SOLAPUR UNIVERSITY, SOLAPUR.

CGPA Pattern Syllabus

B.Sc. Part-II (Sem.III&IV)

STATISTICS

w.e.f. June 2015

SOLAPUR UNIVERSITY, SOLAPUR

Revised Syllabus for B.Sc.Part-II (CGPA Semester pattern): STATISTICS

(Introduced from June 2015)

Introduction:

The main objective of this course is to introduce CGPA semester system to the B.Sc-II (Statistics) students which covers the basic concepts of continuous univariate, bivariate distributions, sampling theory. Study of some standard discrete and continuous distributions, exact sampling distribution, correlation and regression analysis, test of significance and applied statistics.

B.Sc-II (Statistics) CGPA Semester wise pattern to be introduced from June 2015. This syllabus of Statistics carries 600 marks. In semester-III, university examination of theory papers III and IV and in semester-IV, university examination of theory papers V and VI. The university examination of practical paper-II and paper-III will be held annually. The distributions of marks are as below.

Semester No.	Paper No.	Title of the Paper	University Exam.	Internal Exam.	Total
III	STATISTICS PAPER-III	Continuous Probability Distributions.	70	30	100
	STATISTICS PAPER-IV	Discrete Probability Distributions and Statistical Methods.	70	30	100

IV	STATISTICS PAPER-V	Continuous Probability Distributions and Exact Probability Distributions.	70	30	100
	STATISTICS PAPER-VI	Applied Statistics.	70	30	100
Annual Examination	STATISTICS PRACTICAL	Statistics Practical Paper-II	70	30	100
		Statistics Practical Paper-III	70	30	100

Note: Nature of Internal examination, Passing standard, ATKT and the conversion of marks into grades and credits are as per guidelines of Science Faculty Credit and Grading System

Teaching Periods:

(1) Total teaching periods for each theory paper is three periods per week.

(2) Total teaching periods for each practical paper-II and paper-III are four periods per week per batch of 20 students.

Durartion of University Examinations:

1. For theory paper-III and IV: Three hours in semester-III.
2. For theory paper-V and VI: Three hours in semester-IV.
3. For practical paper–II: Four hours for a batch of 20 students annually.
4. For practical paper–III: Four hours for a batch of 20 students annually.

Semester III

Paper III: Continuous Probability Distributions

1. Continuous Univariate Distributions. (16)

1.1 Definition of the continuous sample space with illustrations, definition of continuous random variable (r.v.), probability density function (p.d.f.) and cumulative distribution function (c.d.f.) of continuous r.v., statement of properties of cumulative distribution function, sketch of p.d.f. and c.d.f.

1.2 Expectation of r.v., expectation of a function of r.v, mean, median, mode, quantiles (partition values), harmonic mean, variance, raw and central moments, skewness, kurtosis, examples.

1.3 Moment generating function (m.g.f.) $M_x(t)$: definition, properties.

i) Standardization property $M_x(0) = 1$

ii) Uniqueness property of m.g.f (if exists), (without proof)

iii) Effect of change of origin and scale. Generation of raw and central moments.

Definition of cumulant generating function.

1.4 Transformation of continuous univariate r.v.: Distribution of $Y=g(X)$ (g is monotonic and non-monotonic), application of m.g.f. in transformation of r.v.

1.5 Examples and problems.

2. Continuous Bivariate Distributions. (16)

2.1 Definition of bivariate continuous r.v. (X,Y), joint p.d.f, marginal and conditional distributions. Evaluation of probabilities of various region bounded by straight lines.

2.2 Expectation of g(X,Y), means, variances, covariance, correlation coefficient, conditional expectation, proof of E[E(X/y)]=E(X), conditional variance, regression as conditional expectation.

2.3 Independence of r.v.s, theorems on expectation.

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

ii) $E(XY) = E(X).E(Y)$, when X and Y are independent.

M.g.f. of sum of two independent r.v.s as a product of their m.g.f.s, extension to several variables.

2.4 Transformation of continuous bivariate r.v.s : Distribution of bivaraite r.v.'s using jacobian of transformation.

2.5 Examples and problems.

3. Uniform and Exponential Distribution: (13)

3.1 Uniform distribution: pd.f,

$$f(x) = \frac{1}{b-a} \qquad a \le x \le b$$

$$= 0 \qquad \text{elsewhere}$$

Notation: X~U(a,b), sketch of p.d.f for various values of parameters, c.d.f, mean, variance, m.g.f., moments, β_1 and β_2 coefficients. Distribution of i) $Y=\frac{X-a}{b-a}$

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

3.2 Exponential distribution : p.d.f. (one parameter)

$$f(x) = \theta e^{-\theta x} \qquad x>0, \theta>0$$

$$= 0 \qquad \text{elsewhere}$$

Notation: X ~ Exp(θ), sketch of p.d.f for various values of parameters, c.d.f, m.g.f, mean, variance, coefficient of variation, moments, β_1 and β_2 coefficients, median, quartiles, lack of memory property, distribution of $-(1/\theta)\log X$, $-(1/\theta)\log(1-X)$, where X~U(0,1). Exponential distribution with scale and location parameters.

Paper IV: Discrete Probability Distributions and Statistical Methods

1. Standard discrete distributions: (22)

1.1 Poisson distribution: Probability mass function (p.m.f)

$$P[X=x] = P(x) = \frac{e^{-\lambda}\lambda^x}{x!}, \quad x = 0, 1, 2, 3\text{----}, \quad \lambda > 0$$

$$= 0 \qquad \text{otherwise}$$

Notation: X ~ P(λ). Mean, variance, moments(up to fourth order), probability generating function (p.g.f), recurrence relation for Poisson probabilities, additive property, conditional distribution of X given X+Y where X and Y are independent r.v.s Poisson distribution as a limiting case of binomial distribution, illustration of Poisson distribution in real life situations and examples.

1.2 Geometric distribution: p.m.f.

$$P[X=x] = P(x) = q^x p, \qquad x=0, 1, 2, \text{----}, \quad 0 < p < 1, q = 1 - p$$

$$= 0 \qquad \text{otherwise}$$

Notation: X ~ G(p). Mean, variance, distribution function, p.g.f., lack of memory property.

Waiting time distribution: p.m.f.

$$P[Y = y) = p\, q^{y-1}, \quad y = 1, 2, 3, \text{----}$$

$$= 0 \qquad \text{otherwise}$$

Mean, variance and p.g.f. by using relation with geometric. Examples.

1.3 Negative Binomial distribution: p.m.f.

$$P[X=x] = P(x) = \binom{x+r-1}{r-1} p^r q^x,\ x = 0, 1, 3, - - - ;\ r > 0,\ 0< p <1,\ q = 1 - p$$

$$= \quad 0 \qquad \text{otherwise}$$

Notation: $X \sim NB(r, P)$. Geometric distribution is a particular case of Negative Binomial distribution, mean, variance, p.g.f., recurrence relation of probabilities, additive property, NB(r, p) as a sum of r i.i.d geometric r.v.s, illustration of Negative Binomial distribution in real life situations and simple examples.

1.4 Multinomial distribution: p.m.f., m.g.f., means, variances and covariance using m.g.f. marginal distribution.

2. Multiple linear regression (for tri-variate case): (10)

2.1 Plane of regression, Yule's notation, correlation matrix.

2.2 Fitting of regression plane by method of least squares, definition of partial regression coefficients and their interpretation. Necessary and sufficient condition for three regression planes coincide (with proof).

2.3 Residual: Definition, order, properties, derivation of mean and variance.

3. Multiple and partial correlations: (13)

3.1 Definition of multiple correlation coefficient $R_{i.jk}$, derivation of formula for multiple correlation coefficient.

3.2 Properties of multiple correlation coefficient: i) $0 \le R_{i.jk} \le 1$, ii) $R_{i.jk} \ge |r_{ij}|$, iii) $R_{i.jk} \ge |r_{ik}|$ for $i=j=k=1, 2, 3.\ i \ne j,\ j \ne k$.

3.3 Interpretation of i) $R_{i.jk} = 1$ and ii) $R_{i.jk} = 0$

3.4 Definition of partial correlation coefficient $r_{ij.k}$, derivation of formula for $r_{ij.k}$

3.5 Properties of partial correlation coefficient i) $-1 \leq r_{ij.k} \leq 1$, and ii) $b_{ij.k} * b_{ji.k} = r_{ij.k}^2$. Effect of partial correlation coefficient on regression estimate (Larger the regression coefficients better is the regression estimate).

3.6 Examples and problems.

Semester –IV

PAPER V: Continuous Probability Distributions and Exact Sampling Distributions

1. Gamma, Beta and Normal Distribution: (27)

1.1 Gamma distribution: p.d.f (two Parameters)

$$f(x) = \frac{\alpha^{\lambda}}{\lfloor\overline{\lambda}} e^{-\alpha x} x^{\lambda-1}, \qquad x>0,\ \alpha>0,\ \lambda>0$$

$$= 0 \qquad \text{elsewhere}$$

Notation : $X \sim G(\alpha,\lambda)$, sketch of p.d.f for various values of parameters, 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.

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

$$f(x) = \frac{1}{\beta(m,n)} x^{m-1}(1-x)^{n-1} \qquad 0<x<1;\ \ m, n >0$$

$$= 0 \qquad \text{elsewhere.}$$

Notation : $X \sim \beta_1(m,n)$, sketch of p.d.f for various values of parameters, 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).

1.3 Beta distribution of second kind: p.d.f

$$f(x) = \frac{1}{\beta(m,n)} \frac{x^{m-1}}{(1+x)^{m+n}} \qquad x>0 \; ; \; m, n >0$$

$$= 0 \qquad \text{elsewhere.}$$

Notation : $X \sim \beta_2(m,n)$, mean, harmonic mean, mode, variance, uniform distribution of 1/X. Relation between beta distribution of 1st kind and beta distribution of 2nd kind. Distribution of X+Y, X/Y, and X/(X+Y), where X and Y are independent gamma variates.

1.4 Normal distribution : p.d.f.:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \qquad -\infty < x < \infty \quad -\infty < \mu < \infty \quad \sigma >0$$

Notation : $X \sim N(\mu,\sigma^2)$, sketch of p.d.f for various values of parameters, properties of normal curve, mean, median, mode, variance, quartiles, point of inflexion, moments, recurrence relation for central moments, m.g.f., β_1, β_2 γ_1, γ_2 coefficients, 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 r.v.s, normal as a limiting case of i) Binomial ii) Poisson (without proof), illustrations of use of normal distribution in various fields.

2. Exact Sampling Distributions: (18)

2.1 Chi-square distribution:

Definition of chi-square variate as a sum of square of n i.i.d standard normal varaites, derivation of p.d.f of χ^2 with n degrees of freedom (d.f.) using m.g.f. Sketch of p.d.f for various values of parameters(d.f), mean, mode, variance, moments, skewness, kurtosis, m.g.f., additive property, relation with gamma distribution, Normal approximation to χ^2.

2.2 Students t- distribution:

Definition of t- variate with n d.f. in the form $t = \frac{U}{\sqrt{\frac{\chi^2}{n}}}$ where $U \sim N(0,1)$ and

χ^2 is chi-square variate with n d.f. and U and χ^2 are independent r.v.s, derivation of p.d.f., sketch of p.d.f for various values of parameters, mean, mode, variance, moments, β_1, β_2 γ_1, γ_2 coefficients.

2.3 Snedecor's F- distribution:

Definition of F- variate with n_1 and n_2 d.f. as $F = \frac{\chi_1^{\,2}/n_1}{\chi_2^2/n_2}$ where $\chi_1^2 and \chi_2^2$ are independent chi-square variates with n_1 and n_2 d.f. respectively, mean, mode, variance. Interrelation between t, F and χ^2.

PAPER –VI: Applied Statistics

1. Sampling Theory: (13)

1.1 Definition of population, sample, statistic, parameter, sample survey, census survey. Advantages of sample survey over census survey.

1.2 Methods of sampling: i) Deliberate (purposive) sampling ii) probability sampling and iii) Mixed sampling.

1.3 Simple random sampling (SRS): SRS with and without replacement. Proof of (i) Expected value of sample mean is population mean, (ii) Expected value of product of population size and sample mean is population total, (iii) Expected value of sample mean square is population mean square, (iv) Variance of sample mean and (vi) Estimated variance of sample mean. Standard error of sample means, comparison of SRSWR and SRSWOR.

2. Tests of Hypothesis: (12)

2.1 Notion of hypothesis, null and alternative hypothesis, simple and composite hypothesis, test statistic, critical region, idea of one and two tailed test, type I and type II errors, level of significance, p-value.

2.2 Large sample tests: Construction of test statistic and identification of its probability distribution.

a) Tests for means i) $H_0 : \mu = \mu_0$ ii) $H_0 : \mu_1 = \mu_2$.

b) Tests for proportion: i) $H_0 : P_0 = P_1$ ii) $H_0 : P_1 = P_2$.

c) Tests for population correlation coefficient: i) $H_0: \rho = \rho_0$ ii) $H_0: \rho_1 = \rho_2$, using Fisher's Z transformation.

2.3 Small sample tests: If $X_1, X_2,$ ------- X_n is a r.s from $N(\mu, \sigma^2)$ then and S^2 are

independently distributed (without proof), construction of test statistic and identification of distribution of test statistic.

a) t-tests for means: i) $H_0: \mu = \mu_0$ (σ is unknown), ii)$H_0: \mu_1 = \mu_2$ ($\sigma_1 = \sigma_2$ is unknown) unpaired t test. iii) $H_0: \mu_1 = \mu_2$ (paired t test).

b) χ^2 -tests:

i) test for population variance (when mean is given and not given)

ii) test for goodness of fit,

iii) tests for independence of attributes (a) M X N contingency table (b) 2 X 2 contingency table, Yate's correction for continuity (concept only).

c) F- tests: test for equality of population variance.

2.4 Illustrative examples.

3. Statistical Quality Control (SQC): (12)

3.1 Meaning and purpose of SQC, quality of product, process control, product control, assignable causes, chance causes, Shewhart's control chart: construction, working, theoretical basis, 3σ –control limits and lack of control situation.

3.2 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

3.3 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.

3.4 Control chart for number of defects(C-chart): for standards are not given, construction and working of the chart, revised control limits.

4. Elements of Demography: (08)

4.1 Introduction and need of vital statistics.

4.2 Mortality rates: Crude Death Rate (CDR), Specific Death Rate, Standard Death Rate

4.3 Fertility rates: Crude Birth Rate (CBR), General Fertility Rate (GFR), Age Specific Fertility Rate(ASFR), Total Fertility Rate (TFR).

4.4 Reproduction rates: Gross Reproduction Rate (GRR), Net Reproduction Rate(NRR).

4.5 Illustrative examples.

Practical Course at B.Sc. Part- II

Objectives:

By the end of course students are expected to:

i. Compute probabilities of standard probability distributions.

ii. Compute the expected frequency and test the goodness of fit.

iii. Drawing random samples from standard probability distributions.

iv. Compute the multiple and partial correlation coefficients.

v . Selection of samples by SRS.

vi. Computation and interpretation of vital statistics.

v. Construction of control chart.

vi. Interpretation of results obtained by using MS-Excel.

PRACTICAL –II

1. Fitting of Discrete Uniform distribution and test for goodness of fit.
2. Fitting of Binomial distribution and test for goodness of fit.
3. Fitting of Hyper-geometric distribution and test for goodness of fit.
4. Fitting of Poisson distribution and test for goodness of fit.
5. Fitting of Geometric distribution and test for goodness of fit.
6. Fitting of Negative Binomial distribution and test for goodness of fit.(k should be taken to the next integer.)
7. Model sampling from of Discrete Uniform and Binomial distribution.
8. Model sampling from of Hyper-geometric distribution
9. Model sampling from of Poisson and Geometric distribution
10. Model sampling from of Negative Binomial distribution

11. Fitting of Continuous Uniform distribution and test for goodness of fit.

12. Fitting of Exponential distribution and test for goodness of fit.

13. Fitting of Normal distribution and test for goodness of fit.

14. Model sampling from Continuous Uniform and Exponential distribution.

15. Model sampling from Normal distribution.

16. Application of Exponential and Normal distributions.

17. Fitting of Binomial, Poison & Negative Binomial distribution using MS-Excel.

18. Fitting of Exponential & Normal distribution using MS-Excel.

19. Model sampling from continuous Uniform and Exponential distributions by using MS-Excel.

20. Model sampling from Normal distribution by using MS-Excel.

PRACTICAL –III

1. Fitting of straight lines and second degree curves.

2. Fitting of curves of type $Y = a.b^X$, $Y= a.X^b$ and $Y= a.e^{bX}$

3. Multiple regressions.

4. Multiple and partial correlation.

5. Large sample tests for means.

6. Large sample tests for proportions.

7. Tests for population correlation coefficients (Using Fisher's Z transformation)

8. Tests based on Chi-square distribution.

   (Test for population variance, Test for goodness of fit)

9. Tests for independence.

10. Tests based on t distribution ($\mu=\mu_0$, $\mu_1=\mu_2$, paired and unpaired)

11. Tests based on F distribution ($\sigma_1^2 = \sigma_2^2$)

12. Construction of and R chart.

13. Construction of P and C chart.

14. Application of Poisson, Geometric & Negative Binomial distributions.

15. Application of multinomial distribution.

16. Simple random sampling (with and without replacement).

17. Demography-I (Mortality Rates)

18. Demography-II (Fertility Rates, Population Growth)

19. Fitting of Straight line, parabola, and exponential curves using MS-EXCEL.

20. Multiple, partial correlation and partial regression coefficients using MS-EXCEL.

Note:

i) Computer printouts are to be attached to the journal.

ii) Observation table and/or calculations using statistical formulae should be done by MS-EXCEL and verify by using library functions.

iii) Student must complete the entire practical to the satisfaction of the teacher concered.

iv) Student must produce the laboratory journal along with the completion certificate duly signed by Head of Department at the time of practical examination.

Laboratory requirements:

Laboratory should be well equipped with sufficient number of electronic calculators and computers along with necessary software, printers and UPS.

Nature of Theory question paper of B.Sc.Part-II

Each theory paper is of 70 marks, containing five questions.

Q. NO.	Nature of question	Marks
1.	Objective type questions (Multiple choice)	10
2.	Short answer type questions (Five out of Seven) (Each of 3 marks)	15
3.	Short answer type questions (Three out of Four) (Each of 5 marks)	15
4.	Short answer type questions (Three out of Four) (Each of 5 marks)	15
5.	Long answer type question.	15

Nature of Practical question paper of B.Sc.Part-II

a) Each practical paper of 70 marks, containing four questions each of 30 marks and students has solve two questions. In only one of four questions there shall be a sub question of about 15 marks based on MS-EXCEL.

b) Evaluation of MS-EXCEL based question will be on line and should be demonstrated to the examiner.

c) 5 marks are reserved for journal and 5 marks for oral examination.

d) Practical examination is of FOUR hour duration which includes oral examination and online demonstration.

Reference Books for Paper-III and Paper –IV

Sr.No.	Name of the Authors	Title
1.	Hogg R.V. and Craig A.T.	Introduction to Mathematical Statistics (Third edition), Macmillan Publishing, New York.
2.	Gupta S.C. & Kapoor V.K	Fundamentals of Mathematical Statistics Sultan Chand &sons, New Delhi
3.	Gupta S.C. & Kapoor V.K	Fundamentals of Applied Statistics

		Sultan Chand & sons, New Delhi
4.	Mood A.M.,Graybill F.A and Boes D.C.	Introduction to theory of Statistics Tata McGraw Hill, New Delhi
5.	Walpole R.E & Mayer R.H.	Probability and Statistics MacMillan Publishing Co. Inc, New York
6	Duncan A.J	Quality control and Industrial Statistics D.B.Tataporewala & Sons Co. Mumbai
7.	Mayer P.L	Introductory probability & Statistical Applications. Oxford & IBH Publication Co. 66 Janpath New Delhi.
8.	Kapoor J.N & Saxana H.C	Mathematical Statistics Sultan Chand & sons, New Delhi
9.	Goon A.M., Gupta A.K. and Dasgupta	Fundamentals of Statistics (vol. I &II) The world calcutta Press Pvt.Ltd.,Calcutta
10.	Rohatgi V.K	Introduction to Probability theory & Mathematical Statistics Wiley Eastern Limited.
11.	Kangji K.	100 Statistical Tests
12.	Kulkarni M.B., Gore A.P. &Ghatpande S.B.	Common Statistical Tests. Satyajeet Prakashan, Pune
13.	Gupta S.D.	Statistical Methods. Sultan Chand & sons, New Delhi
14.	Gupta S.C.	Fundamentals of Statistics. Himalaya Publishing House, Mumbai.
15.	Grant E.L.	Statistical Quality Control.
16.	Gupta S.P.	Statistical Method.
17.	Montgomery	Introduction to Statistical Quality Control
18.	Srivastav D.S.	A text book of Demography