Month	Period	Topic / sub- topic to be taught (T.Y sem – 1 Paper-II)
August	12	***1. Point Estimation (2L)*** **1.1** Notion of a parameter, parameter space, sample space as a set of all possible values of (X1, X2, . . , Xn),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. **2. Methods of Estimation (8L)** **2.1Method 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. **2.2** Definition of likelihood as a function of unknown parameter, for a random sample from i) discrete distribution ii) continuous distribution, distinction between likelihood function and p.d.f./ p.m.f. **2.3 Method of maximum likelihood:** Derivation of maximum likelihood estimator (M.L.E.) for parameters of only standard distributions (case of two unknown parameters only for normal distribution). Use of iterative procedure to derive M.L.E.of location parameter μ of Cauchy distribution. Invariance property of M.L.E. **2.4** a) M.L.E. of θ in uniform distribution over i) (0, θ) ii) (- θ, θ) iii) (mθ, nθ)(m<n) b) M.L.E. of θ in f(x ; θ)= Exp {-(x- θ)}, x > θ. c)) M.L.E. of location parameter in Laplace distribution. **3. Criteria of Estimation** **3.1 Unbiasedness (2L)** Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples (these should include unbiased and biased estimators for the same parameters). 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 ø (T) is unbiased estimator of ø (θ) provided ø (.) is a linear function.
September	14	**3.2 Variance of the estimator (3L)** Notion of the Best Linear Unbiased Estimator and uniformly minimum variance unbiased estimator (UMVUE), uniqueness of UMVUE whenever it exists.

		3 Sufficiency (5L) 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. Proofs of the following properties of sufficient statistics: i) If T is sufficient for θ, then ø (T) is also sufficient for θ provided ø is a one to one and onto function. ii) If T is sufficient for θ then T is also sufficient for ø (θ). iii) M.L.E. is a function of sufficient statistic. **3.4 Efficiency (6L)** **Fisher information function:** Amount of information contained in statistic T = T(X1, X2, …, Xn). Statement regarding information in sample and in a sufficient statistic T. **Cramer- Rao Inequality:** Statement and proof of Cramer - Rao inequality, Cramer – Rao Lower Bound (CRLB),definition of minimum variance bound unbiased estimator (MVBUE) of ø (θ) . 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. Comparison of variance with CRLB, relative efficiency of T1 w.r.t. T2 for (i) unbiased (ii) biased estimators. Efficiency of unbiased estimator T w.r.t. CRLB.
October	12	**3.9 Asymptotic Behaviour of an Estimator (6L)** 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 φ (.) is a continuous function, then Φ (T) is a consistent estimator of φ (θ). **4. Interval Estimation (6L)** 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. Interval estimation for the following cases: i) Mean (μ) of normal distribution (σ2known and σ2 unknown). ii) Variance (σ2) of normal distribution (μ known and μ unknown). iii) Median, quartiles using order statistics.

Teaching Plan

Month	Period	Topic / sub- topic to be taught (T.Y sem – 1 Paper-VI)
August	17	**1. Simple linear regression model (12L)** (i) Review of simple linear regression model: $Y = \beta0 + \beta1X + €$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma2$. Estimation of β0 and β1, by the method of least squares. (ii) Properties of estimators of β0,and β1 (Sec. 2.2.2) (iii) Estimation of σ2 (Sec. 2.2.3) (iv) Assumption of normality of ε .Tests of hypothesis of β1 (Sec. 2.3) (v) Interval estimation in simple linear regression model (Sec 2.4) (vi) Coefficient of determination (Sec 2.6) (vii) Residual analysis (Sec 4.1, 4.2.1): Standardized residuals, Studentized residuals, sec. 4.2.2), residual plots (sec. 4.2.3) (viii) Detection and treatment of outliers (Sec 4.4) (ix) Interpretation of four plots produced by lm command in R **2. Multiple linear regression model (5L)** (i) Review of multiple linear regression model $Y = \beta0 + \beta1X1 + \ldots + \beta pXp + €$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma2$. Estimation of regression parameters β0, β1, . . . and βp by the method of least squares, obtaining normal equations, solutions of normal equations. (Sec. 3.2.1)
September	16	(ii) Estimation of σ2 (Sec. 3.2.4)(12) (iii) Assumption of normality of ε .Tests of hypothesis of regression parameters (Sec. 3.3.1, 3.3.2) (iv) Interval estimation in simple linear regression model (Sec 3.4.1) (v) Variable selection and model building (9.1, 9.2) (vi) Residual diagnostics and corrective measures such as transformation of response variable, (Sec. 5.1, 5.2, 5.3) weighted least squares method (Sec. 5.5, (except 5.5.1 and 5.5.2), 5.5.3. (vii) Polynomial regression models (Sec. 7.1, 7.2.1) **3. Logistic regression model (4L)** (i) Binary response variable, Logit transform, estimation of parameters, interpretation of

		parameters.(Sec. 13.2.1, 13.2.2, 13.2.3 or chapter 1except sec.1.5 of HL)
October	8	(ii) Tests of hypotheses of model parameters, model deviance, LR test.(Sec. 13.2.4 or chapter 1except sec.1.5 of HL) (iii) AIC and BIC criteria for model selection (iv) Interpretation of output produced by glm command in R (v) Multiple logistic regression (sec.2.1, 2.2 and 2.3 of HL)

Teaching Plan

Month	Period	Topic / sub- topic to be taught (T.Ysem – 2 Paper-I)
Nov	8	**1. Parametric Tests (8L)** **1.1** (a) 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. (b) Definition and illustrations of (i) level of significance, (ii) observed level of significance (p-value), (iii) size of a test, (iv) power of a test.
December	15	**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. **2. Likelihood ratio tests (9L)** Notion of likelihood ratio test (LRT), $\lambda(x)=\text{Sup } L(\theta 0\|x) / \text{Sup } L(\theta\|x)$ Construction of LRT for $H0 : \theta = \theta 0$ against $H1: \theta \neq \theta 0$ for the mean of normal distribution for i) known σ2 ii) unknown σ2 (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 $-2 \log_e \lambda(x)$.
January	17	**3. Sequential 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 **4. Non-parametric Tests (8 L)** **4.1** Concept of non- parametric tests. Distinction between a parametric and a nonparametric Tests.. Concept of distribution free statistic. One tailed and two tailed test procedure of (i) Sign test, ii) Wilcoxon signed rank test (iii) Mann-Whitney U test, (iii) Run test, one sample and two samples problems.

February	15	**4.2** 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.
	15	**Practical(P-I)** 4. Testing of hypotheses (Probability of type I and type II errors, (1) power of a test etc). 5. Construction of uniformally most powerful (UMP) test, (2) plotting of power function of a test. 7. Non- parametric tests : Sign test, Wilcoxon's signed rank test , (2) Mann-Whitney U test. 8. Non- parametric tests : Run test, median test, (1) 9. Kolmogorov- Smirnov test. (1) 10. SPRT for Bernoulli, Binomial, Poisson, Hypergeometric distributions. (1) (graphical representation also) 11. SPRT for normal, exponential distribution (1) (graphical representation also)

Teaching Plan

Month	Period	Topic / sub- topic to be taught (T.Ysem – 2 Paper-VI)
Nov	9	**1. Fundamentals of R (3L)** Revision of commands and functions studied in S.Y.B.Sc. Creating a vector using scan function, creating a data frame using edit 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" **2 Diagrams (2 L)** Simple bar diagram,Subdivided bar diagram,multiple bar diagram,Piediagram,Stem and leaf diagram **3. Graphs (4 L)** Boxplot for one and more than one variables, rod or spike plot, histogram for raw data with prob=T option and for both equal and unequal class intervals, frequency polygon,ogivecurves,empirical distribution function Saving the diagram and graph in MS-Word file.
December	16	**4. Measures of central tendency, dispersion, skewness and kurtosis. (6 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"scoefficient and KarlPearson"scoefficient of skewness (d) Moments: Computations of raw and central moments,measure of skewness and kurtosis based on it. **5. 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. Binomial,Poisson,Hypergeometric,normal,exponential,gamma,Cauchy,lognormal,Weibull,uniform,laplace ,Graphs of pmf/pdf by varying parameters for above distributions. Fitting of Poisson and normal distribution, testing normality of data by Shapiro- Wilks test. **6 Testing of hypothesis (1 L)**

		Chi-square test for independence of attributes **7. ANOVA (3 L)** One way and two way classification, Bartlett's test for homoscedasticity, Kruscal Wallis test.
January	17	**8. Non parametric tests (5L)** Wilcoxon's signed rank test, Mann Whitney test, Kolmogorov Smirnov test **9. Programming in R: (12L)** Statements: if and if…else, for loop, cat and print commands
February	15	**Practical(P-III)** 7. Simple regression analysis and dignostics by graphical method 8. Multiple regression analysis and dignostics by graphical method 9. Logistic regression 10. Computing mean, median, mode, quartile , decile , percentile for n observations 11. (a) Computation of probabilities of type P [a < X <b], P[X >= a],P[X < b] etc for Standard discrete and continuous distributions (b) Model sampling from standard discrete and continuous distributions (Use of functions starting with d , p, q, r) 12. Non-parametric tests

Teaching Plan(2018-2019)

Month	Period	Topic / sub- topic to be taught (T.Y. sem- 1 paper-III) (ST-333:Sampling Methods)
July	5	**1. Sampling** 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 y_{bar} as an estimator of population mean, derivation of expectation and standard error of y_{bar} , confidence interval for population mean, population total standard error. (b) N y_{bar} as an estimator of population total, derivation of expectation and standard error of N y_{bar} (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 Xi 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) Np as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of Np (c) Estimator of above standard error both 1.3 Sampling for proportion as an application of a simple random sampling with Xi 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) Np as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of Np (c) Estimator of above standard error both in case of SRSWR and SRSWOR.
August	7	**2 Determination of Sample Size** Determination of the sample size for the given: i) Margin of error and confidence coefficient. ii) Coefficient of variation of the estimator and confidence coefficient **3. Stratified Random Sample Size** 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) $Y_{barst}=\sum\frac{Ni\ Ybar}{N}$ as an estimator of population mean (Y_{bar}), Derivation of expectation and standard error of y_{barst} (b) N y_{barst} as an estimator of population total, derivation of expectation and standard error of N y_{barst}.. (c) Estimator of above standard errors.
September	11	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. **4.Ratio and Regression Methods of Estimation for SRSWOR** 4.1 Rationale behind using auxiliary variates in estimation. 4.2 Situations where (i) ratio method is appropriate, (ii) 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

Documents to be attached:-

2. **Teaching Plans for last Five Years**

Teaching Plan(2018-2019)

Month	Period	
October	2	**6. Role of Sample Surveys in Research Methodology** 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 (i) Test – Retest method (ii) Internal Consistency: (A) Kuder Rechardson Coefficient (KR-20) (B) 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

Month	Period	Teaching plan (2018-2019) Topic / sub- topic to be taught (T.Y.sem-1 paper-IV) ST-334: Design of experiment
August	12	**1. Design of Experiments** 1.1 Analysis of variance (ANOVA): concept and technique. 1.2 Basic terms of design of experiments: Experimental unit, treatment, layout of an experiment. 1.3 Basic principles of design of experiments : Replication, randomization and local control. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per unit area of plots. 1.4 Completely Randomized Design (CRD) : Application of the principles of design of experiment in CRD, Layout, 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).

1.5 Randomized Block Design (RBD) : Application of the principles of design of experiments in RBD, layout

Model: $X_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$ $i = 1,2, \ldots\ldots t.$ $j = 1,2, \ldots\ldots\ldots b,$

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).

1.6 Latin Square Design (LSD): Application of the principles of design of experiments in LSD, layout, 16

Model : $X_{ij(k)} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ij(k)}$ $i = 1,2, \cdots m,$ $j = 1,2 \cdots, m,$ $k=1,2 \cdots, m.$

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.

$H_{01} : \alpha_1 = \alpha_2 = \cdots = \alpha_m = 0$

$H_{02} : \beta_1 = \beta_2 = \cdots = \beta_m = 0$

$H_{03} : \gamma_1 = \gamma_2 = \cdots = \gamma_m = 0$ 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.

1.7 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.) 1.8 Identification of real life situations where the above designs are used. 1.9 Analysis of non- normal data using. i) Square root transformation for counts. ii) Sin-1(.) transformation for proportions. iii) Kruskal Wallis test.
September	12	**2. Efficiency of Design** 2.1 Concept and definition of efficiency of a design. 2.2 Efficiency of RBD over CRD. 2.3 Efficiency of LSD over (i) CRD (ii) RBD. **3. Analysis of Covariance (ANOCOVA) with One Concomitant Variable** 3.1 Situations where analysis of covariance is applicable. 3.2 Model for covariance in CRD, RBD. Estimation of parameters (derivations are not expected) 3.3 Preparation of analysis of variance – covariance table, test for β=0, test for equality of treatment effects **4. Factorial Experiments** 4.1 General description of mn factorial experiment, 22 and 23 factorial experiments arranged in RBD. 4.2 Definitions of main effects and interaction effects in 22 and 23 factorial experiments. 4.3 Yate's procedure, preparation of ANOVA table, test for main effects and interaction effects. 4.4 General idea of confounding in factorial experiments.

October	3	4.5 Construction of layouts in total confounding and partial confounding in 22 and 23 factorial experiments. 4.6 Total confounding (confounding only one interaction) ANOVA table, testing main effects and interaction effects. 4.7 Partial confounding (confounding only one interaction per replicate); ANOVA table, testing main effects and interaction effects

Documents to be attached:-

2. Teaching Plans for last Five Years

Month	Period	Teaching plan(2018-2019) Topic / sub- topic to be taught (T.Y sem – 2 Paper-III) ST-343:Statistical Quality Control
November	3	**1. Introduction** Meaning and purpose of Statistical Quality Control (SPC), on line process control methods (control charts) and offline process control methods (Sampling plans). **Seven Process Control (PC) Tools of SPC** (i) Check Sheet, (ii) Cause and effect diagram (CED),(iii) Pareto Diagram, (iv) Histogram, (v) Control chart, (vi)Scatter Diagram,(vii) Design of Experiments
December	16	**2. Control charts** **2.1** 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:
(i) At least one point outside the control limits
(ii) A run of seven or more points above or below central line.
(iii) Presence of a non random pattern eg. cycle or linear trends etc.
Control chart technique as hypotheses testing problem.
Construction of control charts for (i) standards given, (ii) standards not given

2.2 Control charts for variables

(I) R chart and X chart

Purpose of R and X chart, normal probability plot for checking normality assumption, construction of R chart when the process standard deviation is specified: control limits, drawing of control chart, plotting of sample ranges,. drawing conclusion - determination of state of control process, corrective action if the process is out of statistical control. Construction of X chart when the process average is specified: control limits, drawing of control chart, plotting of sample means. Drawing conclusion - determination of state of control of process, corrective action if the process is out of statistical control.

(II) Construction of R chart when the process standard deviation (σ) is not given: control limits, drawing of control chart, plotting sample range values, revision of control limits if necessary, estimate of σ for future use. Construction of X chart when the process average μ is not given : control limits based on $\mu = X_{\text{bar}}$, $\sigma\hat{} = R/d2$, drawing of control chart, plotting sample means, revision of control limits of X_{bar} chart, if necessary. Probability of catching a shift

2.3 Control charts for Attributes

(I) p - chart

(a) Construction and working of p-chart when subgroup sizes are same and value of the process fraction defective P is specified: control limits, drawing of control chart, plotting of sample fraction defectives. Determination of state of control of the process.

(b) p-chart when subgroups sizes are different and value of the process fraction defective P is not specified with separate control limits, drawing of control chart, plotting sample fraction defectives, determination of state of control of the process. Interpretation of high and low spots. Identification of real life situations. Probability of catching a shift.

January	17	(II) **C chart** (a) Construction of c-chart when standard is given; control limits justification of 3 sigma limits, drawing of control chart, plotting number of defects per unit. (b) Construction of c chart when standard is not given; control limits, explanation for the use of 3 sigma limits, drawing of control chart. Plotting number of defects per unit. Determination of state of control, interpretation of high and low spots in above cases. Identification of real life situations. **4. Offline Methods (Lot Control)** **Acceptance Sampling for Attributes** 4.1 **Introduction:** Concept of sampling inspection plan, comparison between 100% inspection and sampling inspection. Procedure of acceptance sampling with rectification. 4.2 **Single Sampling Plan**: Working of SSP, Evaluation of probability of acceptance using Poisson distribution. Producer's risk. Consumer's risk, Acceptable Quality Level (AQL). Lot Tolerance Fraction Defective (LTFD), LTPD, Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), Average Total Inspection (ATI), Operating characteristic (OC) curve, AOQ curve.
February	12	4.3 **Double Sampling Plan**: Working of DSP, Evaluation of probability of acceptance using Poisson distribution. Producer's risk. Consumer's risk, O.C.curve, Average Outgoing Quality (AOQ), AOQ curve, Average Outgoing Quality Limit (AOQL), Average Sample Number (ASN), Average Total Inspection (ATI) (with complete inspection of second sample).

Documents to be attached:-

2. *Teaching Plans for last Five Years*

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Month	Period	Teaching Plan(2018-2019) Topic / sub- topic to be taught (T.Y. sem – 2 Paper-V) ST 345 (B):INTRODUCTION to STOCHASTIC PROCESSES
November	1	1. 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 M.C.
December	17	2.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 $\{X_0, X_1, . . . , X_n\}$, partial sum of independent and identically distributed random variables as Markov chain, illustrations such as random walk, Gambler's ruin problem, Ehrenfest chain.
January	18	2 .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. 3.Stationary distribution for an irreducible ergodic finite Long run behaviour of a M.C.

February	10	**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 process mean and variance functions and its applications
November December, January, February, March.	38	**Practical** 1. 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. 2. Simple random sampling for proportions . (estimation of population proportion, population total with standard errors), confidence interval for population proportion and population total. 3. Stratified random sampling : Proportional and Neyman allocation, comparison with SRSWOR. 4. Stratified random sampling : cost and variance analysis. 5. Ratio and Regression methods of estimation. Comparison with SRSWOR. 6. Analysis of CRD (equal and unequal replications) (1) pairwise comparison of treatments, using critical difference (C.D). Check normality using normal probability plot. 7. Analysis of R.B. D. pairwise comparison of treatments using i) C.D ii) Tukey and Scheff's procedure. Efficiency of RBD w.r.t. CRD. 8. Analysis of L.S.D., pairwise comparison of treatments using C.D . and box plot, efficiency of LSD w.r.t. i) CRD ii) RBD. 9. Kruskal Wallis test (1) 10. Analysis of covariance in CRD, testing B = 0, 11. Analysis of covariance in RBD , testing B= 0 12. Analysis of 2^2 and 2^3 factorial experiments in RBD. 13. Analysis of 23 factorial experiments in RBD (partial confounding)

		14. Analysis of 23 factorial experiments in RBD. (total confounding) 15. R , X_{bar} chart, probability of detecting shift, .for X_{bar} chart, computations of Cp, Cpk. (2) 16. p-chart for (i)fixed sample size (ii) variable sample size based on individual control limits ,probability of detecting shift. 17. Single sampling plan for attributes (OC curve, AOQ,(1) AOQL, ATI using Poisson distribution). 18. Determination of single sampling plan for attributes by (1) i) lot quality approach ii) average quality approach 19. Double sampling plan for attributes(1) (OC curve, AOQ, AOQL, ATI, ASN using Poisson distribution).

Documents to be attached:-

2. Teaching Plans for last Five Years

Teaching Plan

Month	Period	Topic / sub- topic to be taught (T.Y.B.Sc sem- 2) (P-I: ST-341: ACTUARIAL STATISTICS)
Nov.	3	**1) Insurance Business** 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. **2) Feasibility of Insurance Business** 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. **3) Survival Distribution and Life Tables** 3.1 Time- until death random variable, its d.f. and survival function in actuarial notation.
Dec.	12	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. **4) Models for Life Insurance** 4.1 Theory of compound interest, effective rate of interest, discount factor. 4.2 Insurance payable at the end of the year of death,
Jan	11	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. **5) Annuities** 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. **6) Benefit Premiums** 6.1 Concept of a loss random variable. 6.2 Equivalence principle
Feb	8	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.

Month	Period	Topic / sub- topic to be taught (T.Y.B.Sc sem- 2) (P-IV: ST 344: OPERATIONS RESEARCH)
Nov	16	**1) Linear Programming** 1.1 Statement of the linear Programming Problem (LPP),(minimization and maximization) Formulation of problem as L.P. problem. Definition of (i) A slack variable, (ii) A surplus Variable. L.P. Problem in (i) Canonical form ,(ii) standard form. Definition of (i) a solution (ii)basic and non basic variables (iii) a feasible solution (iv) a basic feasible solution, (v) a degenerate and non–degenerate solution (vi) an optimal solution.
Dec	12	1.2 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 solutions , introduction of artificial variable, Big-M method. 1.3 Duality Theory: Writing dual of a primal problem, solution of a L.P.P. by using its dual problem. 1.4 Examples and problems. **2) Transportation Problem** 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) Least cost method (ii) Vogel's approximation method (VAM).

		2.3 u-v (MODI) method of obtaining Optimal solution of T.P., uniqueness and non- uniqueness of optimal solutions, degenerate solution 2.4 Assignment Problem : Statement of an assignment problem , Minimization and maximization problem , balanced and unbalanced problem ,relation with transportation problem
Jan	9	optimal solution using Hungarian method , maximization case 2.6 Examples and problems. **3. Simulation** 3.1 Introduction to simulation, merits, demerits, limitations. 3.2 Pseudo random number generates: Linear congruential , mid square method. 3.3 Model sample from normal distribution (using Box- Muller transformation), uniform distribution, exponential distribution. 3.4 Monte Carlo method of simulation: Statistical applications of simulation in numerical integration such as computation of probabilities of events related to gamma, beta and bivariate normal distribution. **4. Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT)** 4.1 Definition of (i) Event,(ii) Node,(iii)Activity,(iv)Critical Activity,(v)Project Duration. 4.2 CPM: Construction of network, Definitions (i) earliest start time (ii) earliest finish time
Feb	11	(iii) latest start time (iv) latest finish time for an activity. Critical Path, Types of float, total floats, free float, independent float and their significance. Determination of critical path 4.3 PERT: Construction of network; (i) pessimistic time estimate, (ii) optimistic time estimate (iii) most likely time estimates,

		Determination of critical path, determination of mean and standard deviation of project duration, computations of probability of completing the project in a specified duration.