press)

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3506 (B)

Paper   : VI (B)   Title of Paper   : Biostatistics

Credit   : 3 credits   No. of lectures : 48

A) Learning objectives:

1. The main objective of this course is to learn and understand a basic concept of emerging branch of clinical trials belongs to biostatistics.

2. Students should be able to understand the principles of epidemiology and discussion of the concept of natural history of disease particularly with respect to possible clinical interventions.

3. Students should able to understand the phases of clinical trials and the types of study designs typically used in clinical trials, use of randomization and blinding.

4. the purposes for conducting clinical trials.

B) Learning outcomes:

Students should able to understand

1. Basic concept of clinical trials.

2. Identify epidemic events in real life situations.

3. Designs which typically used in clinical trials.

4. Application of appropriate design from clinical trials.

TOPICS/CONTENTS:

Unit-1 Epidemiology (16 L)

1.1 Introduction to Epidemiology

1.2 Odds, odds ratio, relative risk.

1.3 Estimation of odds ratio (OR), Confidence interval for OR. Relation with parameters in a logit model

1.4 Symmetry in square contingency tables, collapsing tables and Simpson's paradox.

Unit-2 Clinical trials (12 L)

2.1 General information on history of drug discovery including Louis Pasteur (rabies and small pox), Ronald Ross and malaria, Alexander Fleming and penicillin, Jonas Salk and polio, cholera, asthma, diabetes, blood pressure, heart attack, arthritis.

2.2 Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical

analysis plan, clinical study report.

Unit-3 Design of clinical trials   **(15 L)**

    3.1 Parallel designs, case control studies, longitudinal studies, safety studies

    3.2 Treatments, 2 periods cross over design.

Unit-4 Bioequivalence and bio-availability   **(5 L)**

    4.1 Bioequivalence and bio-availability, non-inferiority trial

    4.2 Practice based medical research, evidence-based medicine

Books Recommended:

1. A. P. Gore and S. A, Paranjape (2000) Course on mathematical and statistical Ecology (Kluwer publishing Holland)

2. M. B. Kulkarni, V. R. Prayag, (2004) Introduction to Statistical Ecology (SIPF Academy, Nasik)

3. Alan Agrasti (1996) Introduction to Categoric Data Analysis (Wiley) for part–II epidemiology (mainly odds, odds ratios and inference) For the more reference books we need to see the books in the department of Statistics SPPU, Pune.

4. J. N. S. Matthews: Chapman and Hall (2006) Introduction to Randomized Controlled clinical Trials

5. Stephen Sann (2000) Statistical Issues in drug Development (John Wiley)

6. Steven Diantadosi (2000) Clinical Trials – A methodological perpective (John Wiley)

7. L.M. Friedmon, C.D. Forbes, D.L. Demats (TT) Fundamentals of Clinics Trials (Spinner)

8. Steve selvin (2000) Epidemiologic Analysis (Oxford)

9. M.M. Shoukni, C.A. Pavse(1999) Statistical Methods for Health Sciences (CPC Pree)

10. Steve Salvin (1999) Statistical Analysis of Epidomiologic Data (Ph. D: Oxford)

11. A. P. Gore, S. A. Paranjpe and M. B. Kulkarni (2010) Lecture Notes on Medical Statistics

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3507
Paper : VII   Title of Paper : Statistics Practical- V
Credit : 2 credits

A) Learning objectives:

1. The main objective of this course is to learn and understand the various analysis techniques in designs of experiments such as ANOVA, ANOCOVA, etc.
2. Students should be able to identify the design, carryout various experiments and analyze the data.

B) Learning outcomes:

1. Students will be able to understand basic principles and various terms of Design of Experiments.
2. Students will be able to apply Factorial design, confounding in real life problems.
3. Students should be able to analyze the data of various experimental design.

Sr. No.	Title of Experiments
1.	Analysis of CRD (equal and unequal replications, pairwise comparison of treatments, using critical difference (C.D). Check normality using normal probability plot.
2.	Analysis of RBD (pairwise comparison of treatments using i) C.D ii) Tukey test iii) Scheff's test. Efficiency of RBD w.r.t. CRD
3.	Analysis of RBD. Efficiency of RBD w.r.t. CRD
4.	Analysis of LSD and Calculation of Efficiency (pairwise comparison of treatments using C.D. and box plot, efficiency of LSD w.r.t. i) CRD ii) RBD)
5.	Kruskal-Wallies H test
6.	Analysis of Covariance in CRD
7.	Analysis of Covariance in RBD
8.	Analysis of 2^2 and 2^3 factorial experiments in RBD.
9.	Analysis of 2^3 factorial experiments in RBD (partial confounding)
10.	Analysis of 2^3 factorial experiments in RBD (total confounding)

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3508
Paper : VIII   Title of Paper : Statistics Practical- VI
Credit : 2 credits

A) Learning Objectives:

1. Students should be able to understand properties and applications of standard distribution.

2. The main objective of this course is to get knowledge about important inferential aspects of interval estimation.

3. Estimating population parameters using sampling distribution of estimator and obtaining estimators of standard error in estimation under various sampling procedures.

4. Determining adequate sample size for various sampling procedures.

B) Learning Outcomes:

1. Student will be able to fit the distributions.

2. Students will be able to draw model sample from distributions.

3. Students will be able to apply appropriate sample survey design for related problems.

4. Estimates the convenient sample size for Simple random sampling and stratified random sampling.

Sr. No.	Title of Experiments
1.	Model sampling from Cauchy and Laplace distributions
2.	Fitting of lognormal distribution
3.	M.L.E and moment estimator of truncated Binomial and truncated Poisson distributions (truncated at zero)
4.	Construction of confidence interval for population median and quartiles, based on order statistics.
5.	Simple random sampling (estimation of population mean, population total with standard errors), i) with replacement, ii) without replacement. Confidence interval for population mean and population total.

6.	Stratified random sampling: Proportional and Neyman allocation, comparison with SRSWOR.
7.	Stratified random sampling: cost and variance analysis.
8.	Ratio methods of estimation. Comparison with SRSWOR.
9.	Regression methods of estimation. Comparison with SRSWOR.
10.	Determination of Sample Size.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- V) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3509
Paper   : IX   Title of Paper   : Statistics Practical- VII
Credit   : 2 credits

A) Learning objectives:

Students successfully completing this course will be able:

1. The objective of the course is to develop problem solving abilities using computers.

2. The student will develop skills for writing programs using C.

B) Learning outcomes:

1. Student will be solved to problems using programming capability.

2. Student will be exploring their algorithmic approaches to problem solving.

3. Student will be developed modular programs using control structures, pointers, arrays, strings and functions.

Sr. No.	Title of Experiments
1.	A) Converting °C temperature to °F. B) To check whether given number is odd or even. C) To find maximum of 2 numbers or 3 numbers. D) To find area of triangle and circle.
2.	A) To find roots of quadratic equation.
3.	To check whether integer is prime or not.
4.	To find mean, Geometric mean and Harmonic Mean of n numbers.
5.	A) To find mean, variance and coefficient of variation of n observations. B) Arrange the observations in ascending order of magnitude and find median of n observations.
6.	To find mean, median, variance and coefficient of variation of frequency distribution when fi and xi are given.
7.	To find correlation coefficient for a given bivariate data.
8.	To fit a line of regression of Y on X for a given bivariate data.
9.	To fit a Binomial distribution to given data.
10.	To obtain addition of two matrices, multiplication of two matrices.

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure for T. Y. B. Sc. STATISTICS
Semester- VI
(w.e. from June, 2021)

Semester	Paper Code	Title of Paper	No. of Credits
V	STAT3501	Distribution Theory	3
	STAT3502	Statistical Inference- I	3
	STAT3503	Sampling Methods	3
	STAT3504	Design of Experiments	3
	STAT3505	C- Programming	3
	STAT3506(A) STAT3506(B)	Introduction to Stochastic Processes Or Biostatistics	3
	STAT3507	Statistics Practical- V	2
	STAT3508	Statistics Practical- VI	2
	STAT3509	Statistics Practical- VII	2
	CC	Certificate Course	2
VI	STAT3601	Introduction to Regression Analysis	3
	STAT3602	Statistical Inference- II	3
	STAT3603	Statistical Quality Control and Reliability	3
	STAT3604	Operations Research	3
	STAT3605	Statistical Computing Using R- Software	3
	STAT3606(A) STAT3606(B)	Official Statistics Or Actuarial Statistics	3
	STAT3607	Statistics Practical- VIII	2
	STAT3608	Statistics Practical- IX	2
	STAT3609	Project	2

Note:

Paper Code	Title of Paper	Practical Based on Paper
STAT3507	Statistics Practical- V	Design of Experiments
STAT3508	Statistics Practical- VI	Distribution Theory, Statistical Inference- I and Sampling Methods
STAT3509	Statistics Practical- VII	C- Programming
STAT3607	Statistics Practical- VIII	Introduction to Regression Analysis and Operations Research
STAT3608	Statistics Practical- IX	Statistical Inference- II and Statistical Quality Control and Reliability

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3601

Paper   : I   Title of Paper   : Introduction to Regression Analysis

Credit   : 3 credits   No. of lectures : 48

A) Learning Objectives:

1. To introduce students with the concepts of linear regression and multiple regression.

2. To acquaint students with the linear regression model and its limitations.

3. To enable students to compare residual diagnostics and apply corrective measures.

4. To familiarize students with various regression models.

B) Learning Outcomes:

By the end of the course, students should be able to:

1. Understand basic assumption and various terms of regression model.

2. Demonstrate simple linear regression as a tool for exploring the linear relationship between two variables

3. Learn how to estimate and interpret the model.

4. Use graphical and numerical methods to check the assumptions of regression model.

5. Learn about variable transformations and interactions to incorporate nonlinear relationships in the model.

6. Apply Simple Linear Regression model, Multiple Linear Regression Analysis, Logistic Regression Model in real life problems.

7. Determine tests of hypothesis of model parameters, AIC and BIC criteria.

TOPICS/CONTENTS:

Unit-1 Introduction   **(2 L)**

1.1 Regression Analysis as a statistical tool

1.2 Brief History

Unit-2 Simple Linear Regression Model   **(10 L)**

2.1 Review of simple linear regression model: $Y = \beta_0 + \beta_1 X + \varepsilon$, where ε is a continuous random variable with E $(\varepsilon) = 0$, V $(\varepsilon) = \sigma^2$.

2.2 Estimation of β_0 and β_1, by the method of least squares.

2.3 Properties of estimators of β_0, and β_1

2.4 Estimation of σ^2

2.5 Assumption of normality of ε. Tests of hypothesis of β_1

2.6 Interval estimation in simple linear regression model

2.7 Coefficient of determination

2.8 Examples and illustrations

2.9 Transformations.

Unit-3 Multiple Linear Regression Model (10 L)

3.1 Review of multiple linear regression model $Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of regression parameters β_0, β_1, . . ., β_k by the method of least squares, Obtaining normal equations, solutions of normal equations

3.2 Estimation of σ^2

3.3 Assumption of normality of ε. Tests of hypothesis of Regression parameters

3.4 Assessing adequacy of model

    3.4.1 Test of significance of regression

    3.4.2 Test of individual regression coefficient

    3.4.3 Coefficient of determination

3.5 Interval estimation in multiple linear regression models

3.6 Polynomial regression models

3.7 Examples and Illustrations

Unit-4 Regression Diagnostics and Model Building (8 L)

4.1 Residual Analysis, Residual and its scaling, Residual plots

4.2 PRESS Statistics

4.3 Interpretation of four plots produced by lm command in R

4.4 Corrective measures

    4.4.1 Variable Stabilizing Transformation

    4.4.2 Weighted least squares method

    4.4.3 Transformation to Linearize the Model

4.5 Outliers: Detection and treatments

4.6 Detection of Multicollinearity and computation of VIF

4.7 Examples and Illustrations

Unit-5 Variable Selection and Model Building (8 L)

5.1 The model building problem

5.2 Consequences of model Misspecification

5.3 Criteria for evaluating subset regression models

5.4 Computational techniques for variable selection

    5.4.1 All possible regression

5.4.2 Stepwise Regression methods

5.5 Examples and illustrations.

Unit-6 Logistic Regression Model   **(10 L)**

    6.1 Introduction

    6.2 Univariate logistic regression model

        6.2.1 Defining the logistic regression model

        6.2.2 Fitting of logistic regression model

        6.2.3 Interpretation of parameters

        6.2.3 Testing of hypothesis in Logistic Regression

    6.3 Multiple logistic regression model.

        6.3.1 Fitting of logistic regression model

        6.3.3 Interpretation of parameters

        6.3.3 Testing of hypothesis in Logistic Regression

    6.4 AIC and BIC criteria for model selection.

    6.5 Examples and illustrations

Books Recommended

1. Draper, N. R. and Smith, H. (1998) Applied Regression Analysis (John Wiley) Third Edition.

2. Hosmer, D. W. and Lemeshow, S. (1989) Applied Logistic Regression (Wiley).

3. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003) Introduction to Linear Regression Analysis (Wiley).

4. Neter, J., W., Kutner, M. H., Nachtsheim, C.J. and Wasserman, W. (1996) Applied Linear Statistical Models, fourth edition, Irwin USA.

5. Hosmer, D. W., Lemeshow S., and Sturdivant R. X. (1989) Applied Logistic Regression Wiley

6. Chatterjee S. and Hadi A. S. (2012) Regression Analysis by Example, 5th Edition, Wiley.

7. Kleinbaum G. and Klein M. (2011): Logistic Regression, IIIrd Edition A Self learning text, Springer.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3602
Paper : II Title of Paper : Statistical Inference- II
Credit : 3 credits No. of lectures : 48

A) Learning Objectives:

1. To acquaint students with the concepts of Statistical hypothesis, Parametric Tests, Nonparametric tests

2. To learn the Most Powerful Tests and Uniformly Most Powerful test procedures and difference between them.

3. To differentiate between parametric and non-parametric tests

B) Learning Outcomes:

At the end of the course, students should be able to:
1. Use hypothesis testing in real life situations.

2. Compute Type I Error, Type II Error and level of significance for a hypothesis test.

3. Apply Neyman-Pearson Theorem to find MP tests

4. Construct power functions in order to evaluate the hypothesis testing.

5. Learn various methods of non-parametric tests.

TOPICS/CONTENTS:

Unit 1: Parametric Tests   (15 L)

1.1 Statistical hypothesis, problem of testing of hypotheses. Definition and illustrations of (1) simple hypothesis, (2) composite hypothesis, (3) test of hypothesis, (4) critical region, (5) type I and type II errors. probabilities of type I error and type II error. Problem of controlling the probabilities of errors of two kinds. Definition and illustrations of (i) level of significance, (ii) observed level of significance (p-value), (iii) size of a test, (iv)

1.2 Definition of most powerful (M.P.) level α test of simple null hypothesis against simple alternative. Statement of Neyman - Pearson (N-P) lemma for constructing the most powerful level α test of simple null hypothesis against simple alternative hypothesis. Illustrations.

1.3 Power function of a test, power curve, definition of uniformly most powerful (UMP) level α test for one sided alternative. Illustrations

Unit 2: Likelihood Ratio Tests   (9 L)

Notion of likelihood ratio test (LRT), λ (x)=Sup $L(\theta_0|x)$ / Sup $L(\theta|x)$ Construction of LRT for $H_0 : \theta = \theta_0$ against $H_1: \theta \neq \theta_0$ for the mean of normal distribution for i) known σ^2 ii) unknown σ^2 (one sided and two sided alternatives). LRT for variance of

normal distribution for i) known μ ii) unknown μ (one sided and two sided alternatives hypotheses). LRT for parameters of binomial and exponential distribution for two sided alternatives only. LRT as a function of sufficient statistics, statement of asymptotic distribution of $-2\log_e \lambda(x)$.

Unit 3: Sequential Probability Tests (9 L)

Sequential test procedure for simple null hypothesis against simple alternative hypothesis and its comparison with fixed sample size N-P test procedure. Definition of Wald's SPRT of strength (α, β). Illustration for standard distributions like Bernoulli, Poisson, Normal and Exponential. SPRT as a function of sufficient statistics. Graphical representation of SPRT.

Unit 4: Non-Parametric Tests (15 L)

Concept of non- parametric tests. Distinction between a parametric and a nonparametric Tests. Concept of distribution free statistic. One tailed and two tailed test procedures of (i) Sign test, ii) Wilcoxon signed rank test (iii) Mann- Whitney U test, (iii) Run test, one sample and two samples problems. Empirical distribution function Sn (x). Properties of Sn (x) as estimator of F (.). Kolmogorov – Smirnov test for completely specified univariate distribution (one Sample problem only) for two sided alternative hypotheses. Comparison with chi-square test.

Books Recommended

1. Agarwal, B.L. (2003). Programmed Statistics, second edition, New Age International Publications, Delhi

2. Arora, S. and Bansi Lal. (1989): New Mathematical Statistics, first edition, Satya Prakashan, New Delhi.

3. Daniel, W.W. (2000) Applied Nonparametric Statistics, Duxbury Press Boston.

4. Dudeweitz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley and Sons, Inc

5. Gibbons J.D. (1971). Non parametric Statistical Inference, McGraw Hill Book Company, New York.

6. Hoel, P.G.,Port, S. and Stone, C. (1971). Introduction to Statistical Theory, Houghton Mifflin Company (International) Dolphin

7. Hogg, R.V. and Craig, R.G. (1989). Introduction to Mathematical Statistics (fourth edition, Collier Macmillan International Edition, Macmillan Publishing Co.

Inc., New York.

8. Kale, B.K. and Muralidharan, K. (2015). Parametric Inference: An Introduction. Narosa, New Delhi

9. Kendall, M. and Stuart, A. (1943) The advanced Theory of Statistics, Vol 1, Charles and Company Ltd., London.

10. Lindgren, B.W. (1976). Statistical Theory (third edition), Collier Macmillan International Edition, Macmillan publishing Co., Inc. New York.

11. Kunte, S., Purohit, S.G. and Wanjale, S.K.: Lecture Notes on Nonparametric Tests

12. Mood, A.M., Graybill, F. and Bose, D. C. (1974). Introduction to the theory of Statistics (third edition) International Student Edition, McGraw Hill.

13. Rohatgi, V.K. (1976). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi.

14. Siegel, S. (1956). Nonparametric methods for the behavioral sciences, International Student Edition, McGraw Hill, New York.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3603
Paper : III   Title of Paper : Statistical Quality Control and Reliability
Credit : 3 credits   No. of lectures : 48

A) Learning Objectives:

1. To enable students to understand the meaning and use of SPC, construction and working of control charts for variables and attributes.

2. To familiarize students with various capability indices and their utilities with real life situations.

3. To enable students to learn the structural qualities of a coherent system.

4. To familiarize students with the concept of coherent system reliability.

5. To enable students to construct the reliability block diagrams and structure functions of coherent system using minimal path and cut sets.

B) Learning Outcomes:

At the end of the course, students should be able to:

1. Construct Control charts for attributes and variables.

2. Learn the various capability indices.

3. Understand the concept of sampling inspection plan.

4. Compute reliability of coherent system

5. Explain structural properties of coherent system

TOPICS/CONTENTS:

Unit-1 Seven Process Control (PC) Tools of SPC   **(4 L)**

(i) Check Sheet, (ii) Cause and effect diagram (CED), (iii) Pareto Diagram, (iv) Histogram, (v) Control chart, (vi)Scatter Diagram, (vii) Design of Experiments (DOE).

Unit-2 Review of SPC   **(6L)**

Introduction to SPC, Quality of the product, Chance causes and assignable causes of variation, statistical basis of control charts, exact probability limits, k -sigma limits, justification for the use of 3- sigma limits for normal distribution and using Chebychev's inequality for non-normal distributions. Criteria for detecting lack of control situations. Control chart for attribute and variable.

Unit-3 Capability Studies   **(8 L)**

3.1 Specification limits, natural tolerance limits and their comparisons, decisions based on these comparisons, estimate of percent defective.

3.2 Shift in the process average, evaluation of probability of detecting a shift (or getting

signal) on the first sample or on the subsequent samples after the shift (when process standard deviation is fixed). Average Run Length (ARL)for X chart, Average Time to Signal (ATS). Operating Characteristic (O.C.) curve for X chart, using normality assumption.

3.3 Capability ratio and capability indices (Cp), capability performance indices Cpk with respect to machine and process, interpretation, relationship between (i) Cp and Cpk, (ii) defective parts per million and Cp.

Unit-4 Acceptance of Sampling for Attributes (12L)

4.1 Introduction: Concept of sampling inspection plan, comparison between 100 % inspection and sampling inspection. Procedures of acceptance sampling with rectification, single sampling plan and double sampling plan. Explanation of the terms: Producer's risk. Consumer's risk, Acceptable Quality Level (AQL). Lot Tolerance Fraction Defective (LTFD), Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), Average Total Inspection (ATI), Operating characteristic (OC) curve, AOQ curve.

Note: distinction between type A OC curve and type B OC curve is not expected.

4.2 Single Sampling Plan: Evaluation of probability of acceptance using. (i) Hypergeometric (ii) Binomial (iii) Poisson distributions. Derivation of AOQ and ATI.

4.3 Double Sampling Plan: Evaluation of probability of acceptance using Poisson approximation. Derivation of AOQ, ASN and ATI (with complete inspection of second sample).

Unit-5 Reliability Theory (18 L)

5.1 Binary Systems of independent compliments: Block diagrams, fault tree representation. Definition of binary coherent structure and illustrations. Coherent systems of components less than five, (i) Series, (ii) Parallel, (iii) K-out-of-4: Good, (iv) Essentially series, (v) Essentially parallel. Minimal cut, path structure representation of the system.

5.2 Reliability of Binary Components and Systems: Reliability of above systems h(p), when components are independent and identically distributed with common probability p of operating. 'S' shaped ness property of h(p) without proof and workout examples to show that using components of low values of reliabilities, i.e. unreliable components, systems with higher reliabilities can be constructed.

5.3 Ageing Properties: Definitions: Hazard rates, hazard function, survival function, concept of distributions with increasing and decreasing failure rate (IFR/DFR),

Average Increasing (Decreasing) Failure Rate (IFRA/ DFRA). Relationship between: (i) Survival function and hazard function, (ii) Density function and hazard rate. Derivations of the following results: (i) Hazard rate of a series system of components having independent life times is summation of component hazard rates. (ii) Life time of series system of independent components with independent IFR life times is IFR. Illustrations: Exponential, gamma, Weibull distributions.

Books Recommended:

1. Duncan A. J.: Quality Control and Industrial Statistics, D.B. Taraporewala Sons and Co. Pvt. Ltd., Mumbai.

2. Grant, E. L. and Leavenworth: Statistical Quality Control, Mc-Graw Hill Kogakusha Ltd., New Delhi.

3. Montgomery, D. C.: Statistical Quality Control, John Wiley and Sons, Inc., New York.

4. Kamji and Asher: 100 Methods of TQM, Sage Publishers, Delhi.

5. Johnson and Kotz: Capability Studies, Chapman and Hall Publishers.

6. SP20: Handbook of SQC, Bureau of Indian Standards.

7. D.H. Besterfield, C.B. Michna etc. Total Quality Management (3rd edition 2009): Pearson Education, Delhi.

8. Barlow R. E. and Proschan, Frank: Statistical Theory of Reliability and Life Testing, Holt Rinebart and Winston Inc., New York.

9. Sinha, S. K.: Reliability and Life testing, Second Edition, Wiley Eastern Publishers, New Delhi.

10. S. Zacks : Introduction to Reliability Analysis, Probability Models and Statistical Methods, Springer Verlag

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3604

Paper : IV Title of Paper : Operations Research

Credit : 3 credits No. of lectures : 48

A) Learning Objectives:

1. To enable students to formulate Linear programming Problem (LPP), transportation problem, assignment problem and to obtain optimal solutions.

2. To enable students to apply the techniques of solving LPP to obtain optimal solution.

3. To acquaint students with different solutions of LPP such as degenerate solution, multiple optimal solutions, unbounded solutions and infeasible solutions.

4. To enable students to evaluate the CPM and PERT networks

5. To familiarize students to different principles of game theory.

B) Learning Outcomes:

At the end of the course students should be able to:

1. Formulate the given problem into LPP.

2. Understand the features of TP and AP.

3. Classify the solutions and interpret them according to the situations.

4. Differentiate between PERT and CPM network techniques.

5. Understand principles of zero-sum, two-person games.

TOPICS/CONTENTS:

Unit-1 Linear Programming Problem (16 L)

1.1 Statement of the linear Programming Problem (LPP), Formulation of problem as LPP.

1.2 Definition of (i) A slack variable and (ii) Surplus Variable (iii) a solution (iv) basic and non-basic variables (v) a feasible solution (vi) a basic feasible solution, (vii) a degenerate and non–degenerate solution and (viii) an optimal solution

1.3 LPP in Canonical form and LPP in Standard form

1.4 Solution of L.P.P by Simplex Method: Obtaining Initial Basic Feasible Solution (IBFS), criteria for deciding whether obtained solution is optimal, criteria for unbounded solution, no solution, more than one solution.

1.5 Introduction of artificial variable, Big-M method.

1.6 Duality Theory: Writing dual of a primal problem, solution of a L.P.P. by using its dual problem

1.7 Examples and problems.

Unit-2 Transportation Problem (8 L)

2.1 Transportation problem (T.P.), statement of T.P., balanced and unbalanced T.P. minimization and maximization problem.

2.2 Obtaining basic feasible solution of T.P. by (i) North-West Corner Method, (ii) Least Cost Method (iii) Vogel's Approximation Method (VAM).

2.3 Modified Distribution (MODI) method (u-v method) of obtaining Optimal solution of T.P., uniqueness and non- uniqueness of optimal solutions, degenerate solution.

2.4 Examples and problems.

Unit-3 Assignment Problem (4 L)

3.1 Statement of an assignment problem, Minimization and maximization problem, balanced and unbalanced problem, relation with transportation problem, optimal solution using Hungarian method, maximization case.

3.2 Examples and problems.

Unit-4 Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT) (12 L)

4.1 Introduction to CPM

4.2 Definition of (i) Event, (ii) Node, (iii) Activity, (iv) Critical Activity, (v) Project Duration.

4.3 CPM: Construction of network, Definitions

  (i) earliest start time

  (ii) earliest finish time

  (iii) latest start time

  (iv) latest finish time for an activity.

  Critical Path, Types of floats, total floats, free float, independent float and their significance. Determination of critical path

4.4 PERT: Construction of network;

  (i)   Pessimistic time estimate

  (ii) Optimistic time estimate

  (iii) Most likely time estimates

  (iv) Determination of critical path

  (v)   Determination of mean and standard deviation of project duration,

  (vi) Computations of probability of completing the project in a specified duration.

4.5 Basic Difference between CPM and PERT

Unit-5 Game Theory (8 L)

5.1 Introduction

5.2 Two-Person Zero-Sum games

5.3 Pure Strategies, Minimax and Maximin principles, Pay off tables, Games with Saddle Point.

5.4 Mix Strategies: Games without Saddle Point

5.5 Dominance principles. Examples and problems.

Books Recommended:

1. Gass, S. L. (1997). Linear programming methods and applications, Narosa Publishing House, New Delhi.

2. Gupta, P. K. and Hira, D. S. (2008). Operation Research, 3rd edition S. Chand and company Ltd, New Delhi.

3. Kapoor, V. K. (2006). Operations Research, S. Chand and Sons. New Delhi.

4. Phillips, D. T. and Solberg, R. A. (1976). Operation Research principles and practice, John Willey and Sons Inc.

5. Saceini, M., Yaspan, A. and Friedman, L. (2013). Operation Research methods and problems, Willey International Edition.

6. Sharma, J. K. (1989). Mathematical Models in Operation Research, Tata McGraw Hill Publishing Company Ltd., New Delhi.

7. Shrinath.L. S. (1975). Linear Programming, Affiliated East-West Pvt. Ltd, New Delhi.

8. Taha, H. A. (2007). Operation research: An Introduction, eighth edition, Prentice Hall of India, New Delhi.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3605

Paper : V Title of Paper : Statistical Computing Using R Software

Credit : 3 credits No. of lectures : 48

A) Learning objectives:

Student should be able:

1. To Compute the statistical methods using R software

2. To Present the diagrammatic and graphical presentation of data using R software.

3. To Develop the skills for writing the scripts using R software

B) Learning Outcome

At the end of the course, students should be able to:

1. Handle the data easily using R

2. Extensive statistical analysis by using R software.

3. Do an exploratory data analysis and statistical analysis in their project by using R software.

TOPICS/CONTENTS:

Note: Students are expected to write commands in script file wherever applicable

Unit-1 Fundamentals of R (5 L)

Revision of commands and functions studied in F.Y.B.Sc. and S.Y.B.Sc. Creating a vector using scan function, other types of objects, creating a data frame using edit command, fix command, getwd command, importing data from MS-Excel file Using read. Table command, saving the R-output in a file using MS-Excel, concept of R-script file, Graphics using R: (a) High level plotting functions (b) Low level plotting functions (c) Interactive graphic functions. The following statistical methods using R"

Unit-2 Diagrams and Graphs (5 L)

Diagrams: Simple bar diagram, Subdivided bar diagram, multiple bar diagram, Pie diagram, Stem and leaf diagram.

Graphs: Scatter Plot, histogram for raw data with prob=T option and for both equal and unequal class intervals, Boxplot for one and more than one variables, rod or spike plot, empirical distribution function Saving the diagram and graph in MS-Word file.

Unit-3 Measures of central tendency, dispersion, skewness and kurtosis. (7 L)

Computations of following measures for all types of data (a)central tendency mean,

mode, median, quartiles, deciles, percentiles, g.m. and h.m (b)Dispersion: variance, standard deviation, coefficient of variation, mean deviation (c) Skewness: Bowley"s coefficient and Karl Pearson"s coefficient of skewness (d) Moments: Computations of raw and central moments, measure of skewness and kurtosis based on it.

Unit-4 Probability distributions: **(6 L)**

Simulation from distributions, computations of probabilities, cumulative probabilities, quantiles and drawing random sample using d, p, q, r functions for following distributions. normal, exponential, gamma, Cauchy, lognormal, Weibull, uniform, Laplace, Graphs of pmf/pdf by varying parameters for above distributions. Fitting of Lognormal distribution, testing normality of data by Shapiro Wilks test.

Unit-5 Correlation and Regression: **(4 L)**

Computation of correlation coefficient, Fitting of lines of regression and second degree curve, Multiple regression, Logistic regression analysis. Interpretation from residual plot, adequacy of model.

Unit-6 ANOVA   **(4 L)**

One way and two way classification, Bartlett's test for homoscedasticity, Kruscal Wallis test.

Unit-7 Non parametric tests   **(5 L)**

Kolmogorov Smirnov test, Sign test, Sign test for paired data, Wilcoxon's signed rank test, Mann Whitney test.

Unit-8 Programming in R: **(12 L)**

Statements: if and if…else, for loop, while loop, cat and print commands Writing programs in R.

1. Testing normality of number of samples
2. Verifying the assumptions in testing H_0: $\mu = \mu_0$ and then applying appropriate test.
3. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ and then applying appropriate test.
4. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ in paired data and then applying appropriate test.
5. Verifying the assumptions in testing H_0: $\sigma_{12} = \sigma_{22}$ and then applying appropriate test.
6. Performing number of chi-square tests

7. Verifying the assumptions in one way ANOVA and then applying appropriate test.

8. Verifying the assumptions in two-way ANOVA and then applying appropriate test.

9. Testing consistency

Books recommended:

1. Crawley, M. J. (2006). Statistics - An introduction using R. John Wiley, London 32

2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R, second edition. Narosa Publishing House, New Delhi.

3. Shahababa , B. (2011). Biostatistics with R, Springer, New York

4. Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall/CRC Press, New York

5. Pavagi, V. R. (2018).A Book of Statistical Computing using R Software, Nirali Prakashan

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3606 (A)
Paper : VI (A) Title of Paper : Official Statistics
Credit : 3 credits No. of lectures : 48

A) Learning objectives:

1. To acquaint students with Indian official statistics pertaining to agriculture, industry and concept of national income and methods of computation.
2. To understand the functioning of official statistics.
3. To familiarize students with methods of estimating national income.
4. To introduce students to economic time series.
5. To acquaint students with demand and supply analysis and laws of income distribution.

B) Learning outcomes:

At the end of the course, students should be able to:

1. Familiarize themselves with institutional, legal and organizational bases, and principles of functioning of official statistics.
2. Understand the fundamentals of measurement in official statistics.
3. Study different methods of estimating national income.
4. Explain basic models of economic time series and different methods of estimation of trend and seasonal variation.

TOPICS/CONTENTS:
Unit-1 Indian Official Statistics (18 L)

1.1 Agricultural Statistics in India

(I) Statistics of land utilization

(II) Statistics of crop output

(III) Miscellaneous of crop output (not to be studied in detail)

(IV) Indices of agricultural production. Defects of Indian agricultural statistics.

1.2 Price Statistics:

Usefulness of price statistics, wholesale price statistics, index number of wholesale prices. Retail price statistics labor bureau index, number of retail prices for urban and rural areas, consumer price index for industrial workers, non-manual employees and agricultural laborer's, limitations of price statistics.

1.3 Industrial Statistics: primary sources of industrial statistics, statistics collected (description in brief), limitations of industrial statistics, index number of industrial productions. Method of compilation. Index number of industrial profits revised series.

1.4 Educational Statistics: Description of different statistics relating to education, compiled and published by the ministry of education of the India Govt. Number of educational institutions, education of scheduled castes, tribes and backwards classes. Number of scholars, number of teachers, examination result. Sources of publications, critical study of educational statistics in India.

Unit 2 National Income   (4 L)

2.1 Definition (three approaches: product, income and expenditure). Methods of estimating national income: product method, income method, expenditure method and social accounting method.

2.2 Income inequality and GINI Index

Unit 3 Economic Time Series   (11 L)

3.1 Components of time series

3.2 Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series.

3.3 Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential).

3.4 Measurement of seasonal variations by methods of ratio to trend

3.5 Link relative method

3.6 Examples and problem

Unit 4 Demand and Supply Analysis   (11 L)

4.1 Demand: meaning, statement of law, assumptions, exceptions and determinants of demand, individual and market demand.

4.2 Supply: meaning, statement of law, assumptions, exceptions and determinants of supply, individual and market supply

4.3 Elasticity of demand: definition: i) price elasticity of demand ii) income elasticity of demand iii) cross elasticity of demand

4.4 Method of measuring elasticity of demand: i) percentage method, ii) point method iii) total outlay method iv) ARC Method

4.5 Demand forecasting: meaning need and methods of forecasting

4.6 Examples and problems

Unit 5 Pareto and Lognormal laws of income distribution (4 L)

Books Recommended:

1. Gupta S.C. & Kapoor V. K.: Fundamentals of Applied Statistics, S. Chand Sons, New Delhi.

2. Goon, Gupta, Dasgupta: Fundamentals of Statistics, Vol-II, The World Press Pvt. Ltd., Calcutta 1986.

3. Parimal Mukhopadhyay: Applied Statistics, Books and Allied (P) Ltd, Kolkata,2005.

4. Biswas D.(2009) Probability and Statistics (Vol-I) New Central Book Agency Ltd.

5. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.(Refer website-http://mospi.nic.in/).

6. Damodar N. Gujarati , Dawn C. Porter , Manoranjan Pal Basic Econometrics, Sixth Edition.

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3606 (B)
Paper   : VI (B)   Title of Paper : Actuarial Statistics
Credit   : 3 credits   No. of lectures : 48

A) Learning objectives:

1. The main objective of this course is to introduce to the students the various concepts involved in Actuarial Statistics.

2. To acquaint students with the terms used in insurance business and survival analysis

3. To enable students to describe, explain and apply the fundamental theories of actuarial statistics.

4. To apply appropriate modeling techniques for lifetime random variables involved in the field of Insurance.

B) Learning outcomes:

At the end of the course students should be able to:

1. Identify and analyze consequences of events involving risk and uncertainty.

2. Calculate survival function, curtate future lifetime, force of mortality.

3. Calculate various payments from life tables using principle of equivalence, net premiums.

4. Construct life tables for different age groups of people.

TOPICS/CONTENTS:

Unit-1 Insurance Business   (3 L)

    1.1 Insurance companies as business organizations.

    1.2 Role of insurance business in Economy.

    1.3 Concept of risk, types of risk, characteristics of insurable risk.

    1.4 Working of insurance business, introduction of terms such as premium, policy, policyholder and benefit.

    1.5 Role of Statistics in insurance.

    1.6 Insurance business in India.

Unit-2 Feasibility of Insurance Business   (4 L)

    2.1 Measurement of adverse financial impact, expected value principle.

    2.2 Concept of utility function

2.3 Feasibility of insurance business.

2.4 Illustrative examples.

Unit-3   Survival Distribution and Life Tables   **(12 L)**

    3.1 Time- until death random variable, its d.f. and survival function in actuarial notation.

    3.2 Force of mortality.

    3.3 Interrelations among d.f., survival function, force of mortality and p.d.f.

    3.4 Curtate future life random variable, its p.m.f. and survival function in actuarial notation.

    3.5 Construction of life table using random survivorship approach.

Unit-4   Models for Life Insurance   **(11 L)**

    4.1 Theory of compound interest, effective rate of interest, discount factor.

    4.2 Insurance payable at the end of the year of death, present value random variable, actuarial present value.

    4.3 Derivation of actuarial present value for n-year term life insurance, whole life insurance and endowment insurance.

Unit-5   Annuities   **(10 L)**

    5.1 Annuities – certain, annuity due, annuity immediate.

    5.2 Discrete life annuities: n-year temporary life annuity due and a whole life annuity due, present value random variables of the payment, and their actuarial present values.

Unit- 6   Benefit Premiums   **(8 L)**

    6.1 Concept of a loss random variable.

    6.2 Equivalence principle

    6.3 Computation of fully discrete premium for n-year term life insurance, whole life insurance and endowment insurance.

    6.4 Variance of loss random variable

Books Recommended

1. Bowers N.L. Jr., H.S.Gerber, J.C. Hickan, D.A.Jones, C.J.Nesbitt, (1997). Actuarial Mathematics, Society of Actuaries, U.S.

2. Deshmukh, S. R. (2009). Actuarial Statistics, Universities Press, Hyderabad, India.

3. Actuarial Mathematics, Society of Actuaries,ltasca,lllinois,U.S.A.2nd Ed.(1997)

4. Spurgeon E.T. (1972); Life Contingencies, Cambridge University Press. Neill, A. Life Contingencies, Heinemann

Paper Code   : STAT-3607

Paper   : VII   Title of Paper   : Statistics Practical- VIII

Credit   : 2 credits

A) Learning objectives:

1. The main objective of this course is to learn and understand various regression models, estimation of its parameters and perform residual diagnostics.

2. Students should be able to find an appropriate subset of regressors for the model.

3. Logistic regression aims to measure the relationship between a categorical dependent variable and one or more independent variables.

4. Students should be able to find optimal solution of the LPP, TP, AP, etc.

5. Students should be able to construct network diagrams of project.

B) Learning outcomes:

At the end of the course students should be able to:

1. Interpret the regression model and predict the response variable.

2. Determine critical path and floats associated with non- critical activities and events along with total project completion time.

3. Understand the importance of using PERT and CPM techniques for project management.

Sr. No.	Title of Experiments
1.	Simple Linear Regression Analysis and Diagnostics by Residual Plots
2.	Multiple Linear Regression Analysis and Diagnostics by Residual Plots
3.	Variable Selection and Model Building- I (Forward Selection, Backward Elimination)
4.	Logistic Regression
5.	Linear programming problem- I (Simplex Method)
6.	Linear programming problem- II (Big- M Method)
7.	Transportation Problem
8.	Assignment problem
9.	Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT)
10.	Simulations

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code : STAT-3508
Paper   : VIII   Title of Paper   : Statistics Practical- IX
Credit   : 2 credits

A) Learning Objectives:

1. To study Statistical hypothesis, Parametric Tests, Nonparametric tests

2. To Differentiate between parametric and non-parametric tests

3. To study various capability indices and utilities with real life situations.

4. To learn structural qualities of a coherent system.

B) Learning Outcomes:

At the end of the course, students should be able to:

1. Use hypothesis testing in real life situations.

2. To find Type I Error, Type II Error, power functions and level of significance for a hypothesis test,

3. Learn the concept various capability indices.

4. Learn the concept of coherent system reliability.

Sr. No.	Title of Experiments
1.	Testing of hypothesis- I (Probability of type I error and type II error, power of a test)
2.	Testing of hypothesis (Construction of MP and UMP test, plotting of power function of a test)
3.	Non- parametric tests- I (Sign test, Wilcoxon's signed rank test, Mann-Whitney U test)
4.	Non- parametric tests- II (Run test, median test, Kolmogorov- Smirnov test)
5.	SPRT- I (Bernoulli, Binomial, Poisson, Hypergeometric Distributions)
6.	SPRT- II (Normal, Exponential Distribution)
7.	Capability Studies
8.	Single sampling plan for attributes (OC curve, AOQ, AOQL, ATI using Poisson distribution).
9.	Double sampling plan for attribute (OC curve, AOQ, AOQL, ATI, ASN using Poisson distribution)
10.	Reliability

SYLLABUS(CBCS) FOR T. Y. B. Sc. (Semester- VI) STATISTICS
(With Effect from Academic Year 2021-2022)

Paper Code   : STAT-3609
Paper   : IX   Title of Paper   : Project
Credit   : 2 credits

A) Learning objectives:

1. The student will develop skills for data analysis.

2. Students should be able to identify the statistical tools, models for analyze the data.

B) Learning outcomes:

1. Student will able to solve real life situation by using statistical techniques.

2. Student will be exploring their algorithmic approaches to problem solving.

Guideline for Project:

1. For project maximum 5 students are allowed in a group.

2. Project: Equivalent to 10 practical. Statistical techniques have to use for Data Analysis and make report in dissertation form.

3. Students have to prepare project report and have to submit one copy for the assessment to the examiner.

4. Project Evaluation:

   i)   Internal Evaluation: 40 Marks

   ii)   External Evaluation: 60 Marks

5. In order to acquaint the students with applications of statistical methods in various fields such as industries, agricultural sectors, government institutes, etc. at least one Study Tour for T.Y. B.Sc. Statistics students may be arranged.