Shri Sangameshwar Education Society's

Sangameshwar College, Solapur [Autonomous]

(Affiliated to Punyashlok Ahilyadevi Holkar Solapur University, Solapur)

Kannada Linguistic Minority Institute

NAAC Accredited with 'A' Grade (III Cycle CGPA 3.39)

Academic Council 3(3.3)
10th August, 2021

UG Science Programme: B.Sc.-II To be implemented from A.Y. 2021-2022

System: Choice Based Credit System (CBCS) with SGPA and CGPA

B.O.S. in: **Statistics**

Syllabus for: Discipline Specific Core Courses (DSC-C and DSC-D)

Structure and Examination for: Discipline Specific Core Courses (DSC-C and DSC-D)

Table-3

Semester	Course		Teaching Scheme/week			
			Course Code	Hours	Lectures	Credits
III						
	DSC-1C	Theory Paper-V: Probability Distribution–I	2131307	4.8	6	4
		Theory Paper-VI: Statistical Methods	2131308			
		Practical-II: Statistics Practical	2131423	6.4	8	4
	SEC-1	Theory Paper-I: Gr. A: Programming skill using C–I	2131319	4.8	6	2
IV	AECC-C	ENVIRONMENTAL STUDIES	2131315	3.2	4	4
	DSC-1D	Theory Paper-VII: Probability Distribution –II	2131407	4.8	6	4
		Theory Paper-VIII: Applied Statistics	2131408			
		Practical-III: Statistics Practical	2131423	6.4	8	4
	SEC-2	Theory Paper-II: Gr. A: Programming skill using C–II	2131428	4.8	6	2

Table-4

Semester	Course		EXAMINATION Marks			Credits
			CA	SEE	Total	
III	DSC-1C	Theory Paper-V: Probability Distribution–I	15	35	50	2
		Theory Paper-VI: Statistical Methods	15	35	50	2
	SEC-1	Theory Paper-I: Gr. A: Programming skill using C–I	15	35	50	2
IV	AECC-C	ENVIRONMENTAL STUDIES	15	35	50	4
	DSC-1D	Theory Paper-VII: Probability Distribution –II	15	35	50	2
		Theory Paper-VIII: Applied Statistics	15	35	50	2
	SEC-2	Theory Paper-II: Gr. A: Programming skill using C–II	15	35	50	2
	DSC-1C & DSC-1D	Practical-II and III: Statistics Practical	60	140	200	8

CA: Continuous Assessment SEE: Semester End Examination

Note:-

The above structure (Table-3 and Table-4) is for Sem-III and Sem-IV of the undergraduate B.Sc.-II programmes* under science faculty.

*B.Sc.-II Select any three DSC form the four core courses opted at B.Sc.- I.

DSC: Discipline Specific Core Course AECC: Ability Enhancement Compulsory Course

SEC: Skill Enhancement Course

Passing in each course is compulsory including Environment Studies course.

SGPA/CGPA and Total Marks will be calculated excluding AECC course.

Passing in each course is compulsory. SGPA/CGPA and Total Marks will be calculated excluding AECC course.

SEM-III DSC-C Theory-I Title: Probability Distribution –I (2131307)		Hours 36
Unit 1	**Continuous Univariate Distributions:** ● Definition of continuous sample space with illustrations, Definition of continuous random variable (r. v.), probability density function (p. d. f.), cumulative distribution function (c. d. f.) and its properties. ● Expectation of a r. v., expectation of a function of r. v., mean, median, mode, quartiles, variance, harmonic mean, geometric mean, raw and central moments, problems. ● Moments generating function (m. g. f.): definition and properties. Standardization property : (i) $M_X(0) = 1$, (ii) Effect of change of origin and scale, (iii) Uniqueness property of m. g. f., (if exists, statement only). Generation of raw and central moments. Cumulant generating function (c. g. f.): definition, Relations between cumulants and central moments (up to order four). Problems.	10
Unit 2	**Continuous Bivariate Distributions:** ● Definition of bivariate continuous r. v. (X, Y), Joint p. d. f., c. d. f. with properties, marginal and conditional distribution, independence of r. vs., evaluation of probabilities of various regions bounded by straight lines. ● Expectation of function of r. vs., means, variances, covariance, correlation coefficient, conditional expectation, regression as conditional expectation if it is linear function of other variable and conditional variance. Proof of (i) $E(X \pm Y) = E(X) \pm E(Y)$, (ii) $E[E(X/Y)] = E(X)$, (iii) Independence: If X and Y are independent r. vs. then $E(XY) = E(X)\,E(Y)$ (iv) $M_{X+Y}(t) = M_X(t) \times M_Y(t)$ (v) $M_{X,Y}(t1, t2) = M_X(t1, 0) \times M_Y(0, t2)$ (vi) $M_{X+Y}(t, t) = M_X(t, 0) \times M_Y(0, t) = M_{X+Y}(t)$. Problems.	10
Unit 3	**Transformations of a continuous random variable:** ● Transformation of a univariate continuous r. v.: Distribution of Y = g(X), where g is monotonic or non monotonic functions using (i) Jacobian of transformation, (ii) Distribution function and (iii) m.g.f. methods. Transformation of a continuous bivariate r. vs.: Distribution of a bivariate r. vs. using Jacobin of transformation. Problems.	6
Unit 4	**Uniform and Exponential distributions:** ● **Uniform Distribution:** p. d. f. $f(x) = \frac{1}{b-a}$; $a \leq x \leq b$ $= 0$; otherwise Notation X~U (a, b), c.d.f., m.g.f., mean, variance, moments, β_1, β_2, γ_1 and γ_2 coefficients. Distribution of (i) $\frac{(X-a)}{(b-a)}$, (ii) $\frac{(b-X)}{(b-a)}$, (iii) Y = F(x) where F(x) is c.d.f. of any continuous r.v. Problems. ● **Exponential distribution: (one parameter)** p.d.f. $f(x) = \theta e^{\theta x}$; $x \geq 0, \theta > 0$ $= 0$; otherwise Notation X~ Exp (θ) c.d.f., m.g.f., mean, variance, C.V., moments, β_1, β_2, γ_1 and γ_2 coefficients, median, quartiles. lack of memory property, distribution of $Y = -\frac{1}{\theta} logX$ Where, X~ U (0, 1). Exponential distribution with scale and location parameters (only p.d.f.)	10
Course Outcomes: After completion of this course, students can understand the basic concepts of continuous univariate and bivariate distributions, transformation of univariate continuous random variable.		

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SEM-III DSC-C Theory-II Title: Statistical Methods (2131308)		Hours 36
Unit 1	**Multiple Linear Regression (for trivariate data only)** • Concept of multiple linear regression, Plane of regression, Yule's notation, correlation matrix. • Fitting of regression plane by method of least squares, definition of partial regression coefficients and their interpretation. • Residual: definition, order, properties, derivation of mean and variance, covariance between residuals. • Numerical examples	8
Unit 2	**Multiple and Partial Correlation (for trivariate data only)** • Concept of multiple correlations. Definition of multiple correlation coefficient Ri.jk, derivation of formula for multiple correlation coefficient. • Properties of multiple correlation coefficient: (i) $0 \le$ Ri.jk ≤ 1 (ii) Ri.jk > max{ |rij|, |rik|, |rij.k|, |rik.j| } (iii) Ri.jk $\ge$ |rik| , i = j =k = 1, 2, 3. i $\neq$ j, i $\neq$ k • Interpretation of Ri.jk =1, Ri.jk = 0, coefficient of multiple determination $R^2_{ij.k}$. • Concept of partial correlation. Definition of partial correlation coefficient rij.k, derivation of formula for rij.k. • Properties of partial correlation coefficient: a. $-1 \le$ rij.k ≤ 1 b. $b_{ij.k} \times b_{ji.k} = r^2_{ij.k}$ • Numerical examples	10
Unit 3	**Sampling Theory** • Definition of population, sample, parameter, statistic, sample survey, census survey. Advantages of sample survey over census survey, estimator, unbiased estimator Methods of sampling: (i) Deliberate (purposive) sampling, (ii) probability sampling & (iii) Mixed sampling. • Simple random sampling without replacement (SRSWOR) Some results : (i) Probability of a specified unit being selected in sample at any given draw is equal to $\frac{1}{N}$. (ii) Probability of a specific unit included in the sample is $\frac{n}{N}$. (iii)Probability of drawing a sample of size 'n' from a population of size N units is $\frac{1}{\binom{N}{n}}$. (iv) E $(\bar{y}_n) = \bar{Y}$. (v) E $(N\bar{y}_n) = \sum_{i=1}^{N} Y_i$ = Popuation total. (vi) Var $(\bar{y}_n) = \frac{(N-n)}{nN} S^2$. (vii) E (Sample Men Square) = Population Mean square. (viii) Estimated variance of sample mean. • Simple random sampling with replacement (SRSWR) Some results: (i) E $(\bar{y}_n) = \bar{Y}$. (ii) E $(N\bar{y}_n) = \sum_{i=1}^{N} Y_i$ = Population total.	8

	(iii) Var $(\bar{y}_n) = \frac{(N-1)}{nN} S^2$. (iv) E (Sample Men Square) = Population Mean square. (v) Estimated variance of sample mean Standard error of sample means, comparison of SRSWR and SRSWOR, Numerical examples	
Unit 4	**Statistical Quality Control (SQC)** ● Meaning and purpose of SQC, quality of product, process control, product control, SPC tools, assignable causes, chance causes. ● Shewhart's control chart: construction, working, theoretical basis, 3σ –control limits and lack of control situation. ● Control charts for variables: Control chart for process average ($\bar{x}$), control chart for process variation (R), Construction and working of $\bar{x}$ and R chart for known and unknown standards, revised control limits, estimate of process s.d. ● Control charts for attributes: Defects, defectives, fraction defective, control chart for fraction defectives (P-chart) for fixed sample size and unknown standards, construction, working of chart, revised control limits. ● Control chart for number of defects(C chart): for standards are not given, construction and working of the chart, revised control limits.	10
Course Outcomes: After completion of this course, students can understand the basic concepts of Multiple Linear Regression, Multiple and Partial Correlation, Sampling Theory and the meaning, purpose and use of Statistical Quality Control, construction and working of Shewhart's control charts for variables and attributes		

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SEM-IV DSC-D Theory-I Title: Probability Distribution –II (2131407)		**Hours 36**
Unit 1	**Gamma Distribution and beta distributions** ● **Gamma distribution** p.d.f. (two parameters) $f(x) = \frac{\alpha^{\lambda}}{\lfloor\lambda} e^{-\alpha x} x^{\lambda-1}$; $x > 0, \alpha > 0, \lambda > 0$ $= 0$; Otherwise Notation $X \sim G(\alpha, \lambda)$, special cases i) $\alpha=1$, ii) $\lambda=1$, mean, mode, variance, moments, β_1, β_2, γ_1 and γ_2 coefficients. Additive property, distribution of sum of i. i. d. exponential variates. ● **Beta distribution of first kind** p. d. f. $f(x) = \frac{1}{\beta(m,n)} x^{m-1}(1-x)^{n-1}$; $0 < x < 1$, m, n > 0. $= 0$; otherwise Notation $X \sim \beta_1(m, n)$ symmetry around mean when m = n, mean, harmonic mean, mode, variance. Uniform distribution as a particular case when m = n = 1, distribution of (1-X). ● **Beta distribution of second kind** p. d. f. $f(x) = \frac{1}{\beta(m,n)} \frac{x^{m-1}}{(1+x)^{m+n}}$; x > 0, m, n > 0. $= 0$; otherwise Notation $X \sim \beta_2(m, n)$ mean, harmonic mean, mode, variance, Distribution of $\frac{1}{X}$, relation between beta distribution of first kind and second kind, distribution of X+Y, $\frac{X}{Y}$, $\frac{X}{X+Y}$, where X and Y are independent gamma Variate.	10
Unit 2	**Normal Distribution** ● P. d. f. $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$; $-\infty < x < \infty$, $-\infty < \mu < \infty$, $\sigma > 0$ $= 0$; otherwise Notation $X \sim N(\mu, \sigma^2)$, properties of normal curve, mean, median, mode, variance, quartiles, point of inflexion, moments, recurrence relation for central moments, β_1, β_2, γ_1 and γ_2 coefficients, m. g. f. standard normal distribution. Additive property, distribution of X^2 if $X \sim N(0,1)$, distribution of aX+bY+c when X and Y are independent normal random variable's ● Normal distribution as a limiting case of (i) Binomial (ii) Poisson (without proof), illustrations of use of normal distribution in various fields.	10
Unit 3	**Testing of Hypothesis** ● Notion of Population, Sample, Parameter, Statistic, Sampling distribution of Statistic, hypothesis, Simple and composite hypothesis, Null and alternative hypothesis, type I and type II errors, Critical region, level of significance, one and two tailed test, power of test. General procedure of testing of hypothesis. ● **Large Sample Tests** **Tests for means:** (i) Testing of population mean; H_0: $\mu = \mu_0$,	6

	(ii) Testing equality of population means; H_0: $\mu_1 = \mu_2$ **Tests for Proportion:** (i) Testing of population Proportion; H_0: $P = P_0$ (ii)Testing equality of population Proportion; H_0:$P_1 = P_2$ **Test for population correlation** (i) H_0: $\rho = \rho_0$ (ii) H_0: $\rho_1 = \rho_2$ (by Z-transformation)	
Unit 4	**Exact Sampling Distributions** ● **Chi-Square distribution :** Definition of chi square variate as a sum of square of n i. i. d. standard normal variates, derivation of p.d.f. of chi square distribution with n degrees of freedom using m.g.f., mean, mode, variance, moments, β1, β2, γ1 and γ2 coefficients, m. g. f. Additive property, relation with gamma distribution. Normal approximation to chi- square distribution using central limit theorem. ● Application of chi-square distribution **(** χ^2 – test) (i) test for population variance $\sigma^2 = \sigma_0^2$(Mean known and unknown) (ii) test for goodness of fit (iii) test for independence of attributes a) m x n contingency table b) 2 x 2 contingency table, test statistic with proof. Yate's correction for continuity. ● **Student's t- distribution:** Definition of student's t variate in the form $t = \frac{Z}{\sqrt{\frac{\chi^2}{n}}}$, where Z ~ N (0,1) and χ^2 is chi square variate with n d. f. Derivation of p.d.f., mean, mode, variance, moments, β1, β2, γ1 and γ2 coefficients. ● Application of t distribution : t – Test (Test for means) (i) H_0: $\mu = \mu_0$, (ii) H_0: $\mu_1 = \mu_2$, ($\sigma_1 = \sigma_2$), (iii) Paired t- test ● **Snedecor's F distribution:** Definition of F Variate with n_1, n_2 d.f. as a ratio of two independent chi-square variables divided by their respective degrees of freedom. Derivation of pdf, mean, variance and mode. Distribution of $\frac{1}{F}$, Inter relation between t, F and $\chi 2$. ● Application of F distribution (F – test) Test for equality of two population variances H_0: $\sigma_1^2 = \sigma_2^2$	10
Course Outcomes: After completion of this course, students will learn the applications of Uniform, Exponential, Gamma, Beta & Normal distributions in real life. They will learn Exact Sampling distributions and its application in small sample tests. Students will enable to perform small & large sample tests with real life data.		

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SEM-IV DSC-D Theory-II Title: Applied Statistics (2131409)		**Hours 36**
Unit 1	**Time Series** ● Meaning and need of time series analysis, components of time series: (i) Secular trend (ii) Seasonal Variation (iii) Cyclical Variation (iv) Irregular Variation ● Additive and Multiplicative model, utility of time series. ● Measurement of trend: (i) Moving average method (ii) Least square method. ● Measurement of seasonal indices by (i) simple average method (ii) Ratio to moving average method.	10
Unit 2	**Elements of Demography** ● Introduction and need of vital statistics. ● Mortality rates: Crude Death Rate (CDR), Specific Death Rate, Standard Death Rate. ● Fertility rates: Crude Birth Rate (CBR), General Fertility Rate (GFR), Age Specific Fertility Rate (ASFR), Total Fertility Rate (TFR). ● Measurement of population growth: Gross Reproduction Rate (GRR), Net Reproduction Rate (NRR). Interpretation of NRR. ● Illustrative examples.	10
Unit 3	**Life Table** ● Notion of life table, notations and terminology, uses of life table. ● Proof of the following results: (i) ${}_nP_x = P_x P_{x+1} \ldots\ldots P_{x+n-1}$ (ii) ${}_nq_x = \frac{d_{x+n-1}}{l_x}$ (iii) $l_x = \sum_{i=x}^{\omega-1} d_i$ (iv) $T_x = \frac{1}{2}l_x + l_{x+1} + l_{x+2} + \cdots\cdots$ ● Expectation of life, Stable population, Central mortality rates & force of mortality.(derivations are not expected) ● Concept of Abridged life table ● Illustrative examples.	6
Unit 4	**Queuing Theory** ● Introduction, essential features of queuing system, input source, queue configuration, queue discipline, service mechanism. ● Operating characteristics of queuing system, transient- state and steady state, queue length, general relationship among system characteristics. ● Probability distributions in queuing system: Distribution of arrival, distribution of inter arrival time, distribution of departure and distribution of service time (Derivations are not expected). ● Types of queuing models. Solution of queuing Model: M/M/1, using FCFS queue discipline. ● Illustrative Examples.	10
Course Outcomes: After completion of this course, students will understand the concepts of Time Series its need and use in real life, different aspects of demography and its importance, construction of life table, theory and real -life situations of queuing theory.		

DSC-C & DSC-D Practical-II (2131422)	
Experiment	Title
1	Model sampling from Binomial and Poisson distributions
2	Model sampling from Geometric distribution and Negative Binomial distributions
3	Model sampling from Discrete uniform and Hypergeometric distributions
4	Fitting of Binomial and Poisson distributions and test for goodness of fit
5	Fitting of Geometric and Negative binomial distributions and test for goodness of fit.
6	Fitting of Discrete uniform and Hypergeometric distributions and test for goodness of fit.
7	Model sampling from Continuous Uniform distribution.
8	Model sampling from Exponential distribution.
9	Model sampling from Normal distribution.
10	Fitting of Continuous Uniform distribution and test for goodness of fit.
11	Fitting of Exponential distribution and test for goodness of fit.
12	Fitting of Normal distribution and test for goodness of fit.
13	Application of Exponential and Normal distributions.
14	Application of multinomial distribution.
Experiments using softwares like MS-Excel. C programming	
15	Fitting of Binomial, Poison & Negative Binomial distributions.
16	Fitting of Exponential & Normal distributions.
17	Model sampling from continuous Uniform and Exponential distributions.
18	Model sampling from Normal distribution.

DSC-C & DSC-D Practical-III (2131422)	
Experiment	Title
1	Multiple regressions.
2	Multiple and partial correlation.
3	Large sample tests for means.
4	Large sample tests for proportions.
5	Tests for population correlation coefficients (Using Fisher's Z transformation)
6	Tests based on Chi-square distribution. (for population variance, for goodness of fit)
7	Tests for independence.

8	Tests based on t distribution ($\mu=\mu0$, $\mu1=\mu2$, paired and unpaired)
9	Tests based on F distribution ($\sigma^2 = \sigma_0^2$)
10	Construction of $\bar{x}$ and R chart.
11	Construction of P and C chart.
12	Time Series- I (Estimation of trend) i) by moving average ii) by least square method.
13	Time Series- II (Computation of seasonal indices) i) by simple average method ii) by ratio to moving average.
14	Simple random sampling (with and without replacement).
15	Demography-I (Mortality Rates)
16	Demography-II (Fertility Rates, Reproduction rates)
17	Construction of Life Table
Experiments using softwares like MS-Excel. C programming	
18	Multiple, partial correlation and partial regression coefficients

Note:

1. Students are allowed to use any type of calculator or computer using any software like MS-Excel for computations in practical.
2. Students must complete the practical to the satisfaction of the concerned teacher.
3. Students must produce laboratory journal along with completion certificate signed by the HoD of Statistics at the time of practical examination.
4. Nature of SE (at the end of 2nd Sem) practical examination for 70 marks: A student has to attempt any two questions out of four asked, each for 25 marks. 10 marks are reserved for the assessment of journal. Also, 10 marks are reserved for the oral examination. Duration of practical examination is 4 hours.
5. Nature of CA of practical for 30 marks: 5 marks are reserved for data collection , 5 marks are reserved for active participation in laboratory work and 20 marks are reserved for assessment of the laboratory test..

Teaching-Learning-Evaluation: Equipment/Tools/Methods etc.
Use of class room teaching, laboratory, computers, calculators, data collection, test based on MCQ, etc

List of Books:

1. Parimal Mukhopadhyaya: An Introduction to the Theory of Probability. World Scientific Publishing.
2. Hogg R. V. and Criag A.T.: Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
3. Gupta S. C. & Kapoor V.K.: Fundamentals of Mathematical Statistics. Sultan Chand & sons, New Delhi.
4. Goon, A.M., Gupta M.K. and Dasgupta B: Fundamentals of Statistics Vol. I and Vol. II World Press, Calcutta.
5. Dr. Kore B. G. and Dr. Dixit P. G.: "Probability Distributions-I" Nirali Prakashan, Pune.
6. Mood A.M., Graybill F.A.: Introduction to theory of Statistics. (Chapter II, IV, V, VII) and Boes D.C. Tata, McGraw Hill, New Delhi. (Third Edition)
7. Walpole R.E. & Mayer R.H.: Probability & Statistics. (Chapter 4, 5, 6, 8, 10) MacMillan Publishing Co. Inc, New York.
8. Cochran, W.G: Sampling Techniques, Wiley Eastern Ltd., New Delhi. Des Raj: Sampling Theory.
9. Gupta S. C. and Kapoor V. K., "Fundamentals of Applied Statistics", Sultan and Chand, (2010).

10. Dr. Kore B. G. and Dr. Dixit P. G.: “Statistical Methods-I” Nirali Prakashan, Pune.
11. Mukhopadhay, Parimal: Theory and Methods of Survey Sampling, Prentice Hall.
12. Montgomery D. C. (2009). “Introduction to quality Control”, Jon Wiley and sons.
13. Sukhatme, P.V. and Sukhatme, B.V.: Sampling Theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi
14. Trivedi R. S.: Probability and Statistics with Reliability and Computer Science Application, Prentice – Hall of India Pvt. Ltd., New Delhi.
15. Dr. Kore B. G., Dr. Dixit P. G. and Mr. P. S. Kapre: “Probability Distributions-II”, Nirali Prakashan, Pune.
16. Chatfield C. (2004), “The Analysis of Time Series –An Introduction”, Chapman & Hall.
17. Kendall M.G. (1978), “Time Series”, Charles Griffin.
18. Dr. Kore B. G. and Dr. Dixit P. G.: “Statistical Methods-II”, Nirali Prakashan, Pune.
19. Snedecor G.W. and Cochoran W. G. “Statistical Methods”, Lowa State University Press.
20. Cramer H.: Mathematical Methods of Statistics, Asia Publishing House, Mumbai
21Sanjay Arora and Bansi Lal : New Mathematical Statistics (First Edition), Satya Prakashan16/17698, New Market, New Delhi, 5(1989).

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