

**CIRCULAR NO.SU/B.Sc./CBC&GS /67/2023**

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies, Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **following syllabi of Bachelor of Science with Practical Pattern of Question Paper under the scheme of Choice Based Credit & Grading System** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc. Biotechnology (Degree)	IIIrd & IVth semester
2.	B.Sc. Automobile Technology (Degree)	IIIrd & IVth semester
3.	B.Sc. Workshop Technology (Degree)	IIIrd & IVth semester
4.	B.Sc. Refrigeration and Air Conditioning (Degree)	IIIrd & IVth semester
5.	B.Sc. Physics (Optional)	IIIrd & IVth semester
6.	B.Sc. Chemistry (Optional)	IIIrd & IVth semester
7.	B.Sc. Analytical Chemistry (Optional)	IIIrd & IVth semester
8.	B.Sc. Statistics (Optional)	IIIrd & IVth semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.

REF.NO.SU/2023/670-77
Date:- 03.06.2023.

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*Deputy Registrar,
Academic Section*

Copy forwarded with compliments to :-

- 1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

- 1] **The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.**
- 2] The Section Officer,[B.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
- 3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
- 4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
- 5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
- 6] The Public Relation Officer, Dr.BAMU,A'bad.
- 7] The Record Keeper, Dr.BAMU,A'bad.

Dr. Babasaheb Ambedkar Marathwada University



Revised Syllabus of Statistics.

B.A./B. Sc. Second Year

III & IV Semester

Effect from the Academic Year 2023-2024

Semester III								
	Course Code	Course Title	Total Periods (Teaching Period/Week)	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSC-1C) Core Courses	STA-311	Statistical Methods Core Course (Theory Paper-V)	45 (3/week)	2	50	10	40	20
	STA-312	Sampling Techniques Core Course (Theory Paper-VI)	45 (3/week)	2	50	10	40	20
	STA-321	Lab Course 3 (Based on STA-311)	45 (3/week)	1.5	50	10	40	20
	STA-322	Lab Course 4 (Based on STA-312)	45 (3/week)	1.5	50	10	40	20
Skill Enhancement Course (SEC-1)	STA-313	SEC-1 Any one skill to be chosen out of two SEC-1(A) Data Collection and its Presentation Using Excel SEC-1(B) Statistical Data Analysis Using-R	45 (3/week)	2	50	10	40	20
Ability Enhancement Compulsory Courses (AECC-3)	STA-331	Communication Skills in English-III	45 (5/week)	3	50	10	40	20
	STA-332	Marathi/Hindi/Urdu/Sanskrit A Student can Opt. for one of these Languages (SL-III)	45 (4/week)	3	50	10	40	20
			315	15	350	70	280	140
Total Credits for Semester III : 15 (Theory: 12 ; Laboratory : 3)								
Semester IV								
	Course Code	Course Title	Total Periods (Teaching Period/Week)	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional I (DSC-1D) Core Courses	STA-411	Sampling Distributions Core Course (Theory Paper-VII)	45 (3/week)	2	50	10	40	20
	STA-412	Applied Statistics Core Course (Theory Paper-VIII)	45 (3/week)	2	50	10	40	20
	STA-421	Lab Course 5 (Based on STA-411)	45 (3/week)	1.5	50	10	40	20
	STA-422	Lab Course 6 (Based on STA-412)	45 (3/week)	1.5	50	10	40	20
Skill Enhancement Course (SEC-2)	STA-413	SEC-2 Any one skill to be chosen out of two SEC-2(C) Statistical Methods Using Excel SEC-2(D) Statistical Methods Using R Software	45 (3/week)	2	50	10	40	20
Ability Enhancement Compulsory Courses (AECC-4)	STA-431	Communication Skills in English-IV	45 (5/week)	3	50	10	40	20
	STA-432	Marathi/Hindi/Urdu/Sanskrit A Student can Opt. for one of these Languages (SL-IV)	45 (4/week)	3	50	10	40	20
Additional Credits		Environmental Studies	45 (3/week)	2*	50	10	40	20
			315	15	350	70	280	140
Total Credits for Semester IV : 15 (Theory: 12 ; Laboratory : 3)								

Course outcome

After completing the course **STA-311** Students will be able to

- (i) Learn to decide suitable model for the data.
- (ii) Learn to apply different suitable models to data.
- (iii) Learn different probability models inter relations.

After completing the course **STA-312** Students will able to

- (i) To apply different sampling.
- (ii) To comparison of different methods of sampling.
- (iii) To determination of sample size.

After completing the course **STA-411** Students will able to

- (i) To apply sampling distribution
- (ii) To decide the appropriate test according to objectives/Hypothesis.
- (iii) To apply the appropriate test according to objectives/Hypothesis.

After completing the course **STA-412** Students will able to

- (i) To fit Regression.
- (ii) Indentify different trends in data.
- (iii) Compute different Index numbers.


PROFESSOR AND HEAD
DEPARTMENT OF STATISTICS
DR. Babasaheb Ambedkar
Marathwada University
Aurangabad (M.S.)

STA- 311

credit: 2

STATISTICAL METHODS

Unit I: Standard Univariate Continuous Distributions

(15 lectures)

Uniform Distribution:-

- 1.1 Definition mean variance.
- 1.2 Symmetry, c.d.f.
- 1.3 Sketch of p.d.f. Distribution of $\frac{x-a}{b-a}, \frac{b-x}{b-a}$

Normal Distribution:-

- 1.4 Definition mean , variance.
- 1.5 Chief characteristics.
- 1.6 M.G.F. C.G.F. central moments Cumulants $\beta_1, \beta_2, \gamma_1, \gamma_2$
- 1.7 Median, Mode.
- 1.8 Additive property, probability distribution of standard normal variates.
- 1.9 Probability distribution of $\bar{x}$; the mean of i.i.d. $N(\mu, \sigma^2)$ random variables.
- 1.10 Area property central limit theorem(statement only)
- 1.11 Test of Normality

Unit II: Standard Continuous Distributions (Continued)

(15 lectures)

Exponential Distribution :-

- 2.1 Definition.
- 2.2 Nature of p.d.f & curve.
- 2.3 Mean, median, variance, M.G.F , C.G.F.
- 2.4 Lack of memory property.
- 2.5 Distribution of min (x,y) where x,y i.i.d. exponential random variables.

Gamma distribution :-

- 2.6 Definition M.G.F. , C.G.F.
- 2.7 Moments, cumulants, $\beta_1, \beta_2, \gamma_1, \gamma_2$
- 2.8 Mode, additive property.
- 2.9 Distribution of sum of n i.i.d. exponential random variables.
- 2.10 Relation between distribution function of Poisson and Gamma variates.
- 2.11 Recurrence relation between moments

Unit III: Continuous Distributions (Continued)

(15 lectures)

β_1 distribution

- 3.1 Definition.
- 3.2 Mean, median, variance., Moments
- β_2 distribution:-**
- 3.3 Definition.
- 3.4 Mean, median, variance. And Moments
- 3.5 Inter relation between β_1, β_2 and Gamma distributions.
- Cauchy Distribution:-**
- 3.6 Definition ,C.D.F
- 3.7 median, Mode
- 3.8 distribution of x/y is Cauchy if x and y are i.i.d. standard normal(with proof)
- 3.9 properties of Cauchy distribution

STA- 312

Credits :2

SAMPLING TECHNIQUES

Unit I: Basics of sampling

(15 lectures)

- 1.1 Introduction to theory of sampling.
- 1.2 Fundamental Definitions; sample (n), population (N), sample mean, sample variance sample size, sample mean square.
- 1.3 Some more definitions;
Sampling unit, sampling frame, parameter, statistic, sampling distribution, standard error, utility of standard error, Estimator, unbiased estimator.
- 1.4 Principal steps in sample survey.
- 1.5 Principles of sample survey, Principle of statistical regularity, principle of validity and principle of optimization.
- 1.6 Sampling & complete enumeration and their merits & demerits.
- 1.7 Probability and Non probability sampling.
- 1.8 Sampling and Non sampling errors.
- 1.9 Estimation of sample size.

Unit II: Simple random sampling

(15 lectures)

- 2.1 Introduction to SRSWOR Proof of $P(E_r) = \frac{1}{N} = P(E_1)$ where E_r is the event that the specified unit is not selected in anyone of the previous $(r-1)$ draws and then selected at r th draw. Proof of in SRS each of ${}^N C_n$ samples have equal probability of being selected and is $P = \frac{1}{Ncn}$
- 2.2 Methods of selection of simple random sample. Lottery method, mechanical randomization or random numbers method.
- 2.3 Theorems on unbiasedness of sample mean and sample mean square.
- 2.4 Variance of sample mean in SRSWOR standard error of mean & its Estimate sampling fraction $= \frac{n}{N}$ and Finite population correction (FPC) $(1-f)$

- 2.5 Merits & limitations of SRS
- 2.6 Variance of sample mean in SRSWR & comparison with variance of sample mean in SRSWOR.
- 2.7 Simple random sampling of attributes Notations & terminology.
- 2.8 Theorems on unbiasedness and variance of sample proportion
- 2.9 Size of simple random sample for specified precision.

Unit III: Stratified and Systematic sampling (15 lectures)

- 3.1 Introduction and need of stratified sampling. Advantages of stratified random sampling
- 3.2 Notations & terminology in stratified random sampling. Mean of stratified random sample $\bar{y}_{st}$
- 3.3 Theorems on unbiasedness of $\bar{y}_{st}$ and variance of $\bar{y}_{st}$
- 3.4 Allocation of sample size & variance of $\bar{y}_{st}$ in proportional allocation.
- 3.5 Allocation of sample size in Optimum allocation with Linear cost function.
Proof of Variance of $\bar{y}_{st}$ is minimum for fixed total size of the sample (n) if n_i are proportional to $N_i S_i$ where n_i are stratum sample size N_i are stratum population size and S_i are population mean square for i^{th} stratum $i=1,2 \dots k$ is number of strata.
- 3.6 Variance of $\bar{y}_{st}$ for optimum allocation.
- 3.7 Comparison of precisions of simple random sampling proportional & optimum allocation.
- 3.8 Introduction to Systematic random sampling. Linear & Circular systematic sampling merits limitations of systematic sampling.
- 3.9 $\bar{y}_{sys}$ mean of systematic sample unbiasedness of $\bar{y}_{sys}$ and variance of $\bar{y}_{sys}$

STA– 321 (based on paper STA-311)

credit: 1.5

Lab course: 3

- 1) Testing normality of data using plots
- 2) Tests for normality.
- 3) Fitting of normal distribution
- 4) Fitting of exponential distribution.
- 5) Model sample from normal distribution using CDF
- 6) Model sample from normal distribution using Box –Muller transformation
- 7) Model sample from Cauchy distribution.

STA– 322 (based on paper STA-312)

credit: 1.5

Lab course:4

- 8) SRSWOR: Drawing samples of size 'n' from a population of size 'N' and Verification of results: (a) $E(\bar{y}_n) = \bar{Y}_N$ (b) $E(s^2) = S^2$
- 9) Verify $V(\bar{y}_n) = (1-f) \frac{s^2}{n}$ for SRSWOR
- 10) SRSWR: Drawing sample of size 'n' from population size 'N' and verification Of results (a) $E(\bar{y}_n) = \bar{Y}_N$ (b) $E(s^2) = \sigma^2$.

- 11) verify $V(\bar{y}_n) = \left(\frac{N-1}{Nn}\right) S^2$ for SRSWR
- 12) Estimation of sample size in SRS. Using stratum data estimation of $V(\bar{y}_{st})$ and quantify gain due to stratification.
- 13) Determination of stratum sample sizes under proportional and optimum Allocation and comparison of precision with SRSWOR
- 14) Drawing Systematic samples of size n and comparison of precision with SRS.

Skill Enhancement Elective

STA– 313 SEC-I(A) Data collection and its presentation using Excel

credit: 2

UNIT I: Basic Concepts on Population, Sample, Sampling unit, Parameter, Statistic, Standard error, Sample Size and its Determination. Steps in Sample design. Selecting the Problem and necessity of defining the Problem, Designing a questionnaire and a schedule for collecting data for a set of objectives under study with illustrated examples. Methods for collecting Primary and Secondary data and their merits and demerits.

UNIT II Graphical computation of Data and Interpretation : Histogram, frequency curve, frequency polygon, ogive curves. Diagrammatic computation of Data and Interpretation : Bar diagrams (simple, component, multiple, percentage Bars), Pie diagram. Classification and Tabulation of data. Data Interpretation techniques, Precaution in Interpretation. Data interpretation problems.

Reference Books : 1. Kotahri, C.R (2009): Research Methodology: Methods and Techniques, 2nd Revised Ed. Reprint, New Age International Publishers 2. S. P. Gupta : Statistical Methods

STA– 313 SEC-I(B) Statistical Data Analysis Using R

credit: 2

UNIT I Learn how to load data and data entry, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

UNIT II Generate automated reports giving detailed descriptive statistics, correlation and lines of regression. Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

UNIT III Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

Reference Books :

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.
2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York

(Semester-IV)

STA- 411

Credits :2

SAMPLING DISTRIBUTIONS

Unit I: Chi-Square Distributions

(15 lectures)

- 1.1 Definition and derivation of p.d.f of chi-square distribution, and relation with Gamma distribution
- 1.2 M.G.F. and C.G.F. mean variance and other moments of chi-square distribution.
- 1.3 Additive property of chi-square distribution.
- 1.4 Theorems on independent chi-square variates.
- 1.5 Limiting form of chi-square distribution.
- 1.6 Applications of chi-square distribution.
- 1.7 Testing independence of attributes (2x2 and r x s contingency table)
- 1.8 Chi-square test for population variance and its confidence interval.
- 1.9 Chi-square test for testing goodness of fit.

Unit II: Student's Distributions

(15 lectures)

- 2.1 Definition and p.d.f. of t-distribution and derivation of its p.d.f.
- 2.2 M.G.F. of t distribution.

- 2.3 Mean, median, mode, variance and other moments of t distribution.
- 2.4 Limiting form of t distribution
- 2.5 Distribution of $\bar{x}$ and s^2 (without proof)
- 2.6 t test for single mean and confidence interval for mean.
- 2.7 t test for difference between means (independent samples)
- 2.8 Paired – test (dependent samples)
- 2.9 test for significance of correlation coefficient

Unit III: F Distribution and Z transformation (15 lectures)

- 3.1 Definition and derivation of F- statistic its p.d.f., mean, mode and variance.
- 3.2 Distribution of 1/F. Relation between t, F & Chi square
- 3.3 F test for testing difference between population variances
- 3.4 Fisher's Z transformations
- 3.5 Application of Fisher's Z transformation in testing of hypothesis
- 3.6 Test based on proportions.

STA- 412

Credits :2

APPLIED STATISTICS

Unit I: Multiple & partial correlations & multiple regression (trivariate only)(15 lectures)

- 1.1 Concept of multiple & partial correlation and Multiple regressions.
- 1.2 Yule's notations, plane of regression, fitting of plane of regression by using principle of least squares. Estimation of regression coefficients.
- 1.3 Residuals and properties of residuals. Variance of residual.
- 1.4 Derivation of formula for multiple correlations.
- 1.5 Properties of multiple correlation
- 1.6 Derivation of formula for partial correlation and properties of partial correlation.
- 1.7 Multiple correlation in terms of total and partial correlation
- 1.8 Determination of Coefficient of multiple and partial correlation.
- 1.9 Testing significance of multiple and partial correlation coefficient.

Unit II: Time-Series Analysis

- 2.1 Definition and introduction to time series data
- 2.2 Components of time series data.
- 2.3 Analysis of time series. Mathematical model for the analysis of additive multiplicative and mixed model
- 2.4 Uses of time series analysis.
- 2.5 Measurements of trends: Graphical method, Method of semi averages and method of Moving averages, Merits and limitations of all methods.
- 2.6 Curve fitting by principle of least square straight line, second degree parabola, power And exponential curve.

- 2.7 Estimation of trend by method of least square Merits and limitations of the method.
- 2.8 Measurements of seasonal variation by method of simple average, ratio to trend, ratio to moving average mathematical problem, Merits and limitations.
- 2.9 Exponential smoothing.

Unit III: Index Numbers

- 3.1 Introduction to index number and their uses
- 3.2 Problems involved in the construction of index numbers
- 3.3 Notations Unweighted indices and weighted indices
- 3.4 Laspeyre's, Passche's, Fisher's and index number for prices and Quantities. Value of index number.
- 3.5 Upward and downward bias.
- 3.6 Unweighted and weighted averages of price relatives based on arithmetic and Geometric mean.
- 3.7 Chain base index number (CBI) conversion of CBI into fixed base index number (FBI) and vice versa.
- 3.8 Criteria of a good index Number, Mathematical test, Unit test, Time reversal test (TRT) Factor reversal test (FRT) Circular test.
- 3.9 Relation among index number.
- 3.10 Construction of cost of living index number and its uses.

STA– 421 (based on paper STA-411 and first unit of STA-412) credit: 1.5

Lab course:5

- 1) Test based on t distribution
- 2) Test based on F distribution and Test based on z – transformation.
- 3) Test based on chi-square distribution
- 4) Test based on proportions
- 5) Computation of partial and multiple correlation coefficients (Trivariate case only)
- 6) Obtaining plane of regression
- 7) Verification of properties of residuals.

STA– 422 (based on paper STA-412)

credit: 1.5

Lab course:6

- 1) Measurement of trend by method of 3-yearly and 4-yearly moving averages,
- 2) Exponential smoothing
- 3) Measurements of trend by least square method (St. Line, power curve and Exponential curve)
- 4) Measurements of seasonal variations by simple average method, ratio to Trend, ratio to moving average.

- 5) Comparison for unweighted indices by simple aggregative method and Average of price relatives' method.
- 6) Comparison of weighted indices by Lasprey's, Pasche's and fisher's formulae and Verification of test of adequacy for index numbers given by Lasprey's, Pasche's and fisher's formulae.
- 7) Construction of cost of living index number and chain base index number, conversion between C.B.I and F.B.I

Books Recommended:

1. Goon A.M.Gupta, M.K.Dasgupta(1991): Fundamental of Statistics, Vol World fress,Calcutta.
2. Hodges J.K. and Lehman EL (1964); Basic Concept of Probability and Statistics, Hidden day.
3. Mood A.M. Graybil F.A. and Boes D.C. (1974); Introduction to the Theory of Statistics, McGraw Hill.
4. Gupta and Kapoor: Fundamental of Mathematical Statistic, Sultan and Chand Pub.
5. Bhat B.R. Sriventatranana T. And Rao Madava K.S(1997) Statistical A Beginner's Text Vol II Nwe International (p)Ltd
6. Rohatgi V.k(1967) An introduction to probability Theory and Mathematical static John wely and Sons.
7. sucdecor G.w and Coohran W.G(1967): Statistical lows state University
8. Murthy M.N (1967) sampling Theory and Methods statistical Publishing Society Calcutta
9. Sampath S. (2000) :Sampling theory Norosa Publishing House
10. Sukhalme B.V.(1964) Sample Survey methods and its Applications Indian Society of Agricultural Statistics
11. Gupta and Kapoor Fundamental of Applied Statistics; Chand Pub
12. Goon A.M... M.K Gupta and b.daS Gupta Fundamentals of Statistics. VdII; (world Press Calcutta)
13. Des Reej(2000)Sample Survey Theory Naros Publising House
14. Cromon F.M and Cowdon D.j (1969) Applied General Statistics practice Hall of India.
15. Goon A.M Gupta M.K Das Gupta B. (1986) Fundamental of Statiistes Vol.II world press. Calcutta
16. Gupta and Kapoor
17. Fundamental of Applied statistics .S. Chand Gupta S.P,Statistical method .S chand
18. S.C Shrivastava , Sangya Shrivastava, Anmol Prakashan Pvt.ltd, NewDelhi
19. Asthana and Shrivastva: Applied Statistics of India (Cjaotany Pub)
20. Gupta and Mukhopadhyay P.P () Applied Statistics, Central Book Agency

Skill Enhancement Elective

STA- 413 SEC-2(C) Statistical method using R Excel

credit: 2

Unit 1: Testing independence of attributes, Test for population variance, test for goodness of fit, dependent and independent sample t test, testing significance of correlation coefficient.

Unit 2: Simple and multiple correlation, simple regression, Curve fitting (simple, linear, quadratic and exponential), exponential smoothing, index numbers (Lasprey's, Pasche's and fisher's)

Reference Books :

1. KVS Sarma, Excel made easy
2. Microsoft Excel Bible: The Comprehensive Tutorial Resource

STA- 413 SEC-2(D) Statistical method using R software

credit: 2

Unit 1: Testing independence of attributes, Test for population variance, test for goodness of fit, dependent and independent sample t test, testing significance of correlation coefficient.

Unit 2: Simple and multiple correlation, simple regression, Curve fitting (simple, linear, quadratic and exponential), exponential smoothing, index numbers (Lasprey's, Pasche's and fisher's)

Reference Books :

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.
2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York


PROFESSOR AND HEAD
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