No:BCU/BoS/Stat/ౖ೩೫/2021-22   Date: 13.10.2021.

NOTIFICATION

Sub: Statistics Syllabus for III, IV, V and VI Semesters of
        Bengaluru City University.

Ref: 1. Notification of even No. dated 04.09.2020.
        2. Recommendations of the Board of Studies in Statistics.
        3. Resolution of the Academic Council at its meeting
           held on 12.10.2021.
        4. Orders of the Vice-Chancellor dated 13.10.2021.
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The CBCS pattern Statistics Syllabus for I & II Semester students who have been admitted to B.Sc., I Semester during the academic year 2020-21 has been notified vide Notification cited at reference (1) above.

In pursuance to the recommendations of the Board of Studies in Statistics and the resolution of the Academic Council, cited at reference (2) & (3) above, the CBCS pattern Statistic Syllabus for III, IV, V and VI Semester students who have admitted to B.Sc., I Semester during the academic year 2020-21 of Bengaluru City University are hereby notified for implementation .

· The copy of the above Syllabus are notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To,
1. The Dean, Faculty of Science , BCU.
2. The Chairman & Members of BoS in Statistics , BCU.
3. The Principals of the concerned affiliated Colleges of BCU – through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file/University Website www.bcu.ac.in
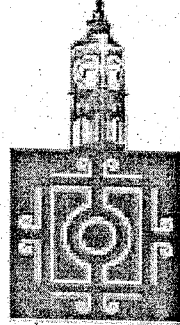
BENGALURU CENTRAL UNIVERSITY

SYLLABUS FOR B.Sc Statistics
(III ಕೆ VI Semester)

CHOICE BASED CREDIT SYSTEM
(SEMESTER SCHEME)

2020-21 onwards

BOARD OF STUDIES IN STATISTICS

Proceedings of the Meeting held on 04-10-2021at 12:00 noon

The meeting of Board of studies started with welcome by Chairman of the Board, Prof. Parameshwar V. Pandit. The members of the board participated actively in the discussion of framing the syllabus for I and II semesters along with structure, scheme for entire under-graduate and post graduate courses as per NEP 2020 guidelines.

The Board arrived at the following decisions:

1. The board finalized the structure, scheme of assessment for BSc, BSc(Honours) for Statistics as Discipline core (Major and Monor). Also, board finalized detailed content of syllabus for I and II semesters.

2. The board finalized the syllabus for III, IV, V and VI semesters syllabus as per 2018 guidelines.

Members Present:

1. Prof. Parameshwar V. Pandit - Chairman
2. Shri. R. Prakash
3. Smt. Mamta Ramesh
4. Dr. S.K. Lakshmi
5. Smt. Ambika .C.

Members Absent:

1. Dr. Ravindra Naika, T.
2. Sri Narayana Gowda
3. Dr. Mohankumari, C.
4. Roopa .M .C.

BENGALURU CITY UNIVERSITY
THIRD SEMESTER

4 hours lecture + 3 hours practical per week
(Theory 2 credits + Practicals 1 credit)

ST 301: STATISTCAL INFERENCE - I

(52 hours : 2 credits)

Unit 1

Sampling distributions: Population and sample. Sampling distribution and standard error. Sampling distribution of mean, variance. Chi-square, t, and F distributions – mean, variance, M.G.F, and properties.

10 hrs

Unit 2

Point estimation: Families of distributions - location and scale families. Single parameter exponential family. Point estimation. Concepts of estimator and estimate. Criteria for estimators: Unbiasedness, consistency. Invariance property of consistent estimators. Efficiency and relative efficiency. Mean square error as a criterion for comparing estimators. Sufficient statistic. Statement of Neyman - Factorization theorem. Fisher information function. Statement of Cramer - Rao inequality and its applications. Minimum variance unbiased estimator and minimum bound estimator.

20 hrs

Unit 3

Methods of point estimation: Maximum likelihood and method of moment estimation. Properties of maximum likelihood and moment estimators and examples.

6 hrs

Unit 4

Interval estimation: Confidence interval, confidence coefficient, shortest confidence interval. Method of constructing confidence intervals using pivotal quantity. Construction of confidence intervals for mean, difference of two means, variance and ratio of variances, proportion, difference of two proportions, and correlation coefficient.

8 hrs

Unit 5

Simulation: Introduction to simulation. Monte Carlo method. Generation of random observations from uniform, exponential, Normal, Cauchy, binomial, Poisson distributions. Simple illustrations.

8 hrs

ST 302: PRACTICAL III List of Assignments

(Demonstration using MS Excel and R Software)

1. Drawing random samples using random number tables .
2. Point estimation of parameters and obtaining estimates of standard errors.
3. Comparison of estimators by plotting mean square error.
4. Computing maximum likelihood estimates -1
5. Computing maximum likelihood estimates - 2
6. Computing moment estimates
7. Constructing confidence intervals based on large samples.
8. Constructing confidence intervals based on small samples.
9. Generating random samples from discrete distributions.
10. Generating random samples from continuous distributions.

Text Books

1. Goon A.M., Gupta, M.K., Das Gupta, B. (1991).*Fundamentals of Statistics*,Vol.I, World Press, Calcutta.
2. Hogg, R. V. and Craig, A.T. (1995).*Introduction to Mathematical Statistics,* 5/e, Prentice Hall, New Jersey, USA.
3. Medhi, J. (1992).*Statistical Methods: An introductory text,* New Age International, New Delhi.
4. Montgomery, D.C. and Runger, G.C. (2013). *Applied Statistics and Probability for Engineers,*WileyIndia, New Delhi.
5. Mukhopadhyay, P.(2015): *Mathematical Statistics,* Books and Allied (P) Ltd., Kolkata.
6. Spiegel, M.R. (2001).*Probability and Statistics*, 4/e, Schaum's Outline Series, McGraw Hill, London.
7. Walpole, R.E., Myers, R.H., and Myers, S.L. (2017). *Probability and Statistics for Engineers and Scientists,* 9/e, Pearson, New Delhi.

References

1. Bhattacharya, G. K. and Johnson, R.A. (1986): *Statistical Concepts and Methods*, John Wiley, New York.
2. Casella, G. and Berger, R.L. (1990). *Statistical Inference*, Duxbury Press, Belmont, California, USA. (2nd Edition).
3. Dudewicz, E.J. and Mishra, S.N.(1980). *Modern Mathematical Statistics,* John Wiley, New York.
4. Rohatgi, V.K. and Saleh, A.K. Md. E. (2002). *An Introduction to Probability and Statistics*, 2/e, John Wiley, New York.
5. Ross, S.M (2003). *Introduction to Probability Models*, 10/e, Academic Press, UK.

FOURTH SEMESTER
4 hours lecture + 3 hours practical per week
(Theory 2 credits + Practicals 1 credit)
ST 401: STATISTICAL INFERENCE - II

(52 hours : 2 credits)

Unit 1

Introduction to tests of hypotheses: Statistical hypotheses- null and alternative, simple and composite hypotheses. Type-I and Type-II errors, test functions. Randomized and nonrandomized tests. Size, level of significance, power function, power of tests. Critical region. p-value and its interpretation. Illustrative examples. Most powerful (MP) test. Statement of Neyman – Pearson lemma and its applications.

12 hrs

Unit 2

Tests of significance I: Large and small sample tests of significance. Tests for single mean, equality of two means, single variance, and equality of two variances for normal populations. Tests for proportions.

12 hrs

Unit 3

Tests of significance II: Tests for simple, partial, and multiple correlation coefficients and regression coefficients. Fisher's Z-transformation and its applications. Analysis of categorical data: contingency tables, tests for the independence and association of attributes. Chi-square tests for independence of attributes and goodness of fit.

12 hrs

Unit 4

Nonparametric tests: Introduction to nonparametric tests. Run test for randomness. Sign test and Wilcoxon signed rank test for one and paired samples. Run test, median test, and Mann-Whitney-Wilcoxon test for two sample problems. Test for independence based on Spearman's rank correlation coefficient.

10 hrs

Unit 5

Sequential tests: Need for sequential tests, Wald's SPRT for binomial proportion and Normal population mean when variance is known.

6 hrs

ST 402: PRACTICAL – IV List of Assignments

(30 hours : 1 credit)

(Demonstration of practicals using MS-Excel)

1. Evaluation of probabilities of Type-I and Type-II errors and powers of tests.
2. MP test for parameters of binomial and Poisson distributions.
3. MP test for the mean of a normal distribution and power curve.
4. Tests for mean, equality of means when variance is (i) known, (ii) unknown under normality (small and large samples)
5. Tests for single proportion and equality of two proportions.
6. Tests for variance and equality of two variances under normality
7. Tests for correlation and regression coefficients.
8. Tests for the independence of attributes, analysis of categorical data and tests for the goodness of fit.(For uniform, binomial and Poisson distributions)
9. Nonparametric tests.
10. SPRT for binomial proportion and mean of a normal distribution.

Text Books

1. Chandra,T. K. and Chatterjee, D. (2005). *A First Course in Probability*, Narosa Publishing House, New Delhi..
2. Hogg, R. V. and Craig, A.T. (1995).*Introduction to Mathematical Statistics, 5/e*, Prentice Hall, New Jersey, USA.
3. Lehmann, E. L. and Romano, J. P. (2005). *Testing Statistical Hypotheses, 2/e*, John Wiley, NewYork.
3. Montgomery, D.C. and Runger, G.C. (2013). *Applied Statistics and Probability for Engineers*, Wiley India, New Delhi.
4. Mukhopadhyay, P.(2015): *Mathematical Statistics*, Books and Allied (P) Ltd., Kolkata.
5. Walpole, R.E., Myers, R.H., and Myers, S.L. (2017). *Probability and Statistics for Engineers and Scientists, 9/e*, Pearson, New Delhi.

References

1. Bhattacharya, G. K. and Johnson, R.A. (1986): Statistical Concepts and Methods, John Wiley, New York.
2. Dudewicz, E.J. and Mishra, S.N.(1980). *Modern Mathematical Statistics*, John Wiley, New York.
3. Rohatgi, V.K. and Saleh, A.K. Md. E. (2002). *An Introduction to Probability Theory and Mathematical Statistics, 2/e*, John Wiley, New York.

BENGALURU CITY UNIVERSITY

FIFTH SEMESTER
6 hours of lecture + 6 hours of practical per week

(Theory: 4 credits + Practicals: 2 credits)
ST 501: SAMPLING THEORY AND STATISTICAL QUALITY CONTROL

(39 hours : 2 credits)

Unit 1

Introduction to sampling theory: Need for sampling. Complete enumeration Vs sample surveys. Probability and non-probability sampling.Methods of drawing random samples. Survey methods, principal steps in a sample survey, planning, execution, analysis, and reporting stages. Sampling and non-sampling errors.

5 hrs

Unit 2

Simple random sampling (SRS): Sampling with and without replacement. Unbiased estimators of population mean and total. Derivation of sampling variances.SRS for proportions.Derivation of the sampling variances and standard errors.Confidence limits.Determination of sample size.Advantages and limitations of SRS.

8 hrs

Unit 3

Stratified and Systematic sampling: Stratified random sampling: Need for stratification, advantages, and limitations. Unbiased estimators of population mean and total. Derivation of the variance of the estimators and their estimation. Proportional, optimum and Neyman allocations. Comparison of variances with SRSWOR.Estimation of gain in precision due to stratification.Linear systematic sampling, its advantages and limitations.Estimation of mean, total and variance of the estimators.Comparison with SRSWOR Circular systematic sampling.

10 hrs

Unit 4

Process control: Introduction to statistical quality control (SQC), aims and objectives. Chance and assignable causes of variation. Process control and product control. Control charts and basis for their construction. Action and warning limits. Various tools of SQC.Rational subgroups. Derivation of control limits, basis, construction, and interpretation of mean, range, and standard deviation charts, np-chart, p-chart, stabilized p-chart,c-chart and u-chart. Criteria for detecting lack of control.
Process capability study: Natural tolerance limits and specification limits, process capability, PCR and interpretation.

10 hrs

Unit 5

Product control: Lot acceptance sampling- Sampling inspection, 100 percent inspection and rectifying inspection. AQL, LTPD, Producer's risk and consumer's risk. Acceptance sampling plans – single and double sampling plans by attributes- Derivation of OC, AOQ, ASN, and ATI, functions for single sampling plan.

6 hrs

ST 502: PRACTICAL – V List of Assignments
(30 hours : 1 credit)

1. Drawing of random sample under SRSWR and SRSWOR from a given population and estimation of the mean and total and the standard errors of the estimators. Construction of confidence intervals.
2. Estimation of the proportion, total, and the standard errors of the estimators based on a random sample under SRSWR and SRSWOR .
3. Stratified random sampling-1
4. Stratified random sampling-2
5. Systematic sampling.
6. $\bar{X}-$ R charts. (Standard values known and unknown).
7. $\bar{X}-$ s charts. (Standard values known and unknown).
8. np and p charts. (Standard values known and unknown).
9. c and u charts. (Standard values known and unknown).
10. Drawing OC, AOQ, ASN, and ATI curves for single sampling plan.

Text Books

1. Goon A.M., Gupta, M.K., Das Gupta, B. (1991).*Fundamentals of Statistics*,Vol.I, World Press, Calcutta.
2. Grant, E.L. and Leavenworth, R. S. (1996). *Statistical Quality Control*. 7th edition, McGrawHill, New York.
3. Mahajan, M. (2001).*Statistical Quality Control*, Dhanpat Rai & Co. (P) Ltd. New Delhi.
4. Montgomery, D.C. (2013). *Introduction to Statistical Quality Control*, (Wiley Int.Edn.)
5. Cochran,W. G. (2007). *Sampling Techniques*. 3/e, John Wiley and Sons, New York.
6. Alwan, L. C. (2000). *Statistical Process Analysis*, McGraw Hill, New York.

References

1. John, S.O. and Followell, R. F. (1990). Statistical Process Control. (East West Press, India.
2. Mukhopadhyay, P (1996). Applied Statistics. Calcutta Publishing House.
3. Des Raj and Chandok, P. (1998). *Sampling Theory*, Narosa, New Delhi.
4. Mukhopadhyay, P. (2015): *Mathematical Statistics,* Books and Allied (P) Ltd., Kolkata.
5. Murthy, M.N. (1977). Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
6. Sampath, S. (2006). Sampling Theory and Methods, 2/e, Narosa, New Delhi.

ST 503: DESIGN AND ANALYSIS OF EXPERIMENTS

(39 hours : 2 credits)

Unit 1

Analysis of variance: Meaning and assumptions. Fixed, random and mixed effect models. Analysis of variance of one-way and two-way classified data with and without interaction effects. Multiple comparison tests: Tukey's method, critical difference.

10 hrs

Unit2

Experimental designs: Principles of design of experiments. Completely randomized, randomized block, and Latin square designs (CRD, RBD, and LSD) -layout formation and the analysis using fixed effect models.

10 hrs

Unit 3

Efficiency of a design and missing plot technique: Comparison of efficiencies of CRD, RBD, and LSD .Estimation of single missing observation in RBD and LSD and analysis.

5 hrs

Unit 4

Factorial experiment: Factorial experiment: Basic concepts, main effects, interactions, and orthogonal contrasts in 2^2 and 2^3 factorial experiments. Yates' method of computing factorial effects total. Analysis and testing the significance of effects in 2^2 and 2^3 factorial experiments in RBD.

8 hrs

Unit 5

Confounding: Need for confounding. Complete and partial confounding in a 2^3 factorial experiment in RBD - layout and its analysis.

6 hrs

ST 504: PRACTICAL – V List of Assignments

(30 hours : 1 credit)

(Demonstration of practicals using MSExcel)

1. ANOVA for one way classified data.
2. ANOVA for two way classified data.
3. Analysis of CRD.
4. Analysis of RBD.
5. Analysis of LSD.
6. Missing plot techniques in RBD and LSD
7. Analysis of 2^2 factorial experiment using RBD layout.
8. Analysis of 2^3 factorial experiment using RBD layout.
9. Analysis of 2^3 factorial experiment using RBD layout. (Complete confounding)
10. Analysis of 2^3 factorial experiment using RBD layout. (Partial confounding)

Text Books

1. Goon A.M., Gupta, M.K., Das Gupta, B. (1991).*Fundamentals of Statistics*, Vol .I, World Press, Calcutta.
2. Montgomery, D.C. (2014). *Design and Analysis of Experiments*, Wiley. New York.
3. Joshi, D. D. (1987).*Linear Estimation and Design of Experiments*, New Age International (P) Limited, New Delhi.
4. Mukhopadhya, P.(2015): Applied Statistics, Books and Allied (P) Ltd., Kolkata.

References

1. Cochran, W.G. and Cox, G. M. (1992).*Experimental Designs*, John Wiley and Sons, New York.
2. Mukhopadhya, P.(2015): *Mathematical Statistics,* Books and Allied (P) Ltd., Kolkata.

SIXTH SEMESTER

6 hours lecture + 6 hours practical per week
(Theory 4 creditsPracticals 2 credits)

ST 601: APPLIED STATISTICS
(39 hours : 2 credits)

Unit 1

Time series analysis: Components of time series. Additive and multiplicative models.Measurements of trend by moving averages and by least squares. Construction of seasonal indices by simple averages and ratio
to moving averages.

8 hrs

Unit 2

Index numbers: Introduction. Price and quantity index numbers. Construction of index numbers: Simple and weighted methods. Tests for consistency of index numbers.Consumer price index. Problems involved in the construction of general and consumer price index numbers. Uses and limitations.

7 hrs

Unit 3

Demography: Sources of demographic data. Measurement of mortality: Crude, specific, and standardized death rates. Infant and maternal mortality rates. Measurement of fertility: crude, age specific general, and total fertility rates. Reproduction rates. Life table: Components of a life table, force of mortality, and expectation of life. Construction of a life table.Uses of a life table.

10 hrs

Unit 4

Clinical trials: Introduction, therapeutic and prophylactic trails. Observational, cross sectional, prospective, retrospective, and randomized controlstudies.Odds ratio and its confidence interval.Relative risk and its confidence interval. Application of Bayes theorem. Sensitivity, specificity, false negative andfalse positive rates.Receiver operating characteristic (ROC) curve. Body mass index.

7 hrs

Unit 5

Official Statistics and national income: History of Indian Statistical System. Pre and post independence era .CSO NSSO and their activities. National income. Basic concepts of GNP, GDP, NNP. National Income at factor cost – NDP, per capita income. Real national income.Methods of estimating national income.

Problems in estimating national income.Uses of national income statistics.National accounts statistics of CSO.

7 hrs

ST 602: PRACTICALS - VII List of Assignments

(30 hours : 1 credit)

1 Time series 1: Measurement of trend.
2 Time series 2: Measurement of seasonal variation .
3 Construction of index numbers and consumer price index numbers.
4 Tests for consistency of index numbers.
5 Vital Statistics 1: Computation of various mortality rates.
6 Vital Statistics 2: Computation of various fertility rates.
7 Vital Statistics 3: Life table construction and computation of reproduction rates.
8 Clinical trials 1: (Odds ratio, relative risk, and confidence interval)
9 Clinical trials 2: (ROC curve and computation of various rates)
10. National income.

Text Books

1. Goon A.M., Gupta, M.K., Das Gupta, B. (1991). *Fundamentals of Statistics*, Vol. II, World Press, Calcutta.

2. Montgomery, D.C. and Runger, G.C. (2013). *Applied Statistics and Probability for Engineers,* Wiley India, New Delhi.

3. Sundar Rao, P.S.S. and Richard, J. (2012). *Introduction to Biostatistics and Research Methods,* 5/e, Prentice Hall of India, New Delhi.

4. Saluja, M. R. (1972). *Indian Official Statistical Systems,* Statistical Publishing Society, Calcutta.

References

1. CSO (1980). National Accounts Statistics - Sources and Health, Govt. of India, New Delhi.

2.   UNESCO: Principles for Vital Statistics Systems. Series M -12.

3.   Sen, A. (1997). Poverty and Inequality, Stanford University Press, USA.

4.   Mukhopadhyay, P. (2015). Applied Statistics, Books and Allied Pvt Ltd., Kolkata.

ST 603: OPERATIONS RESEARCH

(39 hours : 2 Credits)

Unit 1

Introduction to OR and LPP: Definition and scope of operations research (OR). Modelling and solution. Linear programming problem (LPP): Definition, standard and canonical forms. Formulation of LPP.Basic feasible solutions, degenerate and non degenerate solutions.Graphical solution and simplex algorithm for solving an LPP. Artificial variable, Charnes' Big- M Method. Criteria for unbounded, multiple, andinfeasible solutions.Concept of duality in LPP.

14 hrs

Unit 2

Transportation and assignment problems: Mathematical formulation of transportation problem. Existence of feasible solution.Finding initial basic feasible solution: North - West corner rule andVogel's method. Test for optimality. Transportation algorithm. Problem of degenerate solution. Unbalanced transportation problem.

Mathematical formulation of assignment problem and Hungarian algorithm. Unbalanced assignment problem.

8 hrs

Unit 3

Game Theory: Basic concepts of game theory. Two-person zero sum game. Pure and mixed strategies. Maximin–Minimax principles, Games with saddle point. Principle of dominance. Games without saddle point. Mixed strategies.Determination of optimum solution for a 2x2 game. Solution by graphical method for 2xn and mx2 games.

5 hrs

Unit 4

Inventory and replacement theory: Description of an inventory system. Inventory costs. Demand, lead time, and reorder level. Inventory models.EOQ model with and without shortages. Need for replacement. Replacement policy for items which deteriorate with time.Optimum policy with discrete and continuous time.Group replacement policy.

8 hrs

Unit 5

Queuing theory: Characteristics of a queuing system. Steady state system size distribution in M/M/1 queuing system (only statement). Waiting time distributions. Little's formula, measures of effectiveness, derivation of expressions for expected queue length, and expected system size(length) and expected waiting times.

4 hrs

604: PRACTICAL - VIII List of Assignments

(30 hours : 1 credit)

(Demonstration of practicals using TORA software)

1. Formulation of linear programming problem (LPP) - graphical solution.
2. Solution of LPP - simplex algorithm - 1
3. Solution of LPP - simplex algorithm - 2
4. Transportation problems - 1 (IBFS)
5. Transportation problems - 2 (OBFS)
6. Assignment problems
7. Game theory problems.
8. Inventory problems
9. Replacement problems
10. Queuing problems

Text Books

1. Churchman, C.W, Ackoff, R.L., and Arnoff, E.L. (1957). *Introduction to Operations Research*, John Wiley and Sons, New York.
2. KanthiSwaroop, Manmohan and P.K. Gupta (2012). *Operations Research*, Sultan Chand, New Delhi.
3. Kalavathy, S.(2004). *Operations Research*, Vikas Publishing House Pvt. Ltd. New Delhi.
4. Shenoy, G.V., Srivastava, U. K., and Sharma, S.C. (2009). *Operations Research for Management, 2/e,* New Age International, New Delhi.

References

1. Mustafi, C.K. (2006). *Operations Research: Methods and Practice*, 3/e, New Age International, New Delhi.
2. Mital, K.V. and Mohan, C. (2004). *Optimization Methods,* 3/e, New Age International, New Delhi.
3. Narag, A. S. (1970). *Linear Programming and Decision Making,* S. Chand, New Delhi.
4. Hillier, F.S. and Leiberman, G. J. (1962). *Introduction to Operations Research*, Holden Day, NewYork.
5. Taha, H.A. (2013). *Operational Research: An Introduction,* Macmillan, New York.

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