Savitribai Phule Pune University

(Formerly University of Pune)

S. Y. B. Sc. / S. Y. B. A. Statistics Syllabi in NEP

(Level 5.0)

National Education Policy Syllabus

To be implemented from Academic Year 2025-2026

Title of the program: S. Y. B. Sc. / S. Y. B. A. Statistics

Students who have Statistics as one of the major subject at first year of the three year course can offer Statistics as the major subject or minor subject in the second year of under graduation.

At **second year of under-graduation,** students are expected to study various probability distributions and its applications to real life situations. It is a foundation for further theory. An important branch of Statistics, viz. testing of hypotheses related to mean, variance, proportion, correlation etc. will be introduced. Some topics related to applications of Statistics will also be introduced. Further the students are expected to start using statistical software *R* and verify the computations during practical. It is a skill-oriented part of the course.

Course Implementation criteria for Theory and Practical:

a. Each semester comprises of 15 weeks (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).

b. One Credit of the Theory is equal to15 clock hours (Teaching 1 hour per week for each credit, 12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.

c. One Credit of Practical = 30 clock hours. (2 Contact hours per credit per week) One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for journal competition, and Continuous Internal Evaluation of each practical).

d. Practical for each course comprises of 02 Credits = 60 clock hours. Therefore,

- Minimum 12 laboratory/ Filed sessions of 04 clock hours must be conducted in one semester.
- Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.
- For regular practical, 1 Batch = 15 students.

Examination Pattern (For each Semester):

- The examinations will be conducted semester wise for both Theory as well as Practical courses for S. Y. B. Sc. NEP-2020
- Theory Papers are of 02 Credits –
  Internal Exam (20 M) + University Theory Exam (30 M) = Total 50 M
  Duration: For Internal exam = 40 Min. and For University Exam = 02 hours.

- Practical Papers are of 2 Credits –

  Internal Evaluation (20 M) + University Practical Exam (30 M) = Total 50 M

  Duration: For Internal Evaluation = Regular in each practical + internal viva

  For University Exam = 2.40 hours using scientific calculator (In case of MS Excel 2.10 hours).

  Submission of practical records compulsory (Journals).

Note:

1. Students must complete all the practicals to the satisfaction of the teacher concerned.
2. At the time of practical examination, a student must produce the laboratory journal along with the completion certificate signed by the Head of the Department.
3. Structure of evaluation of practical paper at

   a) **Continuous Internal Assessment (CIA) – 20 Marks**

Section		Marks
i)	Journal	10
ii)	Viva-voce	10

   b) End Semester Examination – 30 Marks

   i) Set four questions each of twelve marks.

   ii) Student has to solve any two of these four questions.

   iii) Viva-voce of six marks.

Instruction for Examination

1. The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
2. The practicals are to be conducted in batches as per the University norms for the faculty of Science.
3. Medium of Instruction: English
4. Examination:

   A) Pattern of examination: Semester wise

   B) Standard of passing: As per norms of University.

   C) Each course exam must be of 50 marks – Internal – 20 marks & External – 30 marks.

Statistics as Major (Core) Subject and any other subject as Minor (each theory / practical paper has 2 credits).

Year /Level	Sem	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Lecture/ Practical hours per week
	III	STS-201-MJ	Discrete Probability Distributions	02	02
		STS-202-MJ	Continuous Probability Distributions	02	02
		STS-203-MJP	Statistics Practical–III	02	04
	IV	STS-251-MJ	Test of Significance and Statistical Methods	02	02
		STS-252-MJ	Sampling Distributions and Exact Tests	02	02
		STS-253-MJP	Statistics Practical–IV	02	04

List of Vocational Skill Courses (VSC):

Year / Level	Sem	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Practical hours per week/ Batch
II 5.0/200	III	STS-221-VSCP	Statistical Computing using MS-EXCEL – I (Practical Course)	02	04
	IV	STS-271-VSCP	Statistical Computing using MS-EXCEL – II (Practical Course)	02	04

Field Project (FP) / On Job Training (OJT)/ Community Engagement Project (CEP):

Year / Level	Sem.	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Lecture/Practical hours per week
II 5.0/200	III	STS-231-FP	Field Project	02	
	IV	STS-281-CEP	Community Engagement Project	02	

Statistics as Minor Subject and any other subject as Major (each theory / practical paper has 2 credits)

Year /Level	Sem	Code Number	Title of the paper (Theory /Practical)	Credits allotted	Lecture/Practical hours per week
II 5.0/200	III	STS-241-MN	Probability Distributions and Demography	02	02
		STS-242-MNP	Statistics Practical on Probability Distributions and Demography	02	04
	IV	STS-291-MN	Sampling Distributions & Statistical Inference	02	02
		STS-292-MNP	Practical on Sampling Distributions and Statistical Inference	02	04

List of Generic / Open Electives (OE):

Year / Level	Sem	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Lecture/Practical hours per week
II 5.0/200	**III**	OE-201-STS OE-202-STS	Business Statistics - I **OR** Applied Statistics - I	**02** **02**	**02** **02**
	IV	OE-251-STS OE-252-STS	Business Statistics – II **OR** Applied Statistics - II	**02** **02**	**02** **02**

List of Skill Enhancement Courses (SEC):

Year / Level	Sem	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Lecture/Practical hours per week
II 5.0/200	**IV**	SECP-251-STS	Descriptive Statistics using R-software (Practical Course)	**02**	**04**

Indian Knowledge System (IKS):

Year / Level	Sem	Code Number	Title of the paper (Theory / Practical)	Credits allotted	Lecture/Practical hours per week
II 5.0/200	**III**	STS-201-IKS	Development of Statistics in India	**02**	**02**

Equivalence from old courses (2019 pattern) (from 2020-21) with new courses (NEP 2020 pattern) (w. e. f. 2025-26) in Statistics

Semester III	
ST-231: Discrete Probability Distributions And Time Series	STS-201-MJ: Discrete Probability Distributions
ST-232: Continuous Probability Distributions	STS-202-MJ: Continuous Probability Distributions
ST-233: Statistics Practical	STS-203-MJP: Statistics Practical - III
Semester IV	
ST-241:Tests of Significance and Statistical Methods	STS-251-MJ: Test of Significance and Statistical Methods
ST-242: Sampling Distributions and exact tests	STS-252 – MJ: Sampling Distribution and Exact Test
ST-243: Statistics Practical	STS-253-MJP: Statistics Practical -IV

Semester III

Paper Code and Title: STS-201-MJ: Discrete Probability Distributions

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcome

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

1. Obtain the moments, moments generating functions, cumulant generating function for the bivariate random variable,
2. Compute the conditional expectation, independence, correlation between two variables,
3. Identify the different discrete probability distributions,
4. Calculate the parameters of the different distributions and solve the problems related to the different distributions.

Unit No.	Content	No. of Hours
1	**Mathematical Expectation (Bivariate Random Variable)** 1.1 Definition of raw and central moments, moment generating function (m.g.f), cumulant generating function (c.g.f.). 1.2 Theorems on expectations of sum and product of two jointly distributed random variables. 1.3 Conditional expectation. 1.4 Definitions of conditional mean and conditional variance. 1.5 Definition of covariance, coefficient of correlation, independence and uncorrelatedness of two variables. 1.6 Variance of linear combination of variables Var(aX + bY). 1.7 Numerical examples	**08**
2	**Poisson distribution** 2.1 Notation: X ~ P(m) Probability mass function (p. m. f.) of the distribution $$P(X=x)=\begin{cases}\frac{e^{-m}m^{x}}{x!}; x=0,1,2,\ldots; m>0\\ 0; \quad otherwise\end{cases}$$ 2.2 M. G. F. and C. G. F. Raw and central moments, mean and variance from M.G.F. & C.G.F. Skewness and kurtosis. 2.4 Situations where this distribution is applicable. 2.5 Additive property. 2.6 Conditional distribution of X given (X+Y).	06

2.7 Numerical examples

3 **Geometric distribution** **04**

3.1 Notation: X ~ G(p), Geometric distribution on support (0, 1, 2, ...,) with p. m. f. $p(x) = pq^x$.

3.2 Geometric distribution on support (1, 2,. . .) with p. m. f. $p(x) = pq^{x-1}$. $0 < p < 1$, $q = 1 - p$.

3.3 Situations where this distribution is applicable.

3.4 Distribution function and lack of memory property.

3.5 M. G. F. and C. G. F. Mean and variance from M.G.F. & C.G.F.

3.6 Numerical examples.

4 **Negative Binomial Distribution** **05**

4.1 Probability mass function (p. m. f.)

$$P(X = x) = \begin{cases} \binom{x+k-1}{x} p^k q^x & ; x = 0, 1, \ldots ; 0 < p < 1; q = 1 - p; k > 0 \\ 0; Otherwise \end{cases}$$

Notation X ~ NB(k,p)

4.2 Graphical nature of p.m.f.,

4.3 Negative binomial distribution as a waiting time distribution,

4.4 M. G. F. and C. G. F. Mean and variance from M.G.F. & C.G.F. Skewness, kurtosis.

4.5 Additive property.

4.6 Relation between geometric distribution and negative binomial distribution.

4.7 Poisson approximation to negative binomial distribution. Real life situations.

4.8 Numerical problems.

5 **Multinomial Distribution** **07**

5.1 Probability mass function (p.m.f.)

$$P(X = x) = \frac{n!\, {p_1}^{x_1} {p_2}^{x_2} \ldots {p_k}^{x_k}}{x_1!\, x_2! \ldots x_k!} \; ; \; x_i = 0, 1, \; ., n - \sum_{r=1}^{i-1} x_r; \; x_1 + x_2 + \ldots + x_k = n$$

$$0 < p_i < 1; i = 1, 2, \ldots, k; p_1 + p_2 + \ldots + p_k = 1$$

= 0; otherwise

Notations:

$(X_1, X_2, \ldots, X_k) \sim MD(n, p_1, p_2, \ldots, p_k)$

$\underline{X} \sim MD\left(n, \underline{p}\right) where\ \underline{X} = (X_1, X_2, \ldots, X_k)\ \&\ \underline{p} = (p_1, p_2, \ldots, p_k)$

5.2 Joint MGF of $(X_1, X_2, \ldots, X_k)$. Mean, variance, covariance, total correlation coefficient, variance – covariance matrix from joint MGF. Rank of variance – covariance matrix and its interpretation,

5.3 Additive property.

5.4 Univariate marginal distribution, distribution of $X_i + X_j$,

5.5 Conditional distribution of X_i given $X_j = r$ (without proof).

5.6 Conditional distribution of X_i given $X_i + X_j = r$ (without proof).

5. 7 Numerical problems.

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .

2. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.

3. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.

4. Meyer, P. L.(2017), Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

5. 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

6. Weiss N.(2017), Introductory Statistics, Pearson education publishers.

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Paper Code and Title: STS-202-MJ: Continuous Probability Distributions

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcome

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

1. Understand the concept of continuous univariate distribution,
2. Obtain the moments, moments generating function, cumulant generating function and other terms related to the continuous univariate distribution,
3. Compute the moments, moments generating function, cumulant generating function and other terms related to the continuous bivariate distribution,
4. Identify and solve the problems related to different continuous univariate distribution.

Unit No.	Content	No. of Hours
1	**Continuous Univariate Distributions** 1.1 Continuous sample space: Definition, illustrations. Continuous random variable: Definition, probability density function (p. d. f.), cumulative distribution function (c. d. f.), properties of c. 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)], mean, variance, geometric mean, harmonic mean, raw and central moments. 1.3 Moment generating function (MGF): Definition, properties (without proof). Cumulant generating function (CGF): Definition, properties (without proof). 1.4 Mode, partition values: quartiles (Q_1, Q_2, Q_3), deciles, percentiles. 1.5 Probability distribution of function of 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|. iii) M.G.F. of g(X)	08
2	**Continuous Bivariate Distributions** 2.1 Continuous bivariate random vector or variable (X, Y): Joint p. d. f., joint c. d. f, properties (without proof), probabilities of events related to random variables (events in terms of regions bounded by regular curves, circles, straight lines). Marginal and conditional distributions. 2.2 Expectation of r. v. (X, Y), expectation of function of r. v. E[g(X, Y)], joint moments, Cov(X,Y), Corr(X,Y), conditional mean, conditional variance, regression as a conditional expectation. 2.3 Independence of random variables X and Y. 2.4 Theorems on expectation:	07

i) E(X+Y) = E(X) + E(Y)

ii) E(XY) = E(X)E(Y) if X and Y are independent.

iii) E(aX + bY + c) & Var(aX + bY + c) (statement only proof not expected)

2.5 Moment generating function (MGF): $M_{XY}(t_1, t_2)$, MGF of marginal distribution of random variables(r.v.s.), 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) $M_{X+Y}(t) = M_X(t)\, M_Y(t)$ if X and Y are independent r.v.s.

2.6 Probability distribution of transformation of bivariate r. v.

2.7 Numerical Examples

3 Standard Univariate Continuous Distributions

3.1 Uniform or Rectangular Distribution **03**

3.1.1 Probability density function (p.d.f.)

$$f(x) = \begin{cases} \frac{1}{b-a}, a \le x \le b \\ 0, \quad otherwise \end{cases}$$

Notation : X ~ U[a, b],

3.1.2 Sketch of p. d. f., c. d. f., mean, variance, symmetry, MGF.

3.1.3 Distributions of

i) $\frac{x-a}{b-a}$, ii) $\frac{b-x}{b-a}$, iii) Y = F(X) where F(X) is the c. d. f. of continuous r. v.

3.1.4 Application of the result to model sampling.

(Distributions of X + Y, X–Y, XY and X/Y are not expected.)

3.2 Normal Distribution **08**

3.2.1. Probability density function (p. d. f.)

$$f(x) = \begin{cases} \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}; \ -\infty < x < \infty, -\infty < \mu < \infty, \sigma > 0 \\ 0; otherwise \end{cases}$$

Notation: X ~ N(μ, σ^2)

3.2.2 p. d. f. curve, identification of scale and location parameters, properties of probability curve, mean, variance, MGF, CGF, central moments, mode, points of inflexion of probability curve, mean deviation, additive property.

3.2.3 Probability distribution of :

i) $\left(\frac{x-\mu}{\sigma}\right)$,standard normal variable (S.N.V.),

ii) aX + b,

iii) aX + bY +c, where X and Y are independent normal variates. Probability distribution of $\bar{X}$, the mean of n i.i.d. N(μ, σ^2) r. v s., computations of normal probabilities using normal probability integral tables.

3.2.4 Central limit theorem (CLT) for r.v.s. with finite positive variance (statement only), its illustration for Poisson and Binomial distributions.(Box-Muller transformation and normal probability plot to be covered in practicals) **04**

3.3 Exponential Distribution

3.3.1 Probability density function (p. d. f.)

$$f(x) = \begin{cases} \alpha e^{-\alpha x}; x \geq 0, \alpha > 0 \\ 0; otherwise \end{cases}$$

Notation : X ~ Exp(α)

3.3.2 Nature of density curve, interpretation of α as a interarrival rate of customers joining the queue and $\frac{1}{\alpha}$ as mean, mean, variance, MGF, CGF, c.d.f., lack of memory property, distribution of sum of two i.i.d exponential random variables.

3.4 Numerical Examples

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .

2. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.

3. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.

4. Meyer, P. L.(2017), Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

5. 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

6. Weiss N.(2017), Introductory Statistics, Pearson education publishers.

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Paper Code and Title: STS-203-MJP: Statistics Practical III

Course type- Practical **No. of credits – 2** **No. of contact hours – 60 (48+12)**

Course Outcome

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

1. Fit various discrete probability distributions and to study various real life situations.
2. Fit various continuous probability distributions and to study various real-life situations.
3. Identify the appropriate probability model that can be used in real life.
4. Use simulation technique for generation of data using uniform, exponential and normal distribution.

List of Experiments

Expt. No.	Title of the Experiment	No. of Experiments
1	Problems based on bivariate Discrete Probability Distribution	1
2	Problems based on bivariate Continuous Probability Distribution	1
3	Applications of Poisson distribution.	1
4	Applications of Geometric distribution	1
5	Applications of Multinomial & Negative Binomial distribution	1
6	Applications of uniform & exponential distribution	1
7	Applications of normal distribution	1
8	Fitting of Poisson distribution and computation of expected frequencies.	1
9	Fitting of negative binomial distribution and computation of expected frequencies.	1
10	Fitting of normal distribution and computation of expected frequencies.	1
11	Model sampling from uniform & exponential distribution using distribution function	1
12	Model sampling from normal distribution using (i) distribution function, (ii) Box-Muller transformation.	1

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Vocational Skill Course

Paper Code and Title: STS-221- VSCP: Statistical Computing Using MS EXCEL-I

Course type- Practical No. of credits – 2 No. of contact hours – 60 (48+12)

Course Outcome

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

1. Fit various discrete probability distributions and to study various real life situations.
2. Fit various continuous probability distributions and to study various real life situations.
3. Identify the appropriate probability model that can be used in real life.
4. Use simulation technique for generation of data using uniform, exponential and normal distribution.

List of the Experiments

Expt. No.	Title of the Experiment	No. of Experiments
1	Fitting of Binomial distribution and computation of expected frequency	1
2	Fitting of Poisson distribution and computation of expected frequency	1
3	Fitting of Negative Binomial distribution and computation of expected frequency	1
4	Fitting of Normal distribution and computation of expected frequency	1
5	Computation of probability values for discrete distributions	1
6	Computation of probability values for continuous distributions	1
7	Tracing of p. m. f. curve for Discrete Distributions	1
8	Tracing of density curve for Continuous Distributions	1
9	Model sampling from Exponential Distribution using distribution function	1
10	Model sampling from Normal Distribution using i) distribution function ii) Box Muller transformation	2
11	Data Collection by students in groups of maximum 6 students.	1

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Field Project (FP)

Paper Code and Title: STS-231-FP: Field Project

Course type: Practical **No. of Credits: 2** **No. of Contact Hours: 60 (48+12)**

Course Outcome

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

1. Foster ability to work in team.
2. Align the classroom terms of theory in field data.
3. Apply the formulae and methods for the real data.
4. Develop social awareness and human values among students.

Instructions:

Field Projects must be clearly identified at the beginning of the term, with detailed information about date, time, locations, means of transportation, and any fees for which the student is responsible.

Student has to submit a report based Field Projects and it will be evaluated for credit requirements. The project report prepared by the student is considered as the output of Field Projects. The Comprehensive Project report based on Field Projects carries 02 credits, and carries 50 marks, divided into two parameters: Internal Evaluation (20 Marks) External Evaluation (30 Marks). The report based on it shall be evaluated by two examiners one internal and one external (Subject Expert from Outside College). A Viva voce must be conducted by the panel consisting of Internal Examiner and External Examiner.

Internal Evaluation 20 Marks	Area or topic Selection Regular Evaluation / follow up of field work	10 Marks 10 Marks
External Evaluation 30 Marks	Project Report Log book or record book Viva-voce	10 Marks 10 Marks 10 Marks

Note:

1. Batch size – 15 students/batch/faculty member.
2. Work Hours – 4 hours/week

Rules for Project Field Work:

1. **Group Formation and Size:**
   Students will be allocated project work in groups based on the subject. The group size should be determined by the nature and requirements of the project, with a minimum of 4 students and a maximum of 6 students per group.
2. **Field Work Requirement:**
   Each group must complete 7 full days or 15 days of part-time fieldwork. If the fieldwork is conducted at a recognized institution, the group must provide a certificate or evidence of completion (such as photographs) in the report.
3. **Project Report Submission:**
   The project report must be a minimum of 5,000 words and in printed format. The report should include charts, graphs, photographs, and other relevant materials as needed for the project.
4. **Role and Responsibility:**
   The project methodology section of the report must clearly outline the roles and responsibilities of each group member involved in the project.
5. **Originality of Work:**
   The project work must be original and not copied. Students are required to complete the project based on their own resources and discretion. Along with the report, the student(s) must submit a certificate affirming that the project work is entirely their own original work.

Statistics as Minor Subject and any other subject as Major
(Each theory / practical paper has 2 credits)
Paper Code and Title: STS-241-MN: Probability Distributions and Demography

Course type- Theory No. of credits – 2 No. of contact hours - 30

Course outcomes:

At the end of this course, students are able to:

1. Understand about continuous univariate and bivariate random variables, their expectation, variance, higher order moments and their properties.
2. Get the knowledge of different standard discrete and continuous distributions.
3. Identify various applications of these distributions in real life.
4. Simulate random samples from standard continuous distributions.

Unit No.	Content	No. of Hours
1	**Standard Discrete Probability Distributions** 1.1 Poisson distribution- p.m.f., mean, variance, mode, real life situations where it is applicable, statement of additive property, statement of limiting case of B(n, p). (Consider only statements of above terms, proofs are not expected) 1.2 Geometric distribution-p.m.f., mean, variance, mode, real life situations where it is applicable. Statement of lack of memory property. (Consider only statements of above terms, proofs are not expected) 1.3 Negative binomial distribution-p.m.f., mean, variance, real life situations where it is applicable. Relation with geometric distribution, concept of waiting time distribution. (Consider only statements of above terms, proofs are not expected) 1.4 Numerical Examples	10
2	**Continuous Univariate Distributions** 2.1 Continuous sample space: Definition, illustrations. Continuous random variable: Definition, probability density function (p.d.f.), cumulative distribution function (c.d.f.), properties of c.d.f. (without proof) 2.2 Mathematical expectation, variance, quartiles and quartile deviation. 2.3 Moment generating function (MGF), Cumulant generating function (CGF): Definition, properties (without proof). 2.4 Numerical Examples	05
3	**Standard Continuous Probability Distributions** 3.1 Uniform distribution- statements of p.d.f., c.d.f., mean, variance, nature of p.d.f. curve. Normal distribution- statement of p.d.f., c.d.f., mean, variance, median, mode, nature of p.d.f. curve, statement of additive property, skewness. Standard normal distribution.	10

3.2 Exponential distribution- statement of p.d.f., c.d.f., mean, variance, nature of p.d.f.

3.3 Numerical Examples

4 Demography **05**

4.1 Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.

4.2 Death/Mortality rates: Crude death rate, specific (age, sex etc.) death rate, standardized death rate (direct and indirect), infant mortality rate.

4.3 Fertility/Birth rate: Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.

4.4 Growth/Reproduction rates: Gross reproduction rate, net reproduction rate. (Simple Numerical examples only).

4.5 Interpretations of different rates, uses and applications.

4.6 Numerical Examples

References

1. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
2. 4. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi , 110002 .
3. Hogg, R. V. and Craig, A. T. , Mckean J. W. (2012), Introduction to Mathematical Statistics (Tenth Impression), Pearson Prentice Hall.
4. Kulkarni, M. B., Ghatpande, S. B. and Gore, S. D. (1999), Common Statistical Tests, Satyajeet Prakashan, Pune 411029
5. Medhi, J. (2006), Statistical Methods, Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi – 110002.
6. Meyer, P. L.(2017), Introductory Probability and Statistical Applications, Oxford and IBH Publishing Co. New Delhi.

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Paper Code and Title: STS-242-MNP: Statistics Practical on Probability Distributions and Demography

Course type- Practical **No. of credits – 2** **No. of contact hours: 60(48+12)**

Course Outcomes:

At the end of this course, students will be able to:

1) Fit a suitable continuous probability distributions to the data.
2) Identify the suitable probability model for the population.
3) Generate random samples from the continuous probability distributions.
4) Understand and compute demographic measures.

Expt. No.	Title of the Experiment	No. of Experiments
1	Applications of Poisson distribution.	1
2	Fitting of Poisson distribution.	1
3	Application of geometric distribution.	1
4	Application of negative binomial distribution.	1
5	Fitting of negative binomial distribution.	1
6	Applications of normal distribution.	1
7	Application of exponential distribution.	1
8	Fitting of normal distribution and computation of expected frequencies.	1
9	Model sampling from exponential distribution using distribution function.	1
10	Generating random samples from normal distribution using distribution function	1
11	Computation of CDR, SDR, STDR.	1
12	Computations of GRR and NRR.	1

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Generic / Open Electives (GE/OE)

Paper Code and Title: OE-201-STS: Business Statistics – I

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcomes:

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

1. Understand the use of time series in real life situations.
2. Identify the different components of time series and use it for prediction purpose.
3. Calculate different mortality rates, fertility rates and growth rates.
4. Interpreted the demographic measures

Unit No.	Content	No. of Hours
1	**Time Series** 1.1 Meaning and utility 1.2 Visualization of Time series 1.3 Components of time series 1.4 Additive and multiplicative models 1.5 Methods of estimating trend using moving average method (3,4 and 5 yearly cycle)	**09**
2	**Theory of Attributes** 2.1 Attributes: Concept of a Likert scale, classification, notion of manifold classification, dichotomy, class- frequency, order of a class, positive class- frequency, negative class frequency, ultimate class frequency, relationship among different class frequencies (up to two attributes), and dot operator to find the relation between frequencies, fundamental set of class frequencies. 2.2 Consistency of data up to 2 attributes. 2.3 Concepts of independence and association of two attributes. Yule's coefficient of association (Q), $-1 \leq Q \leq 1$, interpretation.	**12**
3	**Demography:** 3.1 Vital events, vital statistics, methods of obtaining vital statistics, rates of vital events, sex ratios, dependency ratio.	**09**

3.2 Death/Mortality rates: Crude death rate, infant mortality rate.

3.3 Fertility/Birth rate: Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.

3.4 Growth/Reproduction rates: Gross reproduction rate, net reproduction rate.

3.5 Interpretations of different rates, uses and applications. 3.6 Trends in vital rates as revealed in the latest census.

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002 .
2. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
3. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
4. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
5. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.
6. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
7. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, 7th edition, Wiley India Pvt. Ltd.

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Paper Code and Title: OE-202-STS: Applied Statistics - I

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcomes:

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

1. Arrange the data in proper understandable tabular form.
2. Visualize the data for better understanding.
3. Learn descriptive statistics measures and apply them to real data.
4. Calculate and describe data through measures of central tendency.
5. Interpret the measures of dispersion to compare groups.

Unit No.	Content	No. of Hours
1	**Tabulation** 1.1 Raw data, types of characteristics of data (Attribute and variable), Type of variables (Discrete and continuous) 1.2 Construction of frequency distribution table: parts of table, two way and three-way types of tabulations	**05**
2	**Graphical and diagrammatic representation of the data** 2.1 Diagrammatic representation of the data: Bar plot, Subdivided, Multiple, Pie chart 2.2 Graphs- Histogram, frequency curve, less than and more than ogive curves	**05**
3	**Measures of Central Tendency** 3.1 Requisition of good measure of central tendency 3.2 mean, (definitions, formulae, merits and demerits, examples) 3.3 median (definitions, formulae, merits and demerits, examples) 3.4 mode (definitions, formulae, merits and demerits, examples)	**10**
4	**Measures of Dispersion** 4.1 Range, Quartile deviation (definitions, formula, merits and demerits) 4.2 Coefficient of variation (definitions, formula, merits and demerits)	**10**

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002 .
2. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
3. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
4. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
5. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.
6. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
7. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, 7^{th} edition, Wiley India Pvt. Ltd.

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Indian Knowledge System

Paper Code and Title: STS-201-IKS: Development of Statistics in India

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcome

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

1. Know the use of data in different era.
2. Understand the role of statistics in the history of India.
3. Use of probability in ancient time.
4. Different Statistical organizations and offices in India.

Unit	Content	No. of Hours
1	**Historical Perspective of Statistics in India** Data collection system in ancient times, Statistics and Mathematics in ancient Indian poetry, Inferential Statistics and Statistical Economics before and during 4CE (Vishalaksha's contributions to inference and Kautilya's Arthashastra), Statistical System during British India, Statistical System in Independent India, Research Teaching andTraining in Statistics.	10
2	**History and Concept of Probability in ancient India** Concept of permutation and combination in ancient India, notations and rule for binomial expansion given by Pingala and others, history of probability – Rug veda, Mahabharata, Indian-Jaina philosophy.	07
3	**Contribution of Statisticians in the development of Statistics in India** P. C. Mahalanobis, Pandurang Vasudeo Sukhatme, Raghu Raj Bahadur, Debabrata Basu, Gopinath Kallianpur, Keshav Raghavan Nair, Calyampudi Radhakrishna Rao, Vasant Shankar *Huzurbazar*	07
4	**Official Statistics in India** Know about Ministry of Statistics and Programme Implementation (MoSPI) of Indian Government, Standing Committee on Statistics (its past and new overhaul. Historical perspective of Official Statistics in India. Overview of present Indian Statistical System: Statistical organizations and their functions – ISI, CSO, NSO.	06

Evaluation Pattern

Internal Evaluation: 20 Marks

Presentation – Poster or PPT, Preparation of Report on given topic, Examination with Objective questions,

External Evaluation: 30 Marks

1) Multiple choice (Solve any 5 out of 6 questions) – 1 mark each
2) Fill in the blanks (Solve any 5 out of 6 questions) – 1 mark each
3) True or False (Solve any 5 out of 6 questions) – 1 mark each
4) Match the following (Solve any 5 out of 6 questions)– 1 marks each
5) Define or explain the following (Solve any 10 out of 12 questions) – 1 mark each

References:

1. Buchanan, F. (1807) Survey of Eastern India report submitted to the court of directors, London.
2. Chaudhuri, S.B. (1964), History of Gazetteers of India, publication division, New Delhi.
3. Datta A. K. (2002), The concept of arithmetic mean in ancient India in 25 years gone by, ISIREA (2017):158 to 192
4. Ghosh J. K., Mitra, S. K. and Parthasarathy K. R .(1992), Glimpses of India's Statistical Heritage, Wiley Eastern, New Delhi.
5. Ghosh, J. K., Maiti P., Rao, T. J., and Sinha B. K. (1999), Evolution of Statistics in India, international statistical review, 67,13–34
6. Raju, C.K. (2011) "Probability in ancient India" In the handbook of philosophy of Statistics, edited by Paul Thagard Dov M. Gabbay and John Woods 7:1175 – 96.Handbook of the Philosophy of science, Elsevier, 2011

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Semester IV

Paper Code and Title: STS-251-MJ: Test of Significance and Statistical Methods

Course type: Theory **No. of Credits: 2** **No. of Contact Hours: 30**

Course Outcomes:

At the end of this course, students are able to:

1) Identify the appropriate test of hypothesis to be used in a scenario at hand.
2) Infer about the validity of a hypothesis via various approaches.
3) Identify a situation where multiple linear regression, interpretation multiple and partial correlation coefficients can be used.
4) Understand the concept of time series and its applications.

Unit No.	Content	No. of Hours
1	**Tests of Significance**	10
	1.1 Statistics and Parameter, Random sample $x_1, x_2, \dots, x_n$ from a distribution. Sampling distribution of a statistic, standard error with illustrations. Statistical hypothesis, null and alternative hypothesis, one sided and two sided alternative hypothesis, critical region, $type - I$ and $type - II$ error, level of significance, $p - value$. Two sided confidence interval. Tests of hypotheses using i) critical region approach, $ii)$ $p - value$ approach and iii) confidence interval approach.	
	1.2 Test for population means (large sample / approximate tests): $i)$ $H_0 : \mu = \mu_0$ against $H_1: \mu \neq \mu_0$ $H_1: \mu > \mu_0, H_1: \mu < \mu_0$, (variance known) $ii)$ $H_0 : \mu_1 = \mu_2$ against $H_1: \mu_1 \neq \mu_2$ $H_1: \mu_1 > \mu_2, H_1: \mu_1 < \mu_2$. (variances known) $iii)$Construction of two sided confidence interval for μ and $\mu_1 - \mu_2$.	
	1.3 Tests for population proportions: $i)$ $H_0 : P = P_0$ against $H_1: P \neq P_0$ $H_1: P > P_0, H_1: P < P_0$, $ii)$ $H_0 : P_1 = P_2$ against $H_1: P_1 \neq P_2$ $H_1: P_1 > P_2, H_1: P_1 < P_2$. $iii)$ Construction of two sided confidence interval for P and $P_1 - P_2$.	
2	**Multiple Linear Regression Model:**	08
	2.1 Introduction to trivariate data, Notion of multiple linear regression. Yule's notation (trivariate case) (statement only).	

Fitting of regression plane of $Y\ on\ X_1$ and $X_2, Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$ by the method of least squares; obtaining normal equations, solution of normal equations. Definition and interpretation of partial regression coefficients β_1 and β_2.

2.2 Residual: Definition, order, derivation of variance, properties. Finding multiple and partial correlation coefficients if $(X_1, X_2, X_3) \sim MD(n, P_1, P_2, P_3)$.

2.3 Definition of multiple correlation coefficient $R_{Y.X_1,X_2}$.

2.4 Properties of multiple correlation coefficient.

$$i)\ 0 \leq R_{Y.X_1,X_2} \leq 1 \qquad ii)\ R_{Y.X_1,X_2} \geq \{r_{yx_1}, r_{yx_2}\}$$

2.5 Interpretation of coefficient of multiple determination R^2_{Y,X_1,X_2} as

$i)$ Proportion of variation explained by the linear regression

$ii) R^2_{Y.X_1,X_2} = 1$

$iii) R^2_{Y.X_1,X_2} = 0$

2.6 Partial correlation coefficient: Definition and property

$(-1 \leq r_{yx_1.x_2}, r_{yx_2.x_1} \leq 1)$(Statement only)

3 Time series analysis **12**

3.1 Examples of time series, Objectives of time series, Meaning and utility of time series.

3.2 Components of time series: trend, seasonal variations, cyclical variations, irregular (error) fluctuations or noise.

3.3 Exploratory data analysis: Time series plot to (i) check any trend and seasonality in the time series (ii) identify the nature of trend

3.4 Methods of trend estimation: (i) moving average, (ii) linear, parabolic curve fitting by least squares principle (iii) exponential smoothing.

3.5 Measurement of seasonal variations: ratio to moving average method, ratio to trend where linear trend is calculated by method of least square. (Describe the method only, take problems in practical)

References

1. Gupta, S. P. (2002), Statistical Methods (Thirty First Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi 110002.
2. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
3. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
4. Montgomery, D. C., Peck, E. A. and Vining, G.G.(2003), Introduction to Linear Regression Analysis, Wiley.

5. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, Seventh edition, Wiley India Pvt. Ltd.
6. Wilson J. H., Keating B. P., Beal-Hodges M. (2012), Regression Analysis, Business Expert Press.
7. Brockwell, P.J. and Davis, R.A. (2002). Introduction to time series and forecasting. New York, NY: Springer New York.
8. Christopher Chatfield (1975): The Analysis of Time Series, 6th edition, CRC Press.
9. Farmum, N.R. and Stantorr, L.W. (1989): Quantitative Forecasting Methods, PWS Kent Publishing Company, Boston.
10. Montgomery, D.C. and Johnson L.A. (1976): Forecasting and Time Series Analysis, McGraw Hill.
11. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied (P) Ltd.
12. Draper, N. R. and Smith, H. (1998), Applied Regression analysis, (John Wiley) Third Edition.
13. Gross D., Shortle J. F., Thompson J. M., Harris C. M. (2012), Fundamentals of Queuing Theory (Fourth Edition), Wiley Series in Probability and Statistics.
14. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
15. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002.

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Paper Code and Title: STS-252-MJ: Sampling Distributions and Exact Test

Course type: Theory **No. of Credits: 2** **No. of Contact Hours: 30**

Course Outcomes:

At the end of this course, students are expected to be able to:

1) Distinguish between various sampling distributions.
2) Understand properties and interrelationships between sampling distributions.
3) Application of tests of hypothesis testing based on sampling distributions.
4) Solve real life testing problems based on sampling distributions.

Unit No.	Content	No. of Hours
1	**Gamma Distribution** **1.1** Probability density function (p.d.f.) of Gamma distribution with parameter α, λ. $f(x) = \frac{\alpha^{\lambda}}{\Gamma\lambda} e^{-\alpha x} x^{\lambda-1}, x > 0, \quad \alpha, \lambda > 0$ $= 0\ otherwise$ Notation: $X \sim G(\alpha, \lambda)$ (α=scale parameter and λ= shape parameter). Plotting of p.d.f. curve for various parameter values, special cases: i) $\alpha = 1$, ii) $\lambda = 1$ **1.2** Mode, cumulative distribution function (c. d. f.), M.G.F. and its use to find mean, variance, moments, skewness, kurtosis, C.G.F., additive property.	**04**
2	**Chi-square Distribution** **2.1** Definition of Chi-square r.v. as a sum of squares of i.i.d. standard normal variables, derivation of the p.d.f. of Chi-square variable with n degrees of freedom (d.f.) using M.G.F. Notation: $X \sim \chi^2_n$. Plotting of p.d.f. curve for various parameter values. **2.2** M.G.F. and its use to find mean, variance, moments, skewness, kurtosis, C.G.F., mode, additive property. Use of chi-square tables for calculations of probabilities. **2.3** Normal approximation: $\frac{\chi^2_n - n}{\sqrt{2n}}$ (statement only). Distribution of $\bar{X}$ and $\frac{ns^2}{\sigma^2} = \frac{1}{\sigma^2}\sum_{i=1}^{n}(X_i - \bar{X})^2$ for a random sample from a normal distribution using orthogonal transformation, independence of $\bar{X}$ and S^2.	**08**
3	**Student's – t distribution**	**05**

3.1 Definition of t r.v. with n d.f. in the form of $t = \frac{U}{\sqrt{\frac{V}{n}}}$, where $U \sim N(0,1)$ and V is Chi-square with n d.f., where U and V are independent random variables. Notation: $t \sim t_n$.

3.2 Derivation of the p.d.f of t distribution. Plotting of p.d.f. curve for various parameter values, mean, variance, moments, mode. Use of t-tables for calculations of probabilities, statement of normal approximation.

3.3 Distinction between density curves of normal and t-distributions.

4 **Snedecor's F – distribution** **05**

4.1 Definition of F r.v. with n_1 and n_2 d.f. as $F_{n_1,n_2} = \frac{X_1/n_1}{X_2/n_2}$ where X_1 and X_2 are independent Chi-square variables with n_1 and n_2 d.f., Notation: $F \sim F_{n_1,n_2}$.

4.2 Derivation of the p.d.f, plotting of p.d.f. curve for various parameter values, mean, variance, moments, mode.

4.3 Distribution of $\frac{1}{F_{n_1,n_2}}$,use of F - tables for calculation of probabilities. Interrelationship between Chi-square, t and F distributions.

5 **Tests of Hypothesis based on sampling distributions** **08**

5.1 Tests based on chi-square distribution:

(a) Test for independence of two attributes arranged in 2×2 contingency table (with Yate's correction to be covered in practical)

(b) Test for independence of two attributes arranged in $r \times s$ contingency table (problems to be covered in practical).

(c) Test for goodness of fit (problems to be covered in practical).

(d) Test for variance $(H_0: \sigma^2 = \sigma_0^2)$ against one-sided and two-sided alternatives i) for known mean, ii) for unknown mean.

5.2 Tests based on t - distribution:

(a) Tests for population means:

(i) Single sample with unknown variance and two sample for unknown equal variances (for one-sided and two-sided alternatives.)

(ii) $100(1-\alpha)\%$ two-sided confidence interval for population mean and difference of means of two independent normal populations.

(b) Paired t-test for one-sided and two-sided alternatives.

5.3 Test based on F-distribution:

Test for $H_0: \sigma_1^2 = \sigma_2^2$ *:* against one-sided and two-sided alternatives when i) means are known and ii) means are unknown.

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002 .
2. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
3. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
4. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
5. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.
6. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
7. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, 7th edition, Wiley India Pvt. Ltd.

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Paper Code and Title: STS-253-MJP: Statistics Practical –IV

Course type: Practical **No. of Credits: 2** **No. of Contact Hours: 60**

Course Outcomes:

At the end of this course students are expected to be able to:

1) Test the significance of mean, proportions.
2) Test of significance using t-distribution, Chi-square distribution and F-distribution.
3) Fitting of multiple regression and difference between multiple and partial correlation.
4) Understand trend and seasonal variation of time series, simple terminology of demography.

Sr. No.	Title of Practical	Practical
1	Test for means (one sample problem) and construction of confidence interval (large sample test). Verification of result using p-value.	**1**
2	Test for means (two sample problem) and construction of confidence interval (large sample test). Verification of result using p-value	**1**
3	Test for proportions (one sample & two sample problem) and construction of confidence interval. Verification of result using p-value.	**1**
4	Test for means (one sample problem) and construction of confidence interval (small sample test). (for one-sided and two-sided alternatives).	**1**
5	Test for means (two sample problem) and construction of confidence interval (small sample test) (for one-sided and two-sided alternatives).	**1**
6	Paired t-test (for one-sided and two-sided alternatives) and significance of correlation using t-test.	**1**
7	Test for goodness of fit & independence of attributes (2 x 2 and r x s contingency table) using chi-square distribution.	**1**
8	Tests for population variance (one sample and two sample problem) (for one-sided and two-sided alternatives).	**1**
9	Fitting of regression plane of Y on X_1 and X_2 for trivariate data, problems on multiple and partial correlation.	**1**
10	Estimation and forecasting of trend by exponential smoothing, moving averages. Fitting of model.	**1**
11	Estimation of seasonal indices by ratio to trend method. plotting of residuals.	**1**
12	Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate.	**1**

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Paper Code and Title: STS-271: VSCP - Statistical Computing using MS EXCEL-II

Course type: Practical **No. of Credits: 2** **No. of Contact Hours: 60**

List of the Experiments

Expt. No.	Title of the Experiment	No. of Experiments
1	Fitting of exponential curve $Y=ab^x$, $Y=aX^b$	**1**
2	Crude birth rate, general fertility rate, specific (age, sex etc.) fertility rates, total fertility rate	**1**
3	Time Series- Estimation of trend by using the method of moving averages	**1**
4	Time Series- Estimation of trend by using exponential smoothing	**1**
5	*Test for means (Z-test)* i) H_0: $\mu = \mu_0$ vs H_1: $\mu \neq / > / < \mu_0$, σ^2 known	**1**
6	Test for proportion (Z-test) i)H_0: $P = P_0$ vs H_1: $P \neq / > / < P_0$	**1**
7	Test based on students t i) H_0: $\mu = \mu 0$ vs H_1: $\mu \neq / > / < \mu_0$, σ^2 unknown	**1**
8	Test based on χ^2 i) Goodness of fit ii) Independence of attributes (2 x 2) iii) Independence of attributes (2 x 3 or 3 x 2 or 3 x 3)	**2**
9	Tests based on F-distribution i)H_0: $\sigma_1^2 = \sigma_2^2$ vs H_1: $\sigma_1^2 \neq / > / < \sigma_2^2$, means known ii) H0: $\sigma 1^2 = \sigma 2^2$ vs H1: $\sigma_1^2 \neq / > / < \sigma_2^2$, means unknown	**1**
10	Project (Part-II) - Analysis of data collected in semester-III	2

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Paper Code and Title: STS-281-CEP: Community Engagement Project

Course type: Practical **No. of Credits: 2** **No. of Contact Hours: 60**

Course Outcomes:

At the end of this course, students are able to

1. To develop an understanding of community needs and challenges.
2. To equip students with skills to identify problem areas within the community.
3. To guide students in creating effective project proposals.
4. Fostering social responsibility, promoting inclusively and developing practical skills.

Instructions:

Community Engagement Project (CEP) must be clearly identified at the beginning of the term, with detailed information about date, time, locations, means of transportation, and any fees for which the student is responsible.

Student has to submit a report based Community Engagement Project and it will be evaluated for credit requirements. The project report prepared by the student is considered as the output of Community Engagement Project. The Comprehensive Project report based on Community Engagement Project carries 02 credits, and carries 50 marks, divided into two parameters: Internal Evaluation (20 Marks) External Evaluation (30 Marks). The report based on it shall be evaluated by two examiners one internal and one external (Subject Expert from Outside College). A Viva voce must be conducted by the panel consisting of Internal Examiner and External Examiner.

Internal Evaluation 20 Marks	Area or topic Selection Regular Evaluation / follow up of field work	10 Marks 10 Marks
External Evaluation 30 Marks	Project Report Log book or record book Viva-voce	10 Marks 10 Marks 10 Marks

General Guidelines for CESR Course Implementation:

1. **Implementation Mechanism:**
   The method of implementing the CEP course will be determined by each respective department.
2. **Collaborations and Tie-ups:**
   Each department must establish collaborations or tie-ups (through MoUs/LoIs) with relevant industries, organizations, or NGOs as per the project requirements.
3. **Involvement of Local Community Experts:**
   Local community elders, women leaders, tribal representatives, entrepreneurs, and civil society practitioners should be invited to contribute to the course by co-teaching both in classrooms and during fieldwork. These instructors should be duly acknowledged, compensated, and respected for their valuable practical experience and knowledge.

4. **Departmental Coordination:**
   The CEP course must be conducted solely through the department. Students are not permitted to approach NGOs or organizations individually for the course. All communications with NGOs/organizations should be routed through the department.
5. **Document Maintenance:**
   Departments should maintain relevant documentation, such as attendance records, proposals, CEP diaries, MoUs/LoIs, and any correspondence related to the CESR course.

Rules for CEP Work:

1. **Group Formation and Size:**
   Students will be allocated project work in groups based on the subject. The group size should be determined by the nature and requirements of the project, with a minimum of 4 students and a maximum of 6 students per group.
2. **Community Engagement Work Requirement:**
   Each group must complete 7 full days or 15 days of part-time fieldwork. If the fieldwork is conducted at a recognized institution, the group must provide a certificate or evidence of completion (such as photographs) in the report.
3. **Project Report Submission:**
   The project report must be a minimum of 5,000 words and in printed format. The report should include charts, graphs, photographs, and other relevant materials as needed for the project.
4. **Role and Responsibility:**
   The project methodology section of the report must clearly outline the roles and responsibilities of each group member involved in the project.
5. **Originality of Work:**
   The project work must be original and not copied. Students are required to complete the project based on their own resources and discretion. Along with the report, the student(s) must submit a certificate affirming that the project work is entirely their own original work.

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Paper Code and Title: STS-291-MN: Sampling Distributions and Statistical Inference

Course type- Theory **No. of credits – 2** **No. of contact hours - 30**

Course Outcomes:

At the end of this course, students are able to

1) Understand the concept of sampling distributions and its various applications in real life.
2) Understand the concept of testing of hypothesis.
3) Test the hypothesis for population means and population proportions for small sample and large sample.
4) Test for the independence of two attributes and population variance.

Unit No.	Content	No. of Hours
1	**Sampling Distributions** **1.1 Chi-square Distribution** Statement of p.d.f., mean and variance, applications of the chi-square distribution, use of chi-square tables for calculations of probabilities. (Without proof) **1.2 Student's t distribution** Statement of p.d.f., mean and variance, applications of the t distribution, use of t tables for calculations of probabilities. (Without proof) **1.3 Snedecor's F distribution** Statement of p.d.f., mean and variance, applications of the F distribution, use of F tables for calculations of probabilities. (Without proof)	**8 H**
2	**Testing of significance** 2.1 Statistic and Parameter: Random sample $X_1, X_2, \ldots, X_n$ from a distribution, concept of statistic, sampling distribution of a statistic, standard error of a statistic. Notion of parameter and parameter space. Concept of family of distributions. 2.2 Introduction to problem of estimation and testing of hypothesis. Estimator and estimate, difference between estimator and estimate. Point and interval estimation 2.3 Statistical hypothesis, null and alternative hypotheses, simple and composite hypotheses, one-sided and two-sided alternative hypotheses, critical region, type-I and type-II error, notion of size and power of test, level of significance, p-value. Two-sided confidence interval.	**06 H**

3 **Tests based on normal distribution** **06 H**

3.1 Test for population means:

$i)$ $H_0 : \mu = \mu_0$ against $H_1: \mu \neq \mu_0$ $H_1: \mu > \mu_0, H_1: \mu < \mu_0,$ (variance known)

$ii)$ $H_0 : \mu_1 = \mu_2$ against $H_1: \mu_1 \neq \mu_2$ $H_1: \mu_1 > \mu_2, H_1: \mu_1 < \mu_2$ (variances are known)

3.2 Tests for population proportions:

$i)$ $H_0 : P = P_0$ against $H_1: P \neq P_0$ $H_1: P > P_0, H_1: P < P_0,$

$ii)$ $H_0 : P_1 = P_2$ against $H_1: P_1 \neq P_2$ $H_1: P_1 > P_2, H_1: P_1 < P_2.$

4 **Tests based on sampling distributions** **10 H**

4.1 Test for independence of two attributes

4.2 Test for goodness of fit.

4.3 Test for population variance.

4.4 Tests for population means: a) one sample and two sample b) two-sided confidence interval for population mean (variance unknown).

4.5 Paired t-test.

4.6 Test for equalities of variance when i) means are known and ii) means are unknown.

4.7 Examples.

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Paper Code and Title: STS-292-MNP: Practical on Sampling Distributions and Statistical Inference

Course type- Practical **No. of credits – 2** **No. of contact hours – 60(48+12)**

Course Outcomes:

At the end of this course, students will be able to:

1) Understand the concept of sampling distributions and its various applications in real life.
2) Test the hypothesis for population means and population proportions for large sample.
3) Test the independence of two attributes using chi-square test.
4) Test the population mean and population variance for small sample problem.

Expt. No.	Title of the Experiment	No. of Experiments
1	Test for means (one sample problem) (variance known).	1
2	Test for means (two sample problem) (variance known).	1
3	Test for proportions (one sample problem)	1
4	Test for proportions (two sample problem)	1
5	Test for means (one sample problem) (variance unknown).	1
6	Test for means (two sample problem) (variance unknown).	1
7	Paired t-test.	1
8	Test for independence of attributes for 2 x 2 contingency table.	1
9	Test for independence of attributes for r x s contingency table.	1
10	Test for goodness of fit.	1
11	Test for population variance. (μ - known and unknown).	1
12	Tests for equality of population variances.	1

Note:

1. Please do not ask confidence interval problems in the examination.
2. Use only statistical table for inference, do not consider '**p**' value for inference.

Paper Code and Title: OE-251-STS: Business Statistics - II

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcomes:

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

1. Calculate appropriate index numbers in different situations.
2. Interpret the calculated index number according to the situation.
3. Understand the terms related to population and sample.

Unit No.	Content	No. of Hours
1	**Preparation of Questionnaires:** 1.1 Characteristics of a good questionnaire, Problems faced in data collection: problem of non- response, sampling errors, non-sampling errors 1.2 Designing questionnaires for surveys (i.e. survey forms) (with various sections if required) using various online platforms such as Google Forms, Survey Monkey, Form Façade (an add-on to customize Google Forms), etc., Aesthetic presentation of survey forms, Flow of questions. 1.3 Processing Survey Data: Downloading responses as MS-Excel sheets, computation of summated scores (for Likert scale-based questions)	10
2	**Index Number** 2.1 Concept and uses of Index numbers in different fields 2.2 Simple and weighted index numbers 2.3 Cost of living index numbers 2.4 Lasprayes, Paasches and Fisher's Index numbers	10
3	**Concepts and definitions related to test of significance** 3.1 Concept of testing of hypothesis and theory of estimation 3.2 Definitions: population, sample, SRSWR, SRSWOR, random sample from a probability distribution, parameter, statistic. 3.3 Concept of null hypothesis and alternative hypothesis, critical region, level of significance, type I and type II error, one sided and two sided tests, p-value. 3.4 Examples based on concepts.	10

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002 .

2. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
3. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
4. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
5. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.
6. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
7. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, 7th edition, Wiley India Pvt. Ltd.

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Paper Code and Title: OE-252-STS: Applied Statistics - II

Course type- Theory **No. of credits – 2** **No. of contact hours – 30**

Course Outcomes:

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

1. Arrange the data in proper understandable tabular form.
2. Visualize the data for better understanding.
3. Learn descriptive statistics measures and apply them to real data.
4. Calculate and describe data through measures of central tendency and measures of dispersion.

Unit No.	Content	No. of Hours
1	**Index Number** 1.1 Concept and uses of Index numbers in different fields 1.2 Simple and weighted index numbers 1.3 Cost of living index numbers 1.4 Lasprayes, Paasches and Fisher's Index numbers	10
2	**Time Series** 2.1 Introduction, Meaning and utility 2.2 Visualization of Time series 2.3 Components of time series 2.4 Additive and multiplicative models 2.5 Methods of estimating trend using moving average method (3,4 and 5 yearly cycle) 3.6 Numerical problems	10
3	**Concepts and definitions related to testing of Significance** 3.1 Concept of testing of hypothesis and theory of estimation 3.2 Definitions: population, sample, SRSWR, SRSWOR, random sample from a probability distribution, parameter, statistic.	10

3.3 Concept of null hypothesis and alternative hypothesis, critical region, level of significance, type I and type II error, one sided and two sided tests, p-value.

3.4 Examples and rough sketch based on concepts.

References

1. Gupta, S. C. and Kapoor, V. K. (2002), Fundamentals of Mathematical Statistics, (Eleventh Edition), Sultan Chand and Sons, 23, Daryaganj, New Delhi, 110002 .
2. Gupta, S. C. and Kapoor V. K. (2007), Fundamentals of Applied Statistics (Fourth Edition), Sultan Chand and Sons, New Delhi.
3. Mishra Amarendra (2020), Theory of Statistical Hypothesis Testing (First Edition), Notion Press.
4. Taff Arthur (2018), Hypothesis Testing: The Ultimate Beginner's Guide to Statistical Significance, CreateSpace Independent Publishing Platform.
5. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.
6. Goon A. M., Gupta, M. K. and Dasgupta, B. (1986), Fundamentals of Statistics, Vol. 2, World Press, Kolkata.
7. Wayne W. Daniel (2006), Biostatistics: A Foundation for Analysis in Health Sciences, 7th edition, Wiley India Pvt. Ltd.

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Skill Enhancement Course (SEC)

Paper Code and Title- SECP-251-STS: Descriptive Statistics Using R Software

Course Type: Practical **No. of Credits: 02** **No. of Contact Hours:60**

Course Outcomes:

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

1. Understand and apply basic R programming commands and data management techniques in R Studio.
2. Create and interpret diagrammatic and graphical representations for data visualization.
3. Calculate and analyze measures of central tendency, dispersion, and data partitioning.
4. Summarize datasets using frequency distributions, ogive curves, and advanced statistical summaries.
5. Conduct correlation and regression analysis to evaluate relationships and model performance.
6. Simulate, calculate, and visualize probabilities for discrete and continuous distributions.

Unit No.	Content
1	**Introduction to R Studio and Basic Commands**
	1.1 Introduction with R Studio interface and environment.
	1.2 Using c, seq, rep, and scan functions to create vectors.
	1.3 Arithmetic operations on vectors using operators +, - , * , / , ^.
	1.4 Creating data frames using data.frame.
	1.5 Importing and managing datasets from external sources (read.csv, read.table).
	1.6 Exploring datasets in R (mtcars, iris, etc.).
2	**Diagrammatic and Graphical Representation**
	2.1 **Data Visualization**
	a) Bar diagrams (simple, subdivided, and multiple) and pie charts.
	b) Stem-and-leaf plots and boxplots for data distribution.
	2.2 **Graphs**
	a) Histograms (equal and unequal class intervals).

b) Scatterplots and line plots for trends in data.

c) Density plots using density () for smooth visualization.

3 Measures of Central Tendency and Dispersion

4.1 Computing arithmetic mean, geometric mean, harmonic mean, mode and median.

4.2 Partition values: Quartiles, deciles, and percentiles.

4.3 Range, variance, standard deviation, interquartile range, and coefficient of variation. Using boxplots for visualizing data spread and identifying outliers.

4 **Data Summarization**

4.1 Generating frequency and cumulative frequency tables.

4.2 Creating ogive curves for grouped data.

4.3 Summary Statistics using fivenum() and summary() for quick data summaries.

4.4 Exploring skewness and kurtosis using moments package

5 Correlation and Regression Analysis

a. Computing and interpreting Pearson and Spearman correlation coefficients, Scatterplots for identifying relationships between two variables and trends.

b. Estimating parameters for the linear regression model using least squares.

c. Evaluating goodness of fit with residual plots and R^2.

6 **Probability Distributions**

6.1 Discrete Probability Distributions

a) Simulating data from Bernoulli, Binomial, and Poisson distributions.

b) Calculating probabilities and percentiles using dbinom, pbinom, dpois, etc.

6.2 Continuous Probability Distributions

a) Visualization of normal, Chi square, t-distribution using dnorm, pnorm, dchisq, pchisq,dt,pt.

b) Applications of standard normal distribution (Z-scores).

List of Experiments

Sr.No.	Title of the Experiment	No. of Experiments
1	Introduction to R Studio and Basic R Commands	1
2	Creating Vectors in R using c, seq, rep, and scan functions and arithmetic operation on vectors.	1
3	Importing Data and Creating Data Frames	1
4	Diagrammatic Representation (Bar, Pie, Stem-and-Leaf Plots)	1
5	Graphical Representation (Boxplots, Histograms, Density Plots)	1
6	Measures of Central Tendency (Mean, Median, Mode, Partition Values)	1
7	Measures of Dispersion (Range, Variance, SD, Coefficient of Variation)	1
8	Frequency Distributions and Ogive Curves	1
9	Correlation Analysis (Pearson and Spearman)	1
10	Simple Linear Regression Analysis	1
11	Discrete Probability Distributions (Binomial, Poisson)	1
12	Exploring Continuous Probability Distributions (Normal, Z-scores Chi-square, t)	1

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