

UNIVERSITY OF MUMBAI  
No. UG/107 of 2010

CIRCULAR: -

A reference is invited to the Ordinances, Regulations and syllabi relating to the Bachelor of Arts (B.A.) degree course in statistics under the revised pattern vide this Office Circular No. UG/176 of 1999 dated 24<sup>th</sup> May, 1999 and the Principals of the affiliated colleges in Arts concerned are hereby informed that the recommendation made by the Board of Studies in Statistics at its meeting held on 3<sup>rd</sup> February, 2010 has been accepted by the Academic Council at its meeting held on 3<sup>rd</sup> March, 2010 vide item No. 4.30 and that in accordance therewith, the syllabus in the subject of Statistics at the T.Y.B.A. is revised as per Appendix and that the same has been implemented from the academic year 2010-2011.

MUMBAI-400 032  
29<sup>th</sup> May, 2010

(L. R. MANE)  
offg. REGISTRAR

To,

The Principals of the affiliated colleges in Arts.

A.C/4.30/03.03.2010

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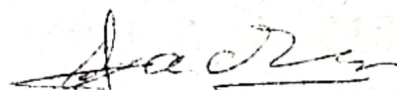
No. UG/107-A of 2010

MUMBAI-400 032

29<sup>th</sup> May, 2010

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1. The Dean, Faculty of Arts,
2. The Chairman, Board of Studies in Statistics.
3. The Controller of Examinations,
4. The Co-ordinator, University Computerization Centre.



(D. N. JADHAV)  
I/c. Deputy Registrar  
U.G./P.G. Section.

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The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative, Ratnagiri for information.

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~~26/02/2010~~  
3103/2010

# UNIVERSITY OF MUMBAI



## **Revised Syllabus For T.Y.B.A. In STATISTICS**

**(with effect from the academic year 2010 - 2011)**



PROBABILITY AND SAMPLING DISTRIBUTIONS

- Unit 1 Univariate random variables (Discrete and Continuous):  
Moment Generating Function, Cumulant generating Function.  
Their important properties.  
Relationship between moments and cumulants and their Uses.  
Characteristic Function. Its properties (without proof).  
Transformation of random variable.  
Standard Discrete Probability Distributions:  
Uniform Distribution, Bernoulli's Distribution, Binomial Distribution, Poisson Distribution, Geometric Distribution, Negative Binomial Distribution, Hypergeometric distribution.  
The following aspects to be discussed wherever applicable to the above stated distributions  
Mode: Median: Derivation of M.G.F., C.G.F.: Moments upto second order; Additive property; Recurrence relation of central moments: Skewness and Kurtosis.  
Limiting distribution (without proof).  
Truncated Binomial and Truncated Poisson Distribution with suitable illustrations; p.m.f. and mean.
- Unit 2 Bivariate Probability Distributions:  
Discrete Joint Probability mass function, Continuous Joint probability density Function.  
Their properties; Marginal and Conditional Distributions; Independence of Random Variables; Conditional Expectation and variance; Regression function; Coefficient of Correlation; Transformation of random variables and Jacobian of transformation (Simple illustrations).  
Standard Continuous Probability Distributions:  
Triangular Distribution; Exponential Distribution; Gamma distribution (with single and double parameter); Beta distribution (Type I and Type II)  
The following aspects to be discussed wherever applicable to the above stated distributions  
Derivation of M.G.F., C.G.F., Moments up to second order, Median, Mode, Additive property, Skewness & Kurtosis (without proof).

### Unit 3 Normal distribution:

23L

Derivation of its Median; Mode; M.G.F.; C.G.F.; Moments upto fourth order; Mean Absolute Deviation; Recurrence relation of central moments; skewness & kurtosis; Distribution of linear function of Independent Normal variables.

Fitting of Normal Distribution.

Central Limit Theorem with proof for i.i.d.r.v.s. using M.G.F.

#### Chi- Square Distribution:

Concept of degrees of freedom; Derivation of Mode; Moments up to second order; Additive Property; Asymptotic Property and Distribution of Sum of Squares of Standard Normal variables.

Sampling Distributions of Sample Mean and Sample Variance and their independence for a sample drawn from Normal population (without proof);

Confidence interval for population variance of Normal population; Test of significance for specified value of variance of Normal population.

### Unit 4 t- distribution:

22L

Derivation of Mode; Moments up to second order;

Distribution of  $U/\sqrt{(V/n)}$  where U is a standard Normal variate and V is an independent Chi-square variate with n degrees of freedom; Asymptotic property.

Definition of Student's t-statistic;

Confidence intervals for small sample for

- i) one Normal population mean
- ii) difference between two Normal population means (assuming equal population variances and based on independent samples)

Tests of significance using one or two samples of small size for comparison with given value of:

- i) for specified value of One Normal population mean
- ii) Difference between two Normal population means
  - a. With equal variances with independent samples.
  - b. Based on paired observations.

#### F- distribution:

Derivation of Mode; Moments up to second order;

Distribution of reciprocal of F-variate; Distribution of  $(U/m)/(V/n)$  where U and V are independent Chi-Square variables with m and n degrees of freedom respectively.

Confidence interval for ratio of variances of two Normal populations. Test of significance of equality of variances of two Normal populations.

Interrelationships of F distribution with a) t-distribution b) Chi-Square distribution.



## TOPICS FOR PRACTICALS:

1. Distribution of random variables: M.G.F., C.G.F.
2. Standard discrete distributions.
3. Bivariate Probability Distribution
4. Standard continuous distributions
5. Normal Distribution, Central Limit Theorem
6. Chi-square distribution
7. t- distribution
8. F- distribution

## REFERENCE BOOKS

1. Introduction to the theory of statistics: A.M. Mood , F.A. Graybill, D.C. Boyes; Third edition; McGraw-Hill Book Company
2. Introduction to Mathematical Statistics: R.V. Hogg, A.T. Craig; Fourth edition; Collier McMillan Publishers
3. Probability and Statistical Inference: R.V. Hogg, E.A. Tanis; Third edition; McMillan Publishing Company
4. John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth edition; Pearson Education Inc.
5. Introduction to Mathematical Statistics: P.G. Hoel; Fourth edition; John Wiley & Sons Inc.
6. Fundamentals of Mathematical Statistics: S.C. Gupta, V.K. Kapoor; Eighth edition; Sultan Chand & Sons
7. Mathematical Statistics: J.N. Kapur, H.C. Saxena; Fifteenth edition; S. Chand & Company Ltd.
8. Statistical Methods: An Introductory Text: J. Medhi; Second edition; Wiley Eastern Ltd.
9. An outline of Statistical Theory Vol. I: A.M. Goon, M.K. Gupta, B. Dasgupta; Third edition; The World Press Pvt. Ltd.

THEORY OF SAMPLING AND DESIGNS OF EXPERIMENTS

- UNIT-1 Simple Random sampling: 23 L
- Simple Random sampling (SRS) for Variables: Estimation of Population Mean and Total. Expectation and Variance of Estimators. Unbiased estimators of Variance of these estimators.[Using SRSWR and SRSWOR]
- SRS for Attributes: Estimation of population proportion and Variance of the estimators. Unbiased estimator of Variance of these estimators.[Using SRSWR and SRSWOR]
- Estimation of sample size based on desired accuracy in case of variables and attributes.
- UNIT-2 Stratified Random Sampling: 22 L
- Concepts of Stratified population and Stratified sample.
- Estimation of population mean and total based on stratified sample. Expectation and variance of unbiased estimator of population mean and total assuming SRSWOR within strata. Unbiased estimators of Variances of these estimators.
- Proportional allocation; Optimum allocation with and without varying costs. Comparison of simple random sampling and stratified random sampling with proportional and optimum allocation.
- Ratio and Regression Estimators under SRSWOR:
- Ratio estimators for population mean, ratio and total. Expectation and M.S.E. of Estimators. Estimators of M.S.E.
- Uses of Ratio estimators.
- Regression estimation of population mean and total. Expectation. Variance and Minimum Variance.
- Uses of Regression estimators.
- Comparison of ratio estimator, Regression estimator and Mean per unit estimator.



### UNIT-3 Analysis of Variance:

One way classification with equal and unequal observations per class.

Mathematical Model and its Assumptions. Cochran's theorem (Statement only). Expectation of various sums of squares.

Estimation of parameters by least squares method. Variance of the estimators. Estimation of treatment contrast and confidence limits for the elementary treatment contrasts.

Two way classification (with one observation per cell)

Mathematical Model and its Assumptions. Expectation of various sums of squares. Estimation of parameters by least squares method. Variance of the estimators. Estimation of treatment contrast and confidence limits for the elementary treatment contrasts.

#### Design of Experiments:

Concepts of Experiments, Experimental unit, Treatment, Replicate, Block, Experimental error and Precision.

Principles of design of experiment: Replication, Randomization and Local Control.

Efficiency of a design  $D_1$  with respect to design  $D_2$ .

Choice of size, shape of plots and block in different agriculture and non-agriculture experiment.

22 L

### UNIT-4 Standard Designs of Experiments:

Completely randomized design (CRD) and Randomized block design (RBD), Mathematical Model and its Assumptions. Expectation of various sums of squares. Estimation of parameters by least squares method. Standard errors of treatment differences. Comparison of their efficiencies.

Latin square design. Mathematical Model and its Assumptions. Expectation of various sums of squares. Estimation of parameters by least squares method. Standard errors of treatment differences. Comparison of the efficiency with RBD and LSD.

Missing Plot Technique for one missing observation in case of CRD and RBD.

Factorial Experiments: Purpose and advantage.

$2^2$ ,  $2^3$  experiments, Calculation of main effects and interactions.

Yates method. Analysis of data from  $2^2$ ,  $2^3$  factorial experiments

## TOPICS OF PRACTICALS

1. Simple random sampling for variables.
2. Simple random sampling for attributes.
3. Estimation of sample size in case of simple random sampling.
4. Stratified Random Sampling.
5. Ratio and Regression methods of Estimations.
6. One way and two way classification models of ANOVA.
7. CRD, RBD
8. LSD
9. Missing plot technique (one observation).
10. Factorial experiments.

### Reference Books:

- W. G. Cochran, Sampling Techniques, 3<sup>rd</sup> Edition., Wiley (1978).
- M. N. Murthy, Sampling Theory and Methods, Statistical Publishing Society (1967).
- Des Raj, Sampling Theory, McGraw-Hill Series in Probability and Statistics (1968).
- P. V. Sukhatme and B. V. Sukhatme, Sampling Theory of Surveys with Applications, 3<sup>rd</sup> Edition, Iowa State University Press (1984).
- S. C. Gupta and V. K. Kapoor, Fundamentals of Applied Statistics, 3<sup>rd</sup> Edition, Sultan Chand and Sons (2001)
- M. N. Das and N. C. Giri, Design and Analysis of Experiments, 2<sup>nd</sup> Edition, New Age International (P) Limited, Publishers (1986).
- D. C. Montgomery, Designs and Analysis of Experiments, 6<sup>th</sup> Edition, Wiley (2004).
- N. K. Malhotra, Marketing Research, 5<sup>th</sup> Edition, Prentice Hall of India Pvt. Ltd., (2007).



APPLIED STATISTICS

Unit 1 Mortality Tables:

23L

Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of  $\mu_x$  from the mortality table. Mortality table as a population model. Stationary population. Expectation of life and Average life at death. Central death rate.

Compound Interest and Annuities Certain:

Accumulated value and present value, nominal and effective rates of interest. Discount and discounted value, Varying rates of interest. Equation of value. Equated time of payment.

Present and accumulated values of annuity certain (immediate and due) with and without deferment period.

Present and accumulated values of

i) increasing annuity

ii) increasing annuity when successive installments form

a) arithmetic progression b) geometric progression.

iii) annuity with frequency different from that with which interest is convertible.

Redemption of loan.

Unit 2 Assurance Benefits:

22L

Present value of Assurance benefits in terms of commutation functions of i) pure endowment assurance ii) temporary assurance iii) endowment assurance iv) whole life assurance v) double endowment assurance vi) increasing temporary assurance vii) increasing whole life assurance viii) special endowment assurance ix) deferred temporary assurance x) deferred whole life assurance.

Present value in terms of commutation functions of Life annuities and Temporary life annuities (immediate and due) with and without deferment period. Present values of Variable and increasing life annuities(immediate and due)

Net premiums and Level annual premiums for the various assurance plans. Natural premiums.

Definition of Time series. Its components. Models of Time Series.

Estimation of trend by i) Freehand curve method ii) Method of semi averages iii) Method of moving averages iv) Method of least squares.

v) Exponential smoothing method

Estimation of seasonal component by i) Method of simple averages

ii) Ratio to moving average method iii) Ratio to trend method

**Simulation:**

Scope of simulation applications. Types of simulation. Monte Carlo Technique of Simulation. Elements of discrete event simulation. Generation of random numbers. Sampling from probability distribution. Inverse method. Generation of random observations from i) Uniform distribution ii) Exponential distribution iii) Normal distribution. Simulation techniques applied to inventory and Queueing models.

**Game Theory:**

Definitions of Two person Zero Sum Game, Saddle Point, Value of the Game, Pure and Mixed strategy.

Optimal solution of two person zero sum games: Dominance property,

Derivation of formulae for (2 x 2) game. Graphical solution of (2 x n) and (m x 2) games.

**Decision Theory:**

Decision making under uncertainty Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwicz  $\alpha$  criterion, Minimax Regret criterion.

Decision making under risk: Expected Monetary value criterion, Expected Opportunity Loss Criterion, EPPI, EVPI.

Decision tree analysis.

**Linear Regression:**

Linear regression model with one or more explanatory variables. Assumptions of the model, Derivation of ordinary least square (OLS) estimators of regression coefficients, (for one and two explanatory variables models) Properties of least square estimators (without proof) Coefficient of determination  $R^2$  and adjusted  $R^2$ . Procedure of testing

i) overall significance of the model ii) significance of individual coefficients iii) significance of incremental contribution of explanatory variable for two explanatory variables model. Confidence intervals for the regression coefficients.

Autocorrelation: Concept, Detection using i) Run Test ii) Durbin Watson Test, Generalized least square (GLS) method.

Heteroscedasticity: Concept, Detection using i) Spearman's



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rank correlation test. ii) Breusch-Pagan-Godfrey test. Weighted least square (WLS) estimators  
Multicollinearity: Concept, Detection using i) R square & t ratios  
ii) pair wise correlation between regressors iii) Variance Inflation Factor (VIF)  
Consequences of using OLS estimators in presence of autocorrelation, heteroscedasticity and multicollinearity.

### TOPICS OF PRACTICALS

1. Mortality tables
2. Annuities
3. Life annuities
4. Assurance benefits
5. Time series
6. Simulation
7. Game Theory
8. Decision Theory
9. Multiple regression model
10. Autocorrelation, Heteroscedasticity, Multicollinearity

### REFERENCES:

1. Neill A : Life Contingencies, First edition, Heineman educational books London
2. Dixit S.P., Modi C.S., Joshi R.V. : Mathematical Basis of Life Assurance, First edition Insurance Institute of India
3. Gupta S. C. & Kapoor V. K. : Fundamentals of Applied Statistics, Fourth edition, Sultan Chand & Sons.
4. Sharma J. K. : Operations Research Theory and Application, Third edition, Macmillan India Ltd.
5. Spiegel M.R. : Theory and Problems of Statistics, Fourth edition, Schaum's Outline Series Tata McGraw Hill
6. Taha Hamdy A. : Operations Research : Eighth edition, Prentice Hall of India Pvt. Ltd
7. N. D. Vora : Quantitative Techniques in Management, Third edition, McGraw Hill Companies
8. Damodar Gujrathi, Sangetha : Basic Econometrics,, Fourth edition, McGraw-Hill Companies
9. William Greene : Econometric Analysis (1991), First edition, McMillan Publishing Company

**Question Paper Pattern for T.Y.B.A. Statistics:****Theory Examination :** each paper of 75 marksFor theory papers the question paper pattern will as follows  
All questions will be compulsory.

Q.1 based on all 4 units

Q.2 based on Unit-I

Q.3 based on Unit-II

Q.4 based on Unit-III

Q.5 based on Unit-IV

**Practical Examination :** 75 marks

Practical examination will consists of two papers each of 30 marks.

Journal : 10 marks

Viva Voce : 5 marks