Deccan Education Society's

Fergusson College (Autonomous) Pune

Learning Outcomes-Based Curriculum
for 3/4 years B. Sc. /B. Sc. (Honours) Programme
as per guidelines of

NEP-2020

for

S. Y. B. Sc. (Statistics)

With effect from Academic Year

2024-2025

Fergusson College (Autonomous), Pune
First Year Curriculum as per NEP 2020

Department of Statistics

Course Structure

Semester	Paper	Paper Code	Paper Title	Type	Credits
III	Major	STS-201	Probability Theory and Distributions – II	Theory	4
		STS-200	Statistics Practical – 3	Practical	2
	Minor	STS-211	Sampling Methods	Theory	2
		STS-212	Statistics Practical – 3	Practical	2
	OE	STS-220	Statistical Techniques -I	Theory	2
	VSC	STS-230	Statistical Quality Control - I	Theory	2
	SEC	STS-240	Statistical Computing using R - I	Theory	2
	Minor (SYBA)	STS-219	Probability Theory and Discrete Probability Distributions	Theory	2
	Minor (CS)	STS-215	Statistical Methods - I	Theory	2
		STS-216	Statistics Practical - 3	Practical	2
	CEP	STS-245	Community Engagement Program		2
IV	Major	STS-251	Sampling and Inferential Statistics	Theory	4
		STS-250	Statistics Practical – 4	Practical	2
	Minor	STS-261	Continuous Probability distributions - I	Theory	2
		STS-262	Statistics Practical – 4	Practical	2
	OE	STS-270	Statistical Techniques -II	Theory	2
	VSC	STS-280	Statistical Quality Control - II	Theory	2
	SEC	STS-290	Statistical Computing using R - II	Theory	2
	Minor (SYBA)	STS-269	Continuous Univariate Distributions and Applications of Statistics	Theory	2
	Minor (CS)	STS-265	Statistical Methods - II	Theory	2
		STS-266	Statistics Practical - 4	Practical	2
	FP	STS-295	Field Project		2

**** OE – Open Elective, SEC- Skill Enhancement Component.***

S.Y. B.Sc. Semester III		
STS-201	**Probability Theory and Distributions – II (Major - Theory)**	**Credits : 04 Hours :60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's Cognitive Level**
CO1	Recall the concepts of random variable and probability distribution of discrete random variable. Define continuous random variable and its probability distribution, distribution function and its properties , mean , variance, moments, m.g.f and its properties, c.g.f. , mode and quartiles of a continuous random variable, p.d.f. of various continuous distribution	**1**
CO2	Understand the concept of statistic and sampling distribution. Articulate the theory of continuous probability distributions, special continuous probability distributions and derived distributions.	**2**
CO3	Apply special continuous probability distributions to real life situations. Compute probability of events related to the applications.	**3**
CO4	Analyze real life situations to fit statistical model and calculate the associated probabilities.	**4**
CO5	Determine the probability distributions of functions of random variables and their interrelations.	**5**
CO6	Develop the theory of derived distributions. Develop ability to use and interpret Normal probability plot and q-q plots for testing Normality of data.	**6**

Unit No.	Contents	No. of Hours
I	**Continuous univariate probability distributions:**	**[09]**
	1.1 Continuous sample space: Definition, illustrations Continuous random variable: Definition, probability density function (p.d.f.), distribution function (d.f.), properties of d.f. (without proof), probabilities of events related to random variable 1.2 Expectation of continuous r.v., expectation of function of r.v. E[g(X)], variance, geometric mean, harmonic mean, raw and central moments, skewness, kurtosis, Mode, median, quartiles 1.3 Moment generating function (m.g.f.): Definition and its properties, Cumulant generating function (c.g.f.): Definition and its properties 1.4 Probability distribution of function of a r. v. : $Y = g(X)$ using i) Jacobian of transformation for g(.) monotonic function and one-to-one, on to functions, ii) Distribution function for $Y = X^2$, $Y = \|X\|$ etc., iii) m.g.f. of g(X)	

II	**Standard Continuous Probability Distributions:**	**[18]**
	2.1 Motivation for distribution theory - Presentation 2.2 Uniform or rectangular distribution: probability density function (p.d.f.) $f(x) = \begin{cases} \frac{1}{b-a}, a \le x \le b \\ 0, \text{ otherwise} \end{cases}$ Notation : $X \sim U[a, b]$ 2.3 Sketch of p. d. f., Nature of p.d.f., d. f., mean, variance Distribution of i) $\frac{X-a}{b-a}$, ii) $\frac{b-X}{b-a}$ iii) Y = F(x) where F(x) is distribution function of a continuous r.v., applications of the result for model sampling. **2.4 Normal distribution:** probability density function (p. d. f.) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(x-\mu)^2\right)$, $-\infty < x < \infty$, $-\infty < \mu < \infty$; $\sigma > 0$ Notation: $X \sim N(\mu, \sigma^2)$, identification of location and scale parameters, nature of probability curve, mean , variance, m.g.f., c.g.f., central moments , cumulants, β_1 , β_2 , γ_1, γ_2 , median, mode, quartiles, mean deviation, additive property, computations of normal probabilities using normal probability integral tables, probability distribution of : i) $\frac{X-\mu}{\sigma}$, standard normal variable (S.N.V.), ii) $aX + b$, iii) $aX + bY + c$, iv) X^2 , where X and Y are independent normal variables. Probability distribution of $\bar{X}$, the mean of n i. i. d. $N(\mu, \sigma^2)$ r. v s. Normal probability plot, q-q plot to test normality. Normal approximation to Poisson and binomial distributions. Model sampling from Normal distribution using i) Distribution function method and ii) Box-Muller transformation as an application of simulation. **2.5 Exponential distribution:** probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x}, & x > 0, \alpha > 0 \\ 0 & \text{otherwise} \end{cases}$ Notation : $X \sim Exp(\alpha)$ 2.6 Nature of p.d.f., mean, variance, m.g.f., c.g.f., d. f., graph of d. f., lack of memory property, median, quartiles. Distribution of min(X, Y) where X and Y are i.i.d. exponential r.v.s	

	2.7 Gamma Distribution : $f(x) = \frac{\alpha^{\lambda}}{\overline{\lambda}} e^{-\alpha x} x^{\lambda-1}$ **= 0** , $x \geq 0$, $\lambda>0$, $\alpha>0$ Otherwise. Notation : $X \sim G(\alpha , \lambda)$ α : scale parameter, λ : shape parameter Nature of probability curve for various values of shape parameter , m.g.f., c.g.f., moments, cumulants, β_1 , β_2 , γ_1, γ_2 , mode, probability distribution of cX, c a constant, additive property, Probability distribution of $\overline{X}$, the mean of n i. i. d. $G(\alpha , \lambda)$ r. v s. Distribution of sum of n iid exponential variables with same scale parameter. Relation between distribution function of Poisson and gamma variates.	
III	**Continuous Bivariate Probability distributions:**	**[08]**
	3.1 Continuous bivariate random vector or variable (X, Y): Joint p.d.f. , joint d.f. , properties (without proof), probabilities of events related to r.v. (events in terms of regions bounded by regular curves, circles, straight lines) Marginal and conditional distributions 3.2 Expectation of r.v., expectation of function of r.v. E[g(X, Y)], joint moments, Cov (X,Y), Corr (X, Y), conditional mean, conditional variance, E[E(X|Y = y)] = E(X), regression as a conditional expectation 3.3Independence of r. v. (X, Y) and its extension to k dimensional r.v. Theorems on expectation: i) E(X + Y) = E(X) + E(Y), (ii) E(XY) = E(X) E(Y) , if X and Y are independent r.v.s , generalization to k variables E(aX + bY + c), Var (aX + bY + c) 3.4 Joint m.g.f. $M_{X, Y} (t_1 , t_2)$, m.g.f. of marginal distribution of r.v.s., and following properties (i) $M_{X ,Y} (t_1,t_2) = M_X (t_1,0) M_Y (0, t_2)$, if X and Y are independent r.v.s (ii) $M_{X+Y} (t) = M_{X , Y} (t , t)$, (iii) $M_{X+Y} (t) = M_X (t) M_Y (t)$ if X and Y are independent r.v.s 3.5 Probability distribution of transformation of bivariate r. v. $U = \phi_1 (X ,Y)$, $V = \phi_2 (X ,Y)$ Standard bivariate probability distributions.	

IV	**Sampling Distributions:** 4.1 Random sample from a distribution of r.v. X as i. i. d. r. v.s. $X_1, X_2, \ldots, X_n$ 4.2 Notion of a statistic as function of $X_1, X_2, , X_n$ with illustrations Sampling distribution of a statistic, concept of sampling variation with illustration 4.3 Distribution of sample mean $\bar{X}$ of a random sample from normal population, exponential and gamma distribution. Notion of standard error of a statistic with illustrations 4.4 Distribution of $\frac{nS^2}{\sigma^2} = \frac{1}{\sigma^2}\sum_{i=1}^{n}(X_i - \bar{X})^2$ for a sample from a normal distribution using orthogonal transformation. Independence of $\bar{X}$ and S^2	**[05]**
V	**Chi-square (χ_n^2) Distribution:** 5.1 Definition of chi-square (χ^2) r. v. as sum of squares of i. i. d. standard normal variates, derivation of p.d.f. of χ^2 with n degrees of freedom using m.g.f., nature of probability. curve with the help of R software, 5.2 Computations of probabilities using tables of χ^2 distribution, mean, variance, m.g.f., c.g.f., central moments, β_1, β_2 , γ_1, γ_2 , mode, additive property of chi-square distribution. 5.3 Normal approximation: $\frac{\chi_n^2 - n}{\sqrt{2n}}$ with proof using m.g.f , Fisher's normal approximation (without proof) 5.4 Distribution of $\frac{X}{X+Y}$ and $\frac{X}{Y}$ where X and Y are two independent chi- square random variables	**[08]**
VI	**Student's t distribution:** 6.1 Definition of student's t distribution with n d. f. where $t = \frac{U}{\sqrt{V/n}}$, U and V are independent random variables such that $U \sim N(0, 1)$, $V \sim \chi_n^2$ 6.2 Derivation of p.d.f., nature of probability curve, mean, variance, moments, mode, use of tables of t-distribution for calculation of probabilities, statement of normal approximation	**[06]**

VII	**Snedecor's F-distribution:** 7.1 Definition of F r.v. with n_1 and n_2 d.f. as $Fn_1, n_2 = \frac{U/n_1}{V/n_2}$ where U and V are independent chi square random variables with n_1 and n_2 d.f. respectively 7.2 Derivation of p.d.f., nature of probability curve, mean, variance, moments, mode 7.3 Distribution of $\frac{1}{F_{n_1,n_2}}$, use of tables of F-distribution for calculation of probabilities, Interrelations among, χ^2, t and F variates**.**	**[06]**

Reference:

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V. K. (2002), *Fundamentals of Mathematical Statistics*, (*Eleventh Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
3. Gupta, S. P. (2002), *Statistical Methods* (*Thirty First Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
4. Gupta, S. C. and Kapoor V. K. (2007), *Fundamentals of Applied Statistics* (*Fourth Edition*), Sultan Chand and Sons, New Delhi.
5. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), *Introduction to Mathematical Statistics (Tenth Impression*), Pearson Prentice Hall.
6. Medhi, J., *Statistical Methods*, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
7. Meyer, P. L., *Introductory Probability and Statistical Applications*, Oxford and IBH Publishing Co. New Delhi.
8. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), *Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI*), McGraw - Hill Series G A 276
9. Mukhopadhya Parimal (1999), *Applied Statistics*, New Central Book Agency, Pvt. Ltd. Kolkata
10. Ross, S. (2003), *A first course in probability (Sixth Edition*), Pearson Education publishers , Delhi, India.
11. Walpole R. E., Myers R. H. and Myers S. L. (1985), *Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10)*, Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.
12. Weiss N., *Introductory Statistics*, Pearson education publishers.

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S.Y. B.Sc. Semester III		
STS-200	**Statistics Practical – 3 (Major - Practical)**	**Credits : 02 Hours :60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's Cognitive Level**
CO1	Identify appropriate probability model for the real life situation	**1**
CO2	Articulate the moments for the probability distributions	**2**
CO3	Apply methods and procedures of fitting distribution to real life situations in various fields. Apply the relevant concepts to real life problems, Calculate probabilities of events with repect to different continuous probability distributions.	**3**
CO4	Analyze continuous univariate and bivariate data.	**4**
CO5	Compare fitted models with the observed frequencies	**5**
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of statistical models.	**6**

Sr. No.	Title of the experiment
1.	Univariate probability distributions (Expectation and moments, m.g.f, c.g.f. ,quantiles and determining p.d.f. of transformed variables)
2.	Applications of uniform distribution.
3.	Applications of exponential distributions
4.	Model sampling from exponential distribution
5.	Applications of gamma distribution.
6.	Applications of normal distribution.
7.	Fitting of normal distributions, plot of observed and expected frequencies, nomal probability plot, q-q plot
8.	Model sampling from normal distribution using distribution function and Box-Muller transformation
9.	Bivariate probability distributions-I (Computation of probabilities, marginal and conditional pd.f. and independence of two variables)
10.	Bivariate probability distributions-II (Moments, m.g.f, c.g.f. , determining p.d.f. of bivariate transformations, Standard bivariate probability distributions.)
11	Computation of probabilities for chi-square, t, F distribution –I
12	Computation of probabilities for chi-square, t, F distribution –II
13, 14 & 15	Case Studies

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S. Y. B. Sc. Semester - III		
STS-211	**Sampling Methods (Minor- Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall concepts of sample and population, various sampling methods	**1**
CO2	Explain simple random sampling for variables and attributes, need of construction of strata and allocation problems in stratified random sampling method, sampling and non-sampling errors,	**2**
CO3	Choose a sample of suitable size by using various sampling methods to collect data in day today life,	**3**
CO4	Calculate estimates of unbiased estimators and their standard errors in different sampling methods	**4**
CO5	Compare simple random sampling, stratified random sampling and systematic sampling	**5**
CO6	Design a questionnaire to carry out sample survey	**6**

Unit No.	Contents	No. of hours
I	**Sampling Methods:** Basic concepts: 1.1 Population and sample, census and sample survey, sampling frame, sampling design, random sample, requisites of a good sample. 1.2 Sample surveys, principles of sample survey, preparing a questionnaire, planning and execution of sample survey, sampling and non-sampling errors. 1.3 Advantages and limitations of sampling. 1.4 Sample survey versus complete enumeration.	**[06]**
II	**Simple Random Sampling (with and without replacement):** 2.1 Notations and terminology, various probabilities of selection. 2.2 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, derivation of expectation and standard error of	**[08]**

	(N $\bar{y}$) as an estimator of population total Estimation of above standard errors in case of SRSWOR and SRSWR 2.3 Simple random sampling of attributes. Sample proportion(p) as an estimator of population proportion of units possessing a certain attribute, derivation of expectation and standard error of (p) Estimator (Np) as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of (Np), Estimator of above standard error in case of SRSWOR and SRSWR 2.4 Determination of sample size for the given (i) margin of error and confidence coefficient (ii)coefficient of variation of the estimator and confidence coefficient 2.5 Determination of Sample Size	
III	**Stratified random sampling:** 3.1 Principles of stratification, notations. 3.2 Estimator ($\bar{y}_{st}$) of population mean, derivation of its expectation and standard error cost function. Estimator (N $\bar{y}_{st}$) of population total, derivation of its expectation and standard error 3.3 Allocation techniques: proportional and optimum allocations derivation of expressions for the standard errors of the above estimators 3.4 Comparison of stratified sampling with simple random sampling. 3.5 Cost and variance analysis, minimization of variance for the fixed cost and minimization of cost for the fixed variance. Neyman's allocation as a special case of optimum allocation in cost and variance analysis.	**[09]**
IV	**Systematic Sampling:** 4.1 Systematic sampling procedure, 4.2 Real life situations where systematic sampling is appropriate. 4.3 Techniques of drawing a sample using systematic sampling. 4.4 estimator of population mean, derivation of its expectation and standard error Ratio and Regression method : 4.5 Rationale behind using auxiliary variates in estimation 4.6 Situations where (i) ratio method is appropriate, (ii) regression method is appropriate 4.7 Ratio and regression estimators of the population mean and population total	**[07]**

References:

1. Arnab R. (2017) : Survey Sampling : Theory and Applications . Academic Press
2. M.M. Desu and D. Raghavarao (1990) : Sample Size Methodology, Academic Press, New York
3. Mukhopadhyay P (2008): Sampling theory and methods of survey sampling. Prentice-Hall of India, New Delhi.
4. Sarjinder Singh (2003) : Advanced Sampling theory with applications, Kluwer Academic publishers.
5. Singh, D. and Chaudhary, F. S. (2022): Theory and Analysis of Sample Survey Designs, 2nd edn. New Age International.
6. Sukhatme, P.V., Sukhatme, B. V. and Ashok (1984) : Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi
7. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
8. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
9. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.

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S. Y. B. Sc. Semester - III		
STS-212	**Statistics Practical - 3 (Minor - Practical)**	**Credits : 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall different sampling procedures	**1**
CO2	Illustrate the random sampling procedures and fitting probability distributions to real life situations.	**2**
CO3	Apply the procedure of drawing random samples for different populations	**3**
CO4	Compare the sampling procedures	**4**
CO5	Justify cost and variance analysis for allocation of sample size on various strata	**5**
CO6	Plan statistical analysis of primary / secondary data	**6**

Sr. No.	Title of the experiment
1	Simple random sampling with replacement for population mean, population total
2	Simple random sampling without replacement for population mean, population total
3	Simple random sampling with replacement for proportions
4	Simple random sampling without replacement for proportions
5	Generating simple random samples from given population , computing estimates of population parameters
6	Stratified random sampling : Generating random samples, estimation of population mean and standard error of the estimate
7	Stratified random sampling : Proportional and Neyman allocation, comparison with SRSWOR
8	Stratified random sampling : cost and variance analysis
9	Drawing random samples from given population by Systematic sampling and estimation of population mean
10	Drawing random samples from given population by Ratio and regression method and estimation of population mean
11	Sample Survey
12	Sample Survey
13, 14, 15	Case Studies

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S. Y. B. Sc. Semester - III		
STS-220	**Statistical Techniques -I (OE - Theory)**	**Credits:02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall concepts of sample, population and various types of simple random sampling methods	**1**
CO2	Explain need of stratification and making clusters and allocation problems in stratified random sampling.	**2**
CO3	Choose appropriate measures of central tendency and dispersion.	**3**
CO4	Distinguish between cluster random sampling and stratified random sampling	**4**
CO5	Compare simple random sampling, stratified random sampling and systematic sampling and Classify sampling and non-sampling error	**5**
CO6	Design questionnaire and plan sample surveys to collect data.	**6**

Unit	Contents	No. of hours
I	**Sample Survey:** 1.1 Objectives of a sample survey 1.2 Designing a questionnaire, characteristics of a good questionnaire (Questions with codes & scores are to be discussed) 1.3 Methods of data collection 1.4 Reliability and validity of questionnaire 1.5 Planning, execution and analysis of a sample survey, practical problems at each of these stages 1.6 Principal steps in a sample survey, Distinction between census and sample survey, advantages and disadvantages of sample survey over census.	**[10]**

II	**Sampling Methods:** 2.1 Types of characteristics: Attributes: Nominal scale, ordinal scale, Likert scale. Variables: Interval scale, ratio scale. discrete and continuous variables. 2.2 Types of data: (a) Primary data, Secondary data. (b) Cross-sectional data and Time series data 2.3 Notion of a statistical population and sample: Finite population, infinite population, homogeneous population and heterogeneous population. sample and a random sample. 2.4 Probability and non-probability sampling methods 2.5 Methods of sampling (description only): 2.6 Simple random sampling with and without replacement (SRSWR and SRSWOR), Stratified Random Sampling, Systematic Sampling, Cluster sampling and Two-stage sampling. 2.6 Allocation techniques in Stratified Random Sampling 2.7 Sampling and non-sampling errors with illustrations.	**[10]**
III	**Exploratory Data Analysis Using EXCEL:** 3.1 Graphical and Diagrammatic representation 3.2 Summary Statistics: measures of central tendency and dispersion. 3.3 Correlation, regression and curve fitting.	**[10]**
	References: 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. New Delhi. 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. 7. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Mathematical Statistics, 3rd Edition, Sultan Chand and Sons Publishers, New Delhi.	

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S. Y. B. Sc. Semester - III		
STS-230	**Statistical Quality Control - I (VSC- Theory)**	**Credits: 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define statistical quality control	**1**
CO2	Articulate the concept of process control tools , control charts , control limits	**2**
CO3	Build the 3 σ control limits for variables and attributes	**3**
CO4	Compare chance and assignable causes ,	**4**
CO5	Catch the shift in process	**5**
CO6	Construct control charts	**6**

Unit No.	Contents	No. of hours
I	**Introduction:** 1.1 Meaning and purpose of Statistical Quality Control (SQC), on line process control methods (control charts) and offline process control methods (Sampling plans). 1.2 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 (DOE).	**[05]**
II	**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. 2.2 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. 2.3 Construction of control charts for (i) standards given, (ii) standards not given.	**[05]**
III	**Control Charts for attributes:** 3.1 Construction and working of p - chart p-chart when subgroup sizes are same and value of the process fraction	**[10]**

	defective p is specified : control limits, drawing of control chart, plotting of sample fraction defectives, revision of control limits if necessary, estimation of p for future use. 3.2 Determination of state of control of the process. Interpretation of high and low spots. 3.3 Probability of detecting the shift in process fraction defective (or signal) using normal approximation. P-chart when subgroups sizes are different and value of the process fraction defective p is not specified : different types of control limits: (i) Separate control limits, (ii) control limits based on average sample size, (iii) stabilized (standardized P)control limits, 3.4 Drawing of control chart, plotting sample fraction defective, determination of state of control of the process. Identification of real life situations. Limitations of P-chart. 3.5 C chart : 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. 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, revision of control limits, if necessary, estimate of process parameter for future use. Determination of state of control, 3.6 Interpretation of high and low spots in above cases. Identification of real life situations. 3.7 Probability of detecting shift (or signal) in parameter λ. Comparison between P and C charts. Limitations of C-chart.	
IV	**Control charts for variables:** 4.1 R chart and $\bar{X}$ chart: Purpose of R and $\bar{X}$ chart, normal probability plot for checking normality assumption, 4.2 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 of the process, corrective action if the process is out of statistical control. 4.3 Construction of $\bar{X}$ chart when the process average is	**[10]**

	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. 4.4 Construction of R chart when the process standard deviation (σ) is not specified : control limits, drawing of control chart, plotting sample range values, revision of control limits if necessary, estimate of σ for future use. Construction of $\bar{X}$ chart when the process average μ is not specified : control limits based on $\hat{\sigma}$, drawing of control chart, plotting sample means, revision of control limits of $\bar{X}$ chart, if necessary. 4.5 Introduction to multivariate normal distribution, multivariate control chart for process mean, multivariate control chart for individual observations. 4.6 Introduction of synthetic control charts	
	References: 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. D.H. Besterfield, C.B. Michna etc. Total Quality Management (3rd edition 2009) : Pearson Education, Delhi.	

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S.Y. B.Sc. Semester III		
STS-240	**Statistical Computing Using R -I (SEC – Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the concepts of how to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data.	**1**
CO2	Understand the concept of how to write the R commands for fitting linear regression , for curve fitting, computation of probabilities of different distributions and fitting of different distributions.	**2**
CO3	Apply the concept of fitting linear regression and curve fitting to different realistic situations using R	**3**
CO4	Analyze real life situations where different probability distributions can be applied	**4**
CO5	Determine the best practice model design methodologies to real problems using R	**5**
CO6	Create, visualize and analyse the data using statistical methods using R .	**6**

Unit No.	Contents	No. of Hours
I	**Linear Regression Model:** 1.1 Meaning of regression, Computation of correlation coefficient using R , Concept of error in regression, error modeled as a continuous random variable. Fitting of simple linear regression model: $Y= a + b X + \varepsilon$, using R where ε is a continuous random variable with $E(\varepsilon) =0$, $V(\varepsilon) = \sigma^2$ 1.2 Estimation of a, b . Interpretation of parameters. Computation of the estimator of σ^2. Computation of residual, Residual plot ,computation of coefficient of determination.	**[05]**

II	**Fitting of curves to the bivariate data:** 2.1 Fitting of curves to the bivariate data : Fitting of second degree curve ($Y = a + b X + c X^2$), Fitting of exponential curves of the type $Y = a b^X$ and $Y = a^X b$. Estimation of parameters.	**[05]**
III	**Probability Distributions:** 3.1 Simulation from distributions, computations of probabilities, cumulative probabilities, quantiles and drawing random sample using d,p,q,r functions for following distributions: Binomial, Hypergeometric, Poisson, Negative Binomial, Geometric, Uniform, Normal, Exponential, Gamma, Graphs of p.m.f/p.d.f by varying parameters for the above distributions.	**[13]**
IV	**Fitting of Distributions:** 4.1 Fitting of the following distributions: Binomial, Negative Binomial, Poisson, Normal.	**[07]**
	Reference : 1. Gardener, M. (2018), Beginning R: The Statistical Programming Language, Wiley & Sons. 2. Sekhar, S.R.M., et al. (2017), Programming with R, Cengage Learning India. 3. Wickham, H., et al. (2017), R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, O'Reilly'. 4. Field, A., Miles, J and Field (2012), Z. Discovering Statistics using R (Indian Reprint 2022), SAGE 5. Simple R - Using R for Introductory Statistics: John Verzani. 6. An Introduction to R: Software for Statistical Modeling & Computing: Petra Kuhnert and Bill Venables. 7. Wickham, H., et al. (2017), R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, O'Reilly'. 8. Lander, J. P. (2014). R for everyone: Advanced analytics and graphics. Pearson Education. 9. Horton, N.J. & Kleinman, K.(2015) Using R & R Studio for Data Management, Statistical Analysis , and Graphics, CRC Press. • CRAN website: https://cran.r-project.org/ • https://prowessiq.cmie.com, • https://data.worldbank.org/indicator, • https://rstudio.com/products/rstudio/download/(Rstudio) • http://r-statistics.co	

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S.Y. B.Sc. Semester III		
CEP-245	**Community Engagement Program**	**Credits : 02** **Hours : 30**
	The Community Engagement and Social Responsibility course is an immersive and transformative learning experience designed for second-year undergraduate students. In an era where the intersections of diverse disciplines are more critical than ever, this course stands at the forefront of transdisciplinary and multidisciplinary education. As the heartbeat of societal progress, this compulsory course seeks to connect students with their communities, fostering a deep sense of social responsibility. Rooted in the belief that academic knowledge should transcend classroom walls, the aim is to equip students with the tools to analyse, comprehend, and address pressing social issues. Through dynamic and interactive learning methods, students will not only explore the complexities of community dynamics but also actively contribute to the development of sustainable solutions. **General guidelines -** 1. The implementation mechanism of CESR Course is to be decided by respective departments. 2. Each department should ensure collaborations/Tie-ups (in terms of MoU/LoI) with relevantindustries/organizations/NGOs as per project requirements. 3. Expertise of Local community elders, women leaders, tribals, entrepreneurs and civil society practitioners can be tapped by inviting them to co-teach courses both in the classrooms and in the field. Such instructors should be duly recognized, compensated and respected for their practical experience and knowledge. 4. The CESR course has to implemented ONLY through the department. Students cannot approach to NGOs /Organisations individually for the same. All the communication to theNGOs/Organizations should be done through the department. 5. Departments should maintain the relevant documents (such as attendance records, proposals, CESR diary, MoUs/LoI etc) and correspondence regarding CESR course. **Objectives:** **1.CESR Theory** a) To develop an understanding of community needs and challenges. b) To equip students with skills to identify problem areas within the community.	

c) To guide students in creating effective project proposals.

d) To apply classroom knowledge of courses to field realities and thereby improve thequality of learning.

2. **CESR Field Work**:

a) To provide practical experience in implementing community projects.

b) To assess students' ability to apply theoretical knowledge in real-world situations.

c) To develop skills in project management, teamwork, and communication.

- As per the NEP guidelines, the UG students are expected to complete this program in their **third semester** from the academic year 2024-25.
- The academic schedule must be planned by the departments, 1 credit to be allotted to classroom and tutorials (15 hours) and 1 credit to field engagement – students learninghours (30 hours)
- **<u>Classroom Engagement and Field Engagement</u>**:

2 credits of classroom engagement and field Engagement comprises of followingcomponents:

- Understanding Community Needs
- Identifying Project Opportunities
- Crafting and Finalising Effective Project Proposals
- Lectures on community sociology and challenges.
- Case studies and discussions on successful community engagement projects.

CEP-20 **Foundations of Community Engagement[Credits-2]**	
Community engagement –Basics (1 Credit)	
Topics Covered	**Activities**
Introduction to Community Engagement	- Overview of theories and models - Importance of interdisciplinary approaches
Social Issues Analysis	- Guest lecture by a social scientist or experts from diversesectors - Group discussion and analysis of contemporary social issues

Community Needs Assessment	- Theory on needs assessment methodologies - Field visit for practical application
Stakeholder Engagement	- Guest lecture from a community organizer - Simulated stakeholder engagement role-play
Community engagement –Field Work (1 Credit)	
Topics Covered	**Activities**
Cultural Competence in Community Work	- Cultural sensitivity training - Case studies on community engagement
Writing Project Proposaland finance resource management	- Develop a community project proposal and finance resourcemanagement - Timeline for implementation
Field Work Skills Training	- Training in data collection, interviewing, and observation - Practical exercises in the community
Ethical Considerations in Community Engagement	- Guest lecture on ethical dilemmas in community work - Case studies and group discussions

	Credit	**Contact/ learning Hours**	**Course component**
Sem III	1	15 hrs.	Classroom engagement and tutorials
	1	30 (student learning hrs.)	Field Engagement (Requirement Gathering)

Evaluation of Classroom Engagement and Field Engagement (Sem. III) Evaluate each student for 50 marks per semester at department level –**20 marks for Continuous evaluation (CE)**

- Participation in class activities and discussions.
- Submission of reflective essays.

30 marks for End Semester Examination (ESE)

- Based on evaluation of Project Proposal.

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S. Y. B. A. Semester III		
STS-219	**Probability Theory and Discrete Probability Distributions** **(Minor - Theory)**	**Credits : 02** **Hours :30**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's Cognitive Level**
CO1	Recall basic knowledge of probability, permutations and combinations.	**1**
CO2	Understand the concept of sample space for random experiment and identify different events and their types.	**2**
CO3	Apply theorems of probability to compute probability of different types of events and univariate discrete probability distributions.	**3**
CO4	Analyze real life situations to apply classical definition of probability , axioms of probability, conditional probability, independence and special discrete distributions.	**4**
CO5	Determine the properties of univariate discrete random variables and computation of probabilities of special discrete distributions	**5**
CO6	Formulate special discrete probability distributions.	**6**

Unit No.	Contents	No. of Hours
I	**Permutations and Combinations:** 1.1 Definitions of permutation and combination 1.2 Relation between permutation and combination (i) ${}^{n}C_{r} = {}^{n}C_{n-r}$ (ii) ${}^{n}C_{r} + {}^{n}C_{r-1} = {}^{n+1}C_{r}$ 1.3 Examples and Problems	**[05]**
II	**Probability:** 2.1Concept and definition of union, intersection of two sets, complement of a set 2.2 Concept of random experiment, sample space, event 2.3 Definition of event, complementary event, elementary event, certain event, impossible event, problems on sample space, events for a given random experiment 2.4 Classical definition of probability and its limitations Probability model 2.5 Axioms of probability Theorems of Probability (Explain through illustrations) (i) P(A) + P(A') = 1	**[09]**

	(ii) $0 \leq P(A) \leq 1$ (iii) $P(\Phi)=0$ (iv) If $A \subset B$ then $P(A) \leq P(B)$ (v) $P(AUB) = P(A)+P(B)-P(A \cap B)$ (vi) $P(AUB) \leq P(A) + P(B)$ (vii) Statement for 3 events for (v) and (vi) 2.6 Definition of conditional probability 2.7 Multiplication theorem on $P(A \cap B)$ 2.8 Concept and definition of independence of two events 2.9 Pairwise independence and complete independence in case of three events	
III	**Uni-variate Discrete Probability Distributions:** 3.1 Definition of a discrete sample space and discrete r.v. 3.2 Definition of probability mass function (p.m.f.) of a discrete r.v. 3.3 Definition of expectation of a discrete r.v. and expectation of a linear combination of discrete r.v. X. 3.4 Definition of variance of discrete r.v. X. 3.5 Properties of expectation and variance	**[04]**
IV	**Special Discrete Distributions:** 4.1 Discrete uniform distribution: p.m.f. mean and variance. Illustrations of real life situations where this distribution can be applied 4.2 Binomial distribution: Notation X~B(n,p). p.m.f., mean and variance, additive property (derivations excluded). Illustrations of real life situations where the distribution can be applied. Computation of probabilities of events related to binomial r.v. 4.3 Poisson distribution: Notation X~P(m) p.m.f., mean and variance, additive property (derivations excluded), Illustrations of real life situations where the distribution can be applied. Computation of probabilities of events related to a Poisson r.v.	**[12]**
	References: 1. Asthana B.N. and Srivastava S.S, Applied Statistics of India Srivastava 2. Goon,Gupta, Das Gupta, Fundamental of Statistics,Vol.II Shripati Bhattachrjee for the World Press Pvt. Ltd,Calcutta World Press Pvt. Ltd,Calcutta 3. Gupta S.C Kapoor, V.K., Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi 4. Lipschutz, Probability and Statistics, Schaum's Outline, Series, New York 5. Walpole,Myres, Probability and Statistics, Mcmillan Publishing Co. New York	

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S. Y. B. Sc. (Computer Science) Semester III		
STS-215	**Statistical Methods - I (Minor – Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define various discrete probability distributions and outline the properties of probability mass functions, cumulative distribution functions.	**1**
CO2	Distinguish between multiple and partial correlation.	**2**
CO3	Demonstrate multiple regression model.	**3**
CO4	Relate the bivariate probability distributions to real life situations.	**4**
CO5	Measure partial regression coefficient, multiple and partial correlation coefficient for tri-variate data.	**5**
CO6	Write an equation of plane of regression for the given data.	**6**

Unit No.	Contents	No. of hours
I	**Multiple and Partial Correlation and Regression (for trivariate data)** 1.1 Yule's notation and concept of multiple regression, 1.2 Fitting of multiple regression plane, Partial regression coefficient, interpretation, Multiple correlation coefficient, concept, definition, computation and interpretation, 1.3 Partial correlation coefficient, concept, definition, computation and interpretation, Numerical Problems	**[06]**
II	**Discrete Random variable** 2.1 Definition of random variable and discrete random variable, Definition of probability mass function, distribution function and its properties, 2.2 Definition of expectation and variance, theorem on expectation, 2.3 Determination of median and mode using p.m.f, Numerical problems related to real life situations.	**[04]**

III	**Standard Discrete Probability Distributions** 3.1 Discrete Uniform Distribution: definition, mean, variance, 3.2 Bernoulli Distribution: definition, mean, variance, additive property, 3.3 Binomial Distribution: definition, mean, variance, additive property, 3.4 Geometric Distribution: definition p.m.f $P[X = x] = pq^x$, $x = 0,1,2....$ $= 0$ otherwise mean, variance, 3.4 Poisson Distribution: definition, mean, variance, mode, additive property, limiting case of B (n, p), Illustration of real life situations, Numerical problems related to real life situations.	**[14]**
IV	**Bivariate discrete probability distribution** 4.1 Definition of two-dimensional discrete random variable, its joint p.m.f. and its distribution function and their properties, 4.2 Concept of identically distributed random variables, Computation of probabilities of events in bivariate probability distribution, 4.3 Concepts of marginal and conditional probability distributions. Independence of two discrete random variables based on joint and marginal p.m.f, Examples and problems.	**[06]**
	References: 1. Statistical Methods, G.W. Snedecor, W.G. Cochran, John Wiley & sons, 1989. 2. Fundamentals of Applied Statistics (4th Edition), Gupta and Kapoor, S. Chand and Sons, New Delhi, 2014. 3. Modern Elementary Statistics, Freund J.E., Pearson Publication, 2005. 4. A First course in Probability 6th Edition, Ross, Pearson Publication, 2006.	

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S. Y. B. Sc. (Computer Science) Semester III		
STS-216	**Statistics Practical - 3 (Minor-Practical)**	**Credits : 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the concepts of tri-variate data, multiple and partial correlation coefficient, partial regression coefficient and its interpretation.	**1**
CO2	Discuss various applications of statistical measures using R software.	**2**
CO3	Execute the computational techniques using R software.	**3**
CO4	Analyse different concepts of statistics using R software.	**4**
CO5	Validate the fundamental knowledge and represent using R software.	**5**
CO6	Write a program using R to build plane of regression for the given data.	**6**

Sr. No.	Title of the Experiment
1	Multiple Regression I
2	Multiple Regression II
3	Discrete Probability theory
4	Applications of Binomial distribution
5	Fitting of Binomial distribution
6	Applications of Poisson distribution
7	Fitting of Poisson distribution
8	Applications of Geometric distribution
9	Bivariate Probability theory
10	Multiple Regression using R
11	Computations of probabilities using R-I (Binomial)
12	Computations of probabilities using R-II(Poisson)
13,14&15	Applications of Statistical techniques to real-life data.

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S. Y. B. Sc. Semester - IV		
STS-251	**Sampling and Inferential Statistics (Major - Theory)**	**Credits : 04 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall concepts of sample and population, various sampling methods , the concept of point estimation , unbiased estimator	**1**
CO2	Explain simple random sampling for variables and attributes, need of construction of strata and allocation problems in stratified random sampling method, sampling and non-sampling errors, Discuss and define the terms used in testing of hypotheses.	**2**
CO3	Choose a sample of suitable size by using various sampling methods to collect data in day today life, Compute probabilities of type I and type II error.	**3**
CO4	Calculate estimates of unbiased estimators and their standard errors in various sampling methods Identify the distributions of various test statistics	**4**
CO5	Compare simple random sampling, stratified random sampling and systematic sampling, Decide the appropriate hypotheses for testing the population parameters like mean , variance , correlation , proportion.	**5**
CO6	Design a questionnaire to carry out sample survey , Construct the tests about various population parameters and test goodness of fit of probability distributions.	**6**

Unit No.	Contents	No. of hours
I	**Sampling Methods:** Basic concepts: 1.1 Population and sample, census and sample survey, sampling frame, sampling design, random sample, requisites of a good sample. 1.2 Sample surveys, principles of sample survey, planning and execution of sample survey, sampling and non-sampling errors.	**[08]**

	1.3 Advantages and limitations of sampling. 1.4 Sample survey versus complete enumeration.	
II	**Simple Random Sampling (with and without replacement):** 2.1 Notations and terminology, various probabilities of selection. 2.2 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, derivation of expectation and standard error of (N $\bar{y}$) as an estimator of population total Estimation of above standard errors in case of SRSWOR and SRSWR 2.3 Simple random sampling of attributes. Sample proportion(p) as an estimator of population proportion of units possessing a certain attribute, derivation of expectation and standard error of (p) Estimator (Np) as an estimator of total number of units in the population possessing a certain attribute, derivation of expectation and standard error of (Np), Estimator of above standard error in case of SRSWOR and SRSWR 2.7 Determination of sample size for the given (i) margin of error and confidence coefficient (ii)coefficient of variation of the estimator and confidence coefficient 2.5 Determination of Sample Size	**[08]**
III	**Stratified random sampling:** 3.1 Principles of stratification, notations. 3.2 Estimator ($\bar{y}_{st}$) of population mean, derivation of its expectation and standard errorcost function. Estimator (N $\bar{y}_{st}$) of population total, derivation of its expectation and standard error 3.3 Allocation techniques: proportional and optimum allocations derivation of expressions for the standard errors of the above estimators 3.4 Comparison of stratified sampling with simple random sampling. 3.5 Cost and variance analysis, minimization of variance for the fixed cost and minimization of cost for the fixed variance. Neyman's allocation as a special case of optimum allocation in cost and variance analysis.	**[10]**
IV	**Systematic Sampling:** 4.1 Systematic sampling procedure, 4.2 Real life situations where systematic sampling is appropriate.	**[04]**

	4.3 Techniques of drawing a sample using systematic sampling. 4.4 estimator of population mean, derivation of its expectation and standard error 4.5 Ratio and Regression method : Rationale behind using auxiliary variates in estimation 4.6 Situations where (i) ratio method is appropriate, (ii) regression method is appropriate 4.7 Ratio and regression estimators of the population mean and population total	
V	**Theory of estimation and testing of hypothesis:** 5.1 Statistics and parameters, statistical inference: problem of estimation and testing of hypothesis. Estimator and estimate. Unbiased estimator (definition and illustrations only), obtaining estimator by method of moments. 5.2 Statistical hypothesis, null and alternative hypothesis, simple and composite hypothesis, one sided and two sided alternative hypotheses, critical region, type I error, type II error, power of the test, level of significance, p-value.	**[08]**
VI	**Tests of significance :** 6.1 One sample and two sample tests for mean(s) based on normal distribution (population variance σ^2 known and unknown), testing correlation coefficient using Fisher's z transformation, 6.2 One sample and two sample tests for population proportion 6.3 Tests based on t-distribution: a. One sample t-tests for population mean b. Two sample t-tests for equality of population means c. Paired t test d. Test of correlation coefficient e. Test of regression coefficient 6.4 Test of equality of two population variances based on F distribution: when i) means are known, ii) means are unknown 6.5 Confidence intervals for population mean and difference of two population means	**[15]**
VII	**Tests based on chi-square distribution:** a) Test for independence of two attributes arranged in r×s contingency table. b) Test for goodness of fit. c) Test of significance of population variance i) mean is known, ii) mean is unknown.	**[07]**

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2. M.M. Desu and D. Raghavarao (1990) : Sample Size Methodology, Academic Press, New York
3. Mukhopadhyay P (2008): Sampling theory and methods of survey sampling. Prentice-Hall of India, New Delhi.
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   applications, Kluwer Academic publishers.
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   Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
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    Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
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12. Medhi, J., Statistical Methods, Wiley Eastern Ltd.,

4835/24, Ansari Road, Daryaganj, New Delhi – 110002.

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Applications, Oxford and IBH Publishing Co. New Delhi.

14. Mood, A. M., Graybill F. A. and Bose, F. A. (1974),

Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276

15. Mukhopadhya Parimal (1999), Applied Statistics, New

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16. Walpole R. E., Myers R. H. and Myers S. L. (2007),

Probability and Statistics for Engineers and Scientists (8th Edition), Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.

17. Weiss N., Introductory Statistics, Pearson education

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S. Y. B. Sc. Semester - IV		
STS-250	**Statistics Practical - 4 (Major - Practical)**	**Credits : 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall concepts of sample and population, various sampling methods , the concept of point estimation , unbiased estimator	**1**
CO2	Explain simple random sampling for variables and attributes, need of construction of strata and allocation problems in stratified random sampling method, sampling and non-sampling errors, Discuss and define the terms used in testing of hypotheses.	**2**
CO3	Choose a sample of suitable size by using various sampling methods to collect data in day today life, Compute probabilities of type I and type II error.	**3**
CO4	Calculate estimates of unbiased estimators and their standard errors in various sampling methods Identify the distributions of various test statistics	**4**
CO5	Compare simple random sampling, stratified random sampling and systematic sampling, Decide the appropriate hypotheses for testing the population parameters like mean , variance , correlation , proportion.	**5**
CO6	Design a questionnaire to carry out sample survey , Construct the tests about various population parameters and test goodness of fit of probability distributions.	**6**

Sr. No.	Title of the experiment
1	Simple random sampling for population mean, population total (i)with replacement , (ii) without replacement
2	Simple random sampling for proportions :(i)with replacement , (ii) without replacement
3	Generating simple random samples from given population , computing estimates of population parameters
4	Stratified random sampling : Proportional and Neyman allocation, comparison with SRSWOR
5	Stratified random sampling : cost and variance analysis
6	Drawing random samples from given population by i) Systematic sampling ii) Ratio and regression method and estimation of population mean
7	Obtaining estimator for parameter of the given distribution and checking its properties
8	Test for means based on normal distribution
9	Test for proportions based on normal distribution

10	Test based on t distribution
11	Tests based on chi-square distribution (Independence of attributes)
12	Tests based on chi-square distribution (Goodness of fit test, test of variance)
13, 14 & 15	Case studies

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S.Y. B.Sc. Semester IV		
STS-261	**Continuous Probability Distributions – I (Minor - Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's Cognitive Level**
CO1	Recall the concepts of random variable and probability distribution of discrete random variable. Define continuous random variable and its probability distribution, mean , variance, moments, m.g.f, c.g.f. , mode and quartiles of a continuous random variable, p.d.f. of different continuous distributions	**1**
CO2	Understand the concept of statistic and sampling distribution. Articulate the theory of continuous probability distributions, special continuous probability distributions.	**2**
CO3	Apply special continuous probability distributions to real life situations. Compute probability of events related to the applications.	**3**
CO4	Analyze real life situations to fit statistical model and calculate the associated probabilities.	**4**
CO5	Determine the probability distributions of functions of random variables and their interrelations.	**5**
CO6	Develop ability to use and interpret probability plots and q-q plots for testing Normality of data.	**6**

Unit No.	Contents	No. of Hours
I	**Continuous univariate probability distributions:** 1.1 Continuous sample space: Definition, illustrations Continuous random variable: Definition, probability density function (p.d.f.), distribution function (d.f.), properties of d.f. (without proof), probabilities of events related to random variable 1.2 Expectation of continuous r.v., expectation of function of r.v. E[g(X)], variance, geometric mean, harmonic mean, raw and central moments, skewness, kurtosis 1.3 Moment generating function (m.g.f.): Definition and its properties, Cumulant generating function (c.g.f.): Definition and its properties 1.4 Mode, median, quartiles 1.5 Probability distribution of function of a r. v. : Y = g(X) using i) Jacobian of transformation for g(.) monotonic function and one-to-one, on to functions, ii) Distribution function for $Y = X^2$, Y = |X| etc., iii) m.g.f. of g(X)	**[08]**

II	**2.1 Standard Continuous Probability Distributions:** Motivation for distribution theory - Presentation **2.2 Uniform or rectangular distribution**: probability density function (p.d.f.) $f(x) = \begin{cases} \frac{1}{b-a}, a \le x \le b \\ 0 \ , \quad \text{otherwise} \end{cases}$ Notation : $X \sim U[a, b]$ **2.3** Sketch of p. d. f., Nature of p.d.f., d. f., mean, variance Distribution of i) $\frac{X-a}{b-a}$, ii) $\frac{b-X}{b-a}$ iii) Y = F(x) where F(x) is distribution function of a continuous r.v., applications of the result for model sampling. **2.4 Normal distribution:** probability density function (p. d. f.) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(x-\mu)^2\right)$, $-\infty < x < \infty$, $-\infty < \mu < \infty$; $\sigma > 0$ Notation: $X \sim N(\mu, \sigma^2)$, identification of location and scale parameters, nature of probability curve, mean , variance, m.g.f., c.g.f., central moments , cumulants, β_1 , β_2 , γ_1, γ_2 , median, mode, quartiles, mean deviation, additive property, computations of normal probabilities using normal probability integral tables, probability distribution of : i) $\frac{X-\mu}{\sigma}$, standard normal variable (S.N.V.), ii) aX + b, iii) aX + bY + c, iv) X^2 , where X and Y are independent normal variables. Probability distribution of $\bar{X}$, the mean of n i. i. d. $N(\mu,\sigma^2)$ r. v s. Normal probability plot, q-q plot to test normality. Normal approximation to Poisson and binomial distributions. Model sampling from Normal distribution using i) Distribution function method and ii) Box-Muller transformation as an application of simulation. **2.5 Exponential distribution:** probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x} , & x > 0 , \alpha > 0 \\ 0 & \text{otherwise} \end{cases}$ Notation : $X \sim Exp(\alpha)$ **2.6** Nature of p.d.f., mean, variance, m.g.f., c.g.f., d. f., graph of d.f., lack of memory property, median, quartiles. Distribution of min(X, Y) where X and Y are i. i. d. exponential r.v.s	**[16]**

III	**Continuous Bivariate Probability distributions:** 3.1 Continuous bivariate random vector or variable (X, Y): Joint p.d.f., joint d.f. , properties (without proof), probabilities of events related to r.v. (events in terms of regions bounded by regular curves, circles, straight lines), Marginal and conditional distributions 3.2 Expectation of r.v., expectation of function of r.v. E[g(X, Y)], joint moments, Cov (X,Y), Corr (X, Y), conditional mean, conditional variance, E[E(X|Y = y)] = E(X), regression as a conditional expectation 3.3 Independence of r. v. (X, Y) and its extension to k dimensional r.v. Theorems on expectation: i) $E(X + Y) = E(X) + E(Y)$, (ii) $E(XY) = E(X) E(Y)$, if X and Y are independent r.v.s , generalization to k variables , $E(aX + bY + c)$, $Var (aX + bY + c)$ 3.4 Joint m.g.f. $M_{X, Y} (t_1 , t_2)$, m.g.f. of marginal distribution of r.v.s., and following properties (i) $M_{X ,Y} (t_1,t_2) = M_X (t_1,0) M_Y (0, t_2)$, if X and Y are independent r .v.s (ii) $M_{X+Y} (t) = M_{X , Y} (t , t)$, (iii) $M_{X+Y} (t) = M_X (t) M_Y (t)$ if X and Y are independent r.v.s 3.5 Probability distribution of transformation of bivariate r. v. $U = \phi_1 (X ,Y)$, $V = \phi_2 (X ,Y)$	**[06]**

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4. Gupta, S. C. and Kapoor V. K. (2007), *Fundamentals of Applied Statistics* (*Fourth Edition*), Sultan Chand and Sons, New Delhi.
5. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), *Introduction to Mathematical Statistics (Tenth Impression*), Pearson Prentice Hall.
6. Medhi, J., *Statistical Methods*, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
7. Meyer, P. L., *Introductory Probability and Statistical Applications*, Oxford and IBH Publishing Co. New Delhi.
8. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), *Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI*), McGraw - Hill Series G A 276
9. Mukhopadhya Parimal (1999), *Applied Statistics*, New Central Book Agency, Pvt. Ltd. Kolkata
10. Ross, S. (2003), *A first course in probability (Sixth Edition*), Pearson Education publishers , Delhi, India.
11. Walpole R. E., Myers R. H. and Myers S. L. (1985), *Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10)*, Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.

12. Weiss N., *Introductory Statistics*, Pearson education publishers.

S.Y. B.Sc. Semester IV		
STS-262	**Statistics Practical – 4 (Minor - Practical)**	**Credits : 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's Cognitive Level**
CO1	Identify appropriate probability model for the real life situation	**1**
CO2	Articulate the moments for the probability distributions	**2**
CO3	Apply methods and procedures of fitting distribution to real life situations in various fields. Apply the relevant concepts to real life problems, Calculate probabilities of events with repect to different continuous probability distributions.	**3**
CO4	Analyze continuous univariate and bivariate data.	**4**
CO5	Compare fitted models	**5**
CO6	Organize and summarize the information by suitable presentations and computations. Formulate the real-life situations in terms of statistical models.	**6**

Sr. No.	Title of the experiment
1.	Univariate probability distributions (Expectation and Moments, m.g.f, c.g.f. , skewness and kurtosis)
2.	Univariate probability distributions-II (Quantiles and determining p.d.f. of transformed variables)
3.	Applications of uniform distribution.
4.	Applications of exponential distributions
5.	Model sampling from exponential distribution
6.	Applications of normal distribution-I
7.	Applications of normal distribution-II
8.	Fitting of normal distributions, plot of observed and expected frequencies, Nomal probability plot, q-q plot
9.	Model sampling from normal distribution using distribution function and Box-Muller transformation
10.	Bivariate probability distributions-I (Computation of probabilities, marginal and conditional pd.f. and independence of two variables)
11,12	Bivariate probability distributions-II (Moments, m.g.f, c.g.f. , determining p.d.f. of bivariate transformations, Standard bivariate probability distributions.)
13, 14, 15	Case studies

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S. Y. B. Sc. Semester - IV		
STS-270	**Statistical Techniques -II (OE - Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall the concepts of probability distributions	**1**
CO2	Explain the need of testing of hypothesis	**2**
CO3	Choose appropriate tests to analyse data	**3**
CO4	Distinguish between large and small sample tests.	**4**
CO5	Compare type I and type II errors in testing of hypothesis	**5**
CO6	Design appropriate tests for collected data	**6**

Unit	Contents	No. of hours
I	**Probability Distributions:** 1 .1 Experiments / Models, deterministic and non- deterministic models. random experiment, concept of statistical regularity. 1.2 Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite, (iii) Continuous sample space, Concept and definition of a discrete random variable, Probability mass function 1.3 Normal distribution: Understanding the nature of probability curve, state mean, variance, computations of normal probabilities using normal probability tables. 1.4 Definition of chi-square (χ^2) r. v. ,nature of probability curve, computations of probabilities using tables of χ^2 distribution 1.5 Definition of student's t distribution with n d. f. nature of probability curve, mean, variance, use of tables of t-distribution for calculation of probabilities	**[10]**
II	**Tests based on normal and t distributions:** 2.1 Statistics and parameters, statistical inference: problem of estimation and testing of hypothesis. Estimator and estimate. 2.2 Statistical hypothesis, null and alternative hypothesis, simple and composite hypothesis, one sided and two sided alternative	**[14]**

	hypotheses, critical region, type I error, type II error, power of the test, level of significance, p-value. 2.3 Concept and working of one sample and two sample tests for mean(s) based on normal distribution (population variance σ^2 known and unknown), 2.4 Concept and working of tests based on t-distribution: a) One sample t-tests for population mean b) Two sample t-tests for equality of population means c) Paired t test 2.5 Numerical examples	
III	**Tests based on chi-square distribution:** 3.1 Concept and working of test for independence of two attributes arranged in $r \times s$ contingency table. 3.2 Concept and working of test of significance of population variance i) mean is known, ii) mean is unknown. 3.3 Numerical examples	**[06]**
	Reference: 1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), *Fundamentals of Statistics, Vol. 2*, World Press, Kolkata. 2. Gupta, S. C. and Kapoor, V. K. (2002), *Fundamentals of Mathematical Statistics,* (*Eleventh Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 . 3. Gupta, S. C. and Kapoor V. K. (2007), *Fundamentals of Applied Statistics* (*Fourth Edition*), Sultan Chand and Sons, New Delhi. 4. Gupta, S. P. (2002), *Statistical Methods* (*Thirty First Edition*), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002. 5. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), *Introduction to Mathematical Statistics (Tenth Impression*), Pearson Prentice Hall. 6. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), *Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI*), McGraw - Hill Series G A 276 7. Mukhopadhya Parimal (1999), *Applied Statistics*, New Central Book Agency, Pvt. Ltd. Kolkata 8. Ross, S. (2003), *A first course in probability (Sixth Edition*), Pearson Education publishers, Delhi, India. 9. Walpole R. E., Myers R. H. and Myers S. L. (1985), *Probability and Statistics for Engineers and Scientists (Third Edition, Chapters 4, 5, 6, 8, 10)*, Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022.	

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S.Y. B.Sc. Semester IV		
STS-280	**Statistical Quality Control -II (VSC - Theory)**	**Credits : 02 Hours : 30**
	Course Outcomes (COs) On completion of the course, the students will be able to:	**Bloom's Cognitive Level**
CO1	Recall the concepts of specification limits, sampling inspection plans and basic principles of charts for monitoring the process mean.	**1**
CO2	Understand the philosophy and the basic concept of quality improvement.	**2**
CO3	Apply the various techniques of capability studies, acceptance sampling and CUSUM and EWMA control charts to realistic examples.	**3**
CO4	Analyze real life situations to apply single, double sampling plans and CUSUM and EWMA control charts	**4**
CO5	Determine the shift in the process average, relationship between C_p and C_{pk} Also comparison between Single and Double sampling plans	**5**
CO6	Design, use, and interpret CUSUM, exponentially weighted moving average control charts.	**6**

Unit No.	Contents	No. of Hours
I	**Capability Studies:** **1.1** Specification limits, natural tolerance limits and their comparisons, decisions based on these comparisons, estimate of percent defective. **1.2** 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 $\bar{X}$ chart, Average Time to Signal (ATS). Operating Characteristic (O.C.) curve for $\bar{X}$ chart, using normality assumption. **1.3** Capability ratio and capability indices (C_p), capability performance indices C_{pk} with respect to machine and process, interpretation, relationship between (i) C_p and C_{pk} (ii) defective	**[06]**

	parts per million and C_p.	
II	**Acceptance of Sampling for Attributes:** **2.1** 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. **2.2 Single Sampling Plan** : Evaluation of probability of acceptance using. (i) Hypergeometric (ii) Binomial (iii) Poisson distributions. Derivation of AOQ and ATI. Graphical determination of AOQL, determination of a single sampling plan by i) lot quality and ii) average quality approaches. Description of Dodge and Roming tables. **2.**3 **Double Sampling Plan** : Evaluation of probability of acceptance using Poisson approximation. Derivation of AOQ, ASN and ATI (with complete inspection of second sample). Graphical determination of AOQL. Comparison of single sampling plan and double sample plan. **2.4** Normal, reduced and tightened inspection.	**[18]**
III	**Cumulative-Sum (Cusum) & Exponentially weighted Moving Average (Ewma) Control Charts:** 3.1 CUSUM Control Chart (basic principles of the chart for monitoring the process mean); 3.2 EWMA control chart (EWMA control chart for monitoring the process mean), design of an EWMA control chart.	**[06]**
	References: 1. Duncan, A.J.: Quality Control and Industrial Statistics, D B. Taraporewalla 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 Hall Pub. 6. Dodge and Roming : Sampling Inspection tables, John Wiley and Sons, Inc. New York. 7. Barlow R. E. and Proschan, Frank: Statistical Theory of Reliability and Life Testing Holt Rinebart and Winston Inc., New York. 8. Sinha S.K. Reliability and Life testing, Second Edition, Wiley Eastern Publishers, New Delhi. 9. Trivedi. R. S.: Probability and Statistics with Reliability and Computer Science Applications, Prentice – Hall of India Pvt. Ltd., New Delhi. 10. S. Zacks: Introduction to Reliability Analysis, Probability Models and Statistical Methods, Springer Verlag. **11.** D. H. Besterfield, C. B. Michna etc. Total Quality Management 3dr edition 2009: Pearson Education, Delhi.	

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S. Y. B. Sc. Semester - IV		
STS-290	**Statistical Computing using R - II (SEC - Theory)**	**Credits : 02 Hours : 30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Recall concepts of sample and population, various sampling methods , unbiased estimator, Define null and alternative hypotheses , describe time series	**1**
CO2	Draw simple random samples from different populations for variables and attributes, Explain basic models of time series and different methods of estimation of trend and seasonal variation	**2**
CO3	Apply commands of R in testing statistical hypotheses. Demonstrate exponential smoothing and autoregressive model fitting technique of time series analysis.	**3**
CO4	Choose a sample of suitable size by using various sampling methods to collect data in day today life, Analyze the real life time series and carry out residual analysis	**4**
CO5	Calculate estimates of unbiased estimators and their standard errors in various sampling methods, Determine an appropriate model to forecast future observations of the time series.	**5**
CO6	Interpret the decision in hypothesis testing, Prepare an appropriate time series model for the given data.	**6**

Unit No.	Contents	No. of hours
I	**Sampling Methods:** 1.1 Generating random samples using SRSWOR and SRSWR Computation of Sample mean ($\bar{y}$) , Verification of sampling distribution of ($\bar{y}$) using R, Computation of Sample proportion (p) , Verification of sampling distribution of p using R Obtaining confidence interval for the population parameters .	**[07]**

	1.2 Estimation of population mean and population total , computation of standard error of these estimates 1.3 Stratified random sampling: Estimation of population mean($\bar{y}_{st}$), population total, computation of standard error of these estimates , using R 1.4 Systematics sampling: Estimation of population mean($\bar{y}_{sys}$), population total, computation of standard error of these estimates using R	
II	**Testing of hypothesis using R:** 2.1 One sample and two sample tests for mean(s) based on normal distribution (population variance σ^2 known and unknown), testing correlation coefficient using Fisher's z transformation, 2.2 One sample and two sample tests for population proportion 2.3 Tests based on t-distribution: a. One sample t-tests for population mean b. Two sample t-tests for equality of population means c. Paired t test 2.4 Test of equality of two population variances based on F distribution: when i) means are known, ii) means are unknown 2.5 Confidence intervals for population mean and difference of two population means 2.6 Chi-square test for independence of two attributes	**[06]**
III	**Time Series Analysis** : 3.1 Meaning of Time Series, Various components of a time series (Explanation and illustrations of each component) . Additive and Multiplicative methods for analysis of time series . 3.2 Methods of estimating trend: (i) Freehand or Graphical method (ii) Method of semi-averages (iii) Method of moving averages (iv) Method of least squares 3.3 Methods of estimating seasonal components (i) Methods of averages (ii) Ratio to trend obtained by moving averages (iii) Ratio to trend by least square method (iv) Link Relative Method 3.4 Decomposition of Time series using R 3.5 Residual analysis Using R 3.6 Single double and triple Exponential smoothing and also using R	**[17]**

	3.7 Stationarity of time series , auto regressive and moving average models and also using R	
	References: 1. M.M. Desu and D. Raghavarao (1990) : Sample Size Methodology, Academic Press, New York 2. Mukhopadhyay P (2008): Sampling theory and methods of survey sampling. Prentice-Hall of India, New Delhi. 3. Sarjinder Singh (2003) : Advanced Sampling theory with applications, Kluwer Academic publishers. 4. Singh, D. and Chaudhary, F. S. (2022): Theory and Analysis of Sample Survey Designs, 2nd edn. New Age International. 5. Sukhatme, P.V., Sukhatme, B. V. and Ashok (1984) : Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi 6. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi. 7. Gupta, S. P. (2002), Statistical Methods (31st Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002. 8. Mood, A. M., Graybill F. A. and Bose, F. A. (1974), Introduction to Theory of Statistics (Third Edition, Chapters II, IV, V, VI), McGraw - Hill Series G A 276 9. Mukhopadhya Parimal (1999), Applied Statistics, New Central Book Agency, Pvt. Ltd. Kolkata 10. Walpole R. E., Myers R. H. and Myers S. L. (2007), Probability and Statistics for Engineers and Scientists (8th Edition), Macmillan Publishing Co. Inc. 866, Third Avenue, New York 10022. 11. Weiss N., Introductory Statistics, Pearson education publishers	

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S.Y. B.Sc. Semester IV

CEP-295	Field Project	Credits : 02 Hours : 60

As per the NEP guidelines, the UG students are expected to complete this program in their **fourth semester** from the academic year 2024-25.
2 credits of **Field Project** comprises of the ways of implementing actual field engagement which needs to be determined by respective departments.

	Credit	**Student learning Hours**	**Course component**
Sem IV	2	60 hrs.	Exclusively Field Project

Community Engagement - Field Project [Credits-2]	
Foundations of Field Work (1 credit)	
Topics Covered	**Activities**
Field visits, Field work Reflection and Analysis	- Reflective journals on field experiences - Group presentations
Community Impact Assessment	- Methods for assessing project impact - Group project: Conduct impact assessment in a chosencommunity
Advanced Field Work (1 credit)	
Topics Covered	**Activities**
Field Work, Project Presentation Review and Integration	- Review of key concepts from previous credits - Integration of community engagement and fieldwork principles - Analysis - Submission of CEP/FP project report

Evaluation :

Evaluate each student for 50 marks per semester at department level –

20 marks for Continuous evaluation (CE)

- Progress report on project implementation. (Field diary)

30 marks for End Semester Examination (ESE)

- Project Report
- Final presentation of field project findings assessing project outcomes andreflections.

UGC Recommended field-based activities:

1. Interaction with Self Help Groups (SHGs) women members, and study their functions and challenges; planning for their skill-building and livelihood activities;
2. Visit Mahatma Gandhi National. Rural Employment Guarantee Act 2005 (MGNREGS) project sites, interact with beneficiaries and interview functionaries at the work site;
3. Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solvingmeasures;
4. Conduct Mission Antyodaya surveys to support under Gram Panchayat DevelopmentPlan (GPDP);
5. Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization;
6. Visit Rural Schools/mid-day meal centres, study academic and infrastructural resources, digital divide and gaps;
7. Participate in Gram Sabha meetings, and study community participation;
8. Associate with Social audit exercises at the Gram Panchayat level, and interact withprogramme beneficiaries;
9. Visit to local Nagarpalika office and review schemes for urban informal workers andmigrants;
10. Attend Parent Teacher Association meetings, and interview school drop outs;
11. Visit local Anganwadi Centre and observe the services being provided;
12. Visit local NGOs, civil society organisations and interact with their staff and beneficiaries;
13. Organize awareness programmes, health camps, Disability camps and cleanliness camps;
14. Conduct soil health test, drinking water analysis, energy use and fuel efficiency surveysand building solar powered village;
15. Raise understanding of people's impacts of climate change, building up community's disaster preparedness;
16. Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers, promotion of traditional species of crops and plants andawareness against stubble burning;
17. Formation of committees for common property resource

	management, village pond maintenance and fishing; 18. Identifying the small business ideas (handloom, handicaraft, khadi, food products, etc.)for rural areas to make the people self reliant. 19. Any other Community engagement activity with approval of BOS and Academic Council. (Note that every department can also find CEP allied with their subject.)

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S. Y. B. A. Semester IV		
STS-269	**Continuous Univariate Distributions and Applications of Statistics (Minor - Theory)**	**Credits : 02 Hours :30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's Cognitive Level**
CO1	Define vital statistics and identify continuous univariate random variable, distribution function and its properties.	**1**
CO2	Compute probability of different events based on continuous probability distributions.	**2**
CO3	Illustrate some special continuous probability distributions, and their properties to real life situations.	**3**
CO4	Analyze the time series by estimating seasonal indices.	**4**
CO5	Evaluate partial regression coefficients, multiple and partial correlation coefficients.	**5**
CO6	Formulate the theory of time series and demographic ratios, mortality and fertility rates.	**6**

Unit No.	Contents	No. of Hours
I	**Continuous Univariate Distributions:** 1.1 Definition of continuous sample space, definition of continuous type of r.v. through p.d.f., Definition of distribution function of continuous type r.v. Statement of properties of distribution function of continuous type r.v.s 1.2 Exponential Distribution: Probability density function (p. d. f.) $f(x) = \begin{cases} \alpha e^{-\alpha x} & x > 0 , \alpha > 0 \\ 0 & \text{otherwise} \end{cases}$ Notation : $X \sim Exp(\alpha)$ Statement of mean and variance, Statement of lack of memory property 1.3 Normal distribution p.d.f. $f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(x-\mu)^2\right)$, $-\infty < x < \infty$, $-\infty < \mu < \infty$; $\sigma > 0$ Notation: $X \sim N(\mu, \sigma^2)$ Standard normal distribution, statement of properties of normal distribution, the graph of p.d.f, nature of probability curve Statement of additive property, Computation of probabilities	**[08]**
II	**Multiple Regression Plane, Multiple and Partial Correlation**	**[09]**

	Coefficient (using tri-variate data): 2.1 Notion of multiple regression plane 2.2 Given total coefficients of correlation and standard deviations, fitting of regression plane by the method of least squares (statement only) and finding estimated values 2.3 Given sums, sums of squares and sum of squares of deviations from respective mean etc. fitting of regression plane, and estimated values by the method of least squares and finding the estimated values 2.4 Notion of multiple correlation coefficient $R_{Y.X_1X_2}$ partial correlation coefficient $r_{YX_1.X_2}$ and its computations	
III	**Time Series:** 3.1 Meaning and usefulness of time series analysis 3.2 Components of a time series: trend, seasonal, cyclical and irregular variations 3.3 Additive and Multiplicative Models 3.4 Methods of estimating seasonal components (i) Methods of averages (ii) Ratio to trend obtained by moving averages (iii) Ratio to trend by least square method (iv) Link Relative	**[07]**
IV	**Elements of Demography** 4.1 Introduction, need of vital statistics. Methods of collecting vital Statistics 4.2 Demographic Ratios 4.3 Mortality Rates: Crude Death Rate(CDR), Standardized Death Rate (STDR) 4.4 Fertility and Reproduction Rates: Crude Birth Rate (CBR), General Fertility Rate(GFR), Age-specific Fertility Rate(ASFR).Total Fertility Rate(TFR), Gross Reproduction Rate(GRR), Net Reproduction Rate(NRR) 4.5 Examples and problems	**[06]**
	References: **1.** Asthana B.N. and Srivastava S.S, Applied Statistics of India Srivastava **2.** Brockwell P.J.and Davis R.A. : Introduction to Time Series and Forecasting (Second Edition), Springer Texts in Statistics **3.** Chatfield C.: The Analysis of Time Series An Introduction, Chapman and Hall / CRC, Texts in Statistical Science **4.** Goon,Gupta, Das Gupta, Fundamental of Statistics,Vol.II Shripati Bhattachrjee for the World Press Pvt. Ltd,Calcutta World Press Pvt. Ltd,Calcutta **5.** Gupta S.C Kapoor, V.K., Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi **6.** Lipschutz, Probability and Statistics, Schaum's Outline, Series, New York **7.** Walpole,Myres, Probability and Statistics, Mcmillan Publishing Co. New York	

S. Y. B. Sc. (Computer Science) Semester IV		
STS-265	**Statistical Methods - II (Minor – Theory)**	**Credits : 02 Hours :30**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Define various continuous probability distributions and outline the properties of probability density functions, cumulative distribution functions.	**1**
CO2	Explain basic models of time series and different methods of estimation of trend and seasonal variation.	**2**
CO3	Demonstrate the significance of the distributions and identify the real -life situations for probability distributions.	**3**
CO4	Relate the probability distributions to real life situations.	**4**
CO5	Determine an appropriate model to forecast future observations of the time series.	**5**
CO6	Build an appropriate time series model for the given data.	**6**

Unit No.	Contents	No. of hours
I	**Continuous Random Variable** 1.1 Definition of continuous random variable (r.v.), Probability density function (p.d.f.), Cumulative distribution function (c.d.f.), its properties, 1.2 Calculation of mean, mode, median, variance, standard deviation for continuous r. v. Numerical problems related to real life situations.	**[04]**
II	**Standard Continuous Probability Distributions** 2.1 Uniform Distribution: statement of p.d.f., mean, variance, nature of probability curve, 2.2 Exponential Distribution: statement of p.d.f. of the form $f(x) = \frac{1}{\theta} e^{\frac{-x}{\theta}}$ mean, variance, nature of probability curve, lack of memory property, 2.3 Normal Distribution: statement of p.d.f., identification of parameters, nature of probability density curve, standard normal distribution, symmetry, distribution of aX+b, aX+bY+c where X and Y are independent normal variables, computations of probabilities using normal probability table, normal approximation to binomial and Poisson distribution, central limit theorem (statement only), normal probability plot,	**[15]**

	2.4 Pareto Distribution: p.d.f., mean, variance, applications, Numerical problems related to real life situations.	
III	**Time Series** 3.1 Meaning and Utility, Components of Time Series, Additive and Multiplicative models, 3.2 Methods of estimating trend: moving average method, least squares method and exponential smoothing method, 3.3 Elimination of trend using additive and multiplicative models, 3.4 Measurement and estimation of seasonal variations using link relative method and ratio to trend method, 3.5 Simple time series models: AR (1), AR (2), Numerical problems related to real life situations.	**[11]**
	References: 1. Statistical Methods, G.W. Snedecor, W.G. Cochran, John Wiley & sons, 1989. 2. Fundamentals of Applied Statistics (4th Edition), Gupta and Kapoor, S. Chand and Sons, New Delhi, 2014. 3. Modern Elementary Statistics, Freund J.E., Pearson Publication, 2005. 4. A First course in Probability 6th Edition, Ross, Pearson Publication, 2006.	

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S. Y. B. Sc. (Computer Science) Semester IV		
STS-266	**Statistics Practical-4 (Minor - Practical)**	**Credits : 02 Hours : 60**
Course Outcomes (COs) On completion of the course, the students will be able to:		**Bloom's cognitive level**
CO1	Identify different real-life situations to find probability of different continuous distributions.	**1**
CO2	Discuss various applications of statistical measures using R software.	**2**
CO3	Execute the computational techniques using R software.	**3**
CO4	Analyze different concepts of statistics using R software.	**4**
CO5	Validate the fundamental knowledge and represent using R software.	**5**
CO6	Build models of time series and different methods of estimation of trend and seasonal variation.	**6**

Sr. No.	Title of the Experiment
1	Continuous probability theory
2	Applications of Uniform distribution
3	Applications of Exponential distribution
4	Applications of Normal distribution
5	Fitting of Normal distribution
6	Model sampling from continuous probability distributions
7	Computations of probabilities using R-I (Uniform)
8	Computations of probabilities using R-II(Exponential)
9	Computations of probabilities using R-III(Normal)
10	Time Series I (Measurement of trend)
11	Time Series II (Measurement of seasonal variations)
12	Time Series III (Autoregressive models)
13,14&15	Applications of Statistical techniques to real-life data.

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