Savitribai Phule Pune University

(Formerly University of Pune)

REVISED SYLLABUS OF

T. Y. B. A. STATISTICAL PREREQUISITES (General)
Choice Based Credit System Syllabus

With Effect from June 2021

Preamble:

Statistics is used in different contexts various different ways. For example, for a cricket fan, Statistics is the information about runs scored or wickets taken by a player. For the manager of a manufacturing unit, Statistics may be the information about the production/manufacturing process. For a medical researcher, investigating the effects of a new drug, Statistics is the evidence of research efforts. For a college student, Statistics shows the grades or marks scored in a course. Thus, in all these examples, Statistics refers to quantitative data from the area under study. Statistics as a subject is an important branch of knowledge and is devoted to various techniques of collection, presentation, analysis and interpretation of data. It is a science of learning from data. The subject provides tools from probability for making decisions when conditions of uncertainty prevail. Hence Statistical tools and techniques are used in almost all fields such as agriculture, business, management, economics, finance, insurance, education, sports, biotechnology, medical science, etc. During the last two decades, large amount of data has been collected with the help of computers and various information technology system and more and more sophisticated statistical techniques are needed for the effective analysis and to draw meaningful conclusions from these data. Knowledge of different aspects of Statistics has become crucial in the present technologically advanced scenario. There is a continuous demand for statisticians in fields of education, industry, software and research. The syllabi of three-year B.A. (Special) degree course in Statistics are framed in such a way that the students at the end of the course are thorough in basic statistical techniques and are ready to pursuea Master degree and/or simultaneously able to seek jobs involving statistical analysis related to a variety of data sets in order to arrive at some valid conclusions.

Note:

(1) A student of the Three-Year B.A. Degree Course opting ‘Statistics’ at the special level must opt ‘Mathematical Statistics’ as a General level subject in all the three years of the course. Further, students of the three-year B.A. Degree Course are advised not to opt ‘Statistics’ as the General level unless they have opted for ‘Mathematical Statistics’ as a General level subject in all the three years of the course.

(2) A student of three-year B.A. Degree Course offering ‘Statistics’ will not be allowed to take ‘Applied Statistics’ and ‘Statistical Pre-requisites’ in any of the three years of the course.

(3) Structure of evaluation of theory paper at T.Y.B.A. Statistics (special and general), Applied statistics and Statistical pre-requisites:

A) Continuous Internal Assessment (CIA) for theory subjects:

Section	Marks
i) Theory examination ii) Home assignment iii) Seminar/class test etc.	20 05 05
Total of CIA	30

B) End Semester Examination (ESE) for theory subjects:

Question	Nature	Marks
1	a) Choose correct alternative: i) ii) iii) iv) v) (each with four multiple choice answer A, B, C, D) b) True or false: i) ii) iii) iv) v)	5 5
2	Attempt any four of the following: a) b) c) d) e) f)	20
3	Attempt any four of the following: a) b) c) d) e) f)	20
4	Attempt any two of the following: a) b) c) d)	20
	Total ESE	**70***

* Numerical problem should not exceed 40% of total marks with option questions.

Instruction for Examination:

1. Theory question paper for each subject shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of prescribed.
2. Medium of Instruction: English
3. Examination:

A) Pattern of examination: Semester wise

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

NOTE: The course Statistical Pre-requisites may be opted only by candidates opting for one of the social sciences as their special subject at the B.A. Degree Examination. The course Statistical Pre-requisites cannot be opted by those who opt for any of the courses in Statistics Groups for their B.A. Examination

Subject: STATISTICAL PREREQUISITES (General)

SEMESTER V

ST-33575: Continuous Distribution and Tests of Significance (SEC 1C)

Note: (i) Proof or derivations of results are not expected.
(ii) Emphasis should be given more on numerical problems.

Objectives: The main objective of this course is to introduce students to continuous type distributions, central limit theorem and tests based on significance. Also to acquaint students with testing procedures based on t, chi-square and F distributions.

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

- to understand continuous probability distribution. Also, to apply Normal distribution and its properties to different situations,
- to work Central Limit Theorem and Weak Law of Large Numbers,
- to apply tests based on Normal distribution,
- to carry out tests based on based on t, Chi-square and F distributions.

Contents:

1. Continuous type distributions: (10L)

1.1 Definition of continuous type of r.v. using p.d.f.

1.2 Continuous distribution function: Definition and properties.

1.3 Normal distribution: Definition using p.d.f.

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

$$= 0, otherwise$$

Notation: $X \rightarrow N(\mu, \sigma^2)$

Nature of probability curve for various values of parameters, statement for properties of normal distribution, Standard normal distribution

2. Central Limit Theorem and Weak Law of Large Numbers: (8L)

2.1 Sequence of r.v.s., convergence of sequence of r.v. in a) probability b) distribution with simple illustrations.

2.2 Only statements of the Central Limit Theorem (CLT) for i.i.d. r.v.s. and Weak law of large numbers (WLLN). Applications of CLT and WLLN.

3. Tests of significance: **(15L)**

3.1 Notion of random sample and a statistic as a function $T(X_1, X_2, \ldots, X_n)$ and its illustrations.

3.2 Sampling distribution of $T(X_1, X_2, \ldots, X_n)$. Notion of standard error of a statistic.

3.3 Notion of hypothesis, null and alternative, critical region, level of significance, Type-I and Type-II error, size and power of test.

3.4 Tests for population mean and proportion based on Normal distribution

(i) $H_0 : \mu = \mu_0$ against $H_1 : \mu \neq \mu_0 , \mu < \mu_0 , \mu > \mu_0$
(ii) $H_0 : \mu_1 = \mu_2$ against $H_1 : \mu_1 \neq \mu_2 , \mu_1 < \mu_2, \mu_1 > \mu_2$
(iii) $H_0 : P = P_0$ against $H_1 : P \neq P_0 , P < P_0 , P > P_0$
(iv) $H_0 : P_1 = P_2$ against $H_1 : P_1 \neq P_2, P_1 < P_2 , P_1 > P_2$

4. Tests based on t, Chi-square and F distributions: **(15L)**

4.1 t-tests for mean

(i) H_0: $\mu = \mu_0$ against H_1: $\mu \neq \mu_0$, $\mu < \mu_0$, $\mu > \mu_0$
(ii) H_0: $\mu_1 = \mu_2$ against H_1: $\mu_1 \neq \mu_2$, $\mu_1 < \mu_2$, $\mu_1 > \mu_2$
(iii) Paired t-test

4.2 Chi-square test for variance

(i) H_0: $\sigma^2 = \sigma_0^2$ against H_1: $\sigma^2 \neq \sigma_0^2$, $\sigma^2 < \sigma_0^2$, $\sigma^2 > \sigma_0^2$
(ii) Goodness of fit.
(iii) Independence of attributes: Chi square test for independence of 2 x 2 contingency- table (without proof). Yate's correction not expected.

4.3 F-test for H_0: $\sigma_1^2 = \sigma_2^2$ against H_1: $\sigma_1^2 \neq \sigma_2^2$, $\sigma_1^2 < \sigma_2^2$, $\sigma_1^2 > \sigma_2^2$

References:

1. Goon, Gupta and Dasgupta (1968): Fundamentals of Statistics, Vol. I, The World Press Pvt. Ltd. Calcutta.
2. Gupta, S. P. (2014): Statistical Methods, Sultan Chand and Sons, Delhi.
3. Gupta S.C., and Kapoor V.K. (1994): Fundamentals of Applied Statistics, Sultan Chand & Sons, Delhi.
4. Hoel, P. G. (1965): Introduction. of Mathematical Statistics, John Wiley and Sons Co. New York.
5. Larson H.J. (1982): Introduction to Probability Theory and Statistical Applications, A Wiley International Edition.
6. Meyer, P. L. (1970): Introductory Probability Theory and Statistical Applications, Addison-Wesley Publishing Company.
7. Walpole, *R.E.* (1982): Introduction to Statistics, Macmillan Publishing Co. New York.
8. Gupta S.C., and Kapoor V.K. (2000): Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Delhi.
9. D. C. Montgomery, D. C. (2013): Design and Analysis of Experiments, John Wiley & Sons Inc.

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Subject: STATISTICAL PREREQUISITES (General)
SEMESTER VI

ST-33576: Design of Experiments, Non-parametric Tests and Statistical Quality Control (SEC 1D)

Note: (i) Proof or derivations of results are not expected.
(ii) Emphasis should be given more on numerical problems.

Objectives: The main objective of this course is to introduce students to basic concepts of Design of Experiments and Non-Parametric tests, Also to strengthen students' regarding the foundation of Statistical Quality Control.

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

- to understand Analysis of Variance techniques,
- to get acquainted with basics of Design of Experiment,
- to apply Non-Parametric tests,
- to understand the concepts of Statistical Quality Control.

Contents:

1. Design of Experiments: (18L)

1.1 Basic terms of design of experiments: Experimental material, experimental unit, experimental error, treatment, block, layout of an experiment. Basic principles of design of experiments: Replication, randomization and local control. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per unit area of plots

1.2 Concept of analysis of variance:
One-way and two-way classification: break up of total sum of squares and total degrees of freedom (d.f.), analysis of variance table, test of hypotheses of (i) equality of several means, (ii) equality of two means.

1.3 Completely Randomized Design(CRD): Application of the principles of design of experiment in CRD, layout,

Model: $X_{ij}= \mu+ \alpha_i+ \varepsilon_{ij}$, where i=1, 2, …, t; j=1,2,…,n_i

Assumptions and interpretations Testing normality graphically. Statement of partition of total sum of squares and degrees of freedom(d.f). Hypotheses to be tested, ANOVA table and test of significance of hypotheses.

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

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

Assumptions and interpretations Statement of partition of total sum of squares and degrees of freedom (d.f) Hypotheses to be tested, ANOVA table and test of significance of hypotheses.

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

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

Assumptions and interpretations, statement of partition of total sum of squares and degrees of freedom (d.f) Hypotheses to be tested, ANOVA table and test of significance of hypotheses.

2. Non - parametric tests: (8L)

2.1 Distinction between a parametric and non-parametric problem.

2.2 Concept of distribution free statistic.

2.3 One-tailed and two-tailed test procedure of

(a) Sign test, (b) Wilcoxon's signed rank test.

2.4 Test for randomness.

3. Statistical quality control (22L)

3.1 Statistical quality control: Meaning and Scope.

3.2 Control chart - Introduction:

Chance and assignable causes of quality variations, statistical basis of control chart (connection with test of hypothesis is NOT expected). Control limits (3- sigma limits only). Criteria for judging lack of control:

(i) One or more points outside the control limits and

(ii) Non-random variations within the control limits: such as a run of seven or more points on either side of the control line, presence of trend or cycle.

3.3 Control charts for variables:

Purpose of R-chart and X-bar chart, construction of R-chart, X-bar chart when standards are not given. Plotting the simple mean and ranges on X-bar and R charts respectively Necessity for plotting R-chart. Revision of R-chart. Drawing conclusion about state of process. Revision of X-bar chart, Control limits for future production.

3.4 Control Chart for attributes:

(a) Control chart for fraction defective (p-chart) only for fixed sample size. Determination of central line, control limits on p-chart, plotting of sample fraction-defectives on p-chart. Revision of p-chart, determination of state of control of the process and interpretation of high and low spots on p-chart. Estimation of central line and control limits for future production.

(b) Control chart for number of defects per unit (c-chart) Construction of c-chart when standards are not given. Plotting of number of defects per unit on c-chart, determination of state of control of the process, revision of control limits for future production.

3.5 Identification of real life situations where these charts can be used.

References:

1.Goon, Gupta and Dasgupta (1968): Fundamentals of Statistics, Vol. I, The World Press Pvt.Ltd. Calcutta.

2. Gupta, S. P. (2014): Statistical Methods, Sultan Chand and Sons, Delhi.

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