AC 19-3-2012
Item 4.82

UNIVERSITY OF MUMBAI

Syllabus for the S.Y.B.Sc.
Program: B.Sc.
Course : STATISTICS

(Credit Based Semester and Grading System with effect from the academic year 2012–2013)

S.Y.B.Sc STATISTICS Syllabus
Credit Based and Grading System
To be implemented from the Academic year 2012-2013
SEMESTER III

Course Code	UNIT	TOPICS	Credits	L / Week
USST301	I	Univariate Random Variables. (Discrete and Continuous)	2	1
	II	Standard Discrete Probability Distributions.		1
	III	Bivariate Probability Distributions.		1
USST302	I	Concepts of Sampling and Simple Random Sampling.	2	1
	II	Stratified Sampling.		1
	III	Ratio and Regression Estimation.		1
USST303	I	Linear Programming Problem.	2	1
	II	Transportation Problem.		1
	III	Assignment & Sequencing Problem.		1
USSTP3	Practicals based on all courses in theory		3	9

SEMESTER IV

Course Code	UNIT	TOPICS	Credits	L / Week
USST401	I	Standard Continuous Probability Distributions.	2	1
	II	Normal Distribution.		1
	III	Exact Sampling Distributions.		1
USST402	I	Analysis of Variance.	2	1
	II	Design Of Experiments, Completely Randomized design & Randomized Block Design.		1
	III	Latin Square Design & Factorial Experiments.		1
USST403	I	CPM and PERT.	2	1
	II	Control charts.		1
	III	Lot Acceptance Sampling Plans By Attributes.		1
USSTP4	Practicals based on all courses in theory		3	9

Course Code	Title	Credits
USST301	**PROBABILITY DISTRIBUTIONS**	**2 Credits (45 lectures)**
Unit I : 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		**15 Lectures**
Unit II : Standard Discrete Probability Distributions: Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial & Hypergeometric distributions. The following aspects of the above distributions(wherever applicable) to be discussed: Mean, Mode and Standard deviation. Moment Generating Function, Cumulant Generating Function, Additive property, Recurrence relation for central Moments, Skewness and Kurtosis (without proof), Limiting distribution. Fitting of Distribution. Truncated Binomial and Truncated Poisson Distribution: Suitable illustrations, probability mass function, mean.		**15 Lectures**
Unit III : Bivariate Probability Distributions: Joint Probability mass function for Discrete random variables**,** Joint Probability density function for continuous random variables. Their properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation. Transformation of Random Variables and Jacobian of transformation with illustrations.		**15 Lectures**

REFERENCES:

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.Tannis, Third Edition; Collier McMillan Publishers.
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. 1: A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; The World Press Pvt. Ltd.
10. Statistical Methods Using R Software :V. R. Pawagi and Saroj A. Ranade ;Nirali Publications.
11. Statistics Using R**.** S. G. Purohit, S. D. Gore, and S. R. Deshmukh. Narosa Publishing House.

Course Code	Title	Credits
USST302	**THEORY OF SAMPLING**	**2 Credits (45 lectures)**
Unit I : Concepts: Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiasedness, Mean square error & Standard error. Census survey, Sample Survey. Steps in conducting a sample survey with examples on designing appropriate Questionnaire. Concepts of Sampling and Non-sampling errors. NSSO, CSO and their functions. Concepts and methods of Probability and Non Probability sampling. **Simple Random Sampling:** (SRS). Definition, Sampling with & without replacement (WR/WOR). Lottery method & use of Random numbers to select Simple random sample. Estimation of population mean & total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR). Estimation of population proportion. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR). Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes. (WR/WOR).		**15 Lectures**
Unit II : Stratified Sampling: Need for Stratification of population with suitable examples. Definition of Stratified Sample. Advantages of stratified Sampling. **Stratified Random Sampling:** Estimation of population mean & total in case of Stratified Random Sampling (WOR within each strata). Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. Proportional allocation, Optimum allocation with and without varying costs. Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation & Neyman allocation.		**15 Lectures**
Unit III : a. Ratio & Regression Estimation assuming SRSWOR: Ratio Estimators for population Ratio, Mean & Total. Expectation & MSE of the Estimators. Estimators of MSE. Uses of Ratio Estimator. Regression Estimators for population Mean & Total. Expectation & Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Uses of regression Estimator. Comparison of Ratio, Regression & mean per Unit estimators. **b.** Introduction to Systematic sampling, Cluster sampling & Two Stage sampling with suitable illustrations.		**15 Lectures**

REFERENCES:

1. Sampling Techniques: W.G. Cochran; 3rd Edition; Wiley(1978)
2. Sampling Theory and methods: M.N. Murthy; Statistical Publishing Society. (1967)
3. Sampling Theory: Des Raj; McGraw Hill Series in Probability and Statistics. (1968).
4. Sampling Theory of Surveys with Applications: P.V. Sukhatme and B.V. Sukhatme; 3rd Edition; Iowa State University Press (1984).
5. Fundamentals of Applied Statistics: S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
6. Theory and Analysis of Sample Survey Designs: Daroga Singh, F.S.Chaudhary, Wiley Eastern Ltd. (1986).

7. Sampling Theory and Methods: S. Sampath, Second Edition (2005),Narosa.
8. Theory and Methods of Survey Sampling: Parimal Mukhopadhyay, (1998), Prentice Hall Of India Pvt. Ltd.

Course Code	Title	Credits
USST303	**OPERATIONS RESEARCH**	**2 Credits (45 lectures)**
Unit I : Linear Programming Problem (L.P.P.) : Mathematical Formulation: Maximization & Minimization. Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal solution. Graphical Solution for problems with two variables. Simplex method of solving problems with two or more variables. Big M method. Concept of Duality. Its use in solving L.P.P. Relationship between optimum solutions to Primal and Dual. Economic interpretation of Dual.		**15 Lectures**
Unit II : Transportation Problem: Concept, Mathematical Formulation. Concepts of Solution, Feasible Solution. Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method. Optimality test, Improvement procedure. Variants in Transportation Problem: Unbalanced, Maximization type.		**15 Lectures**
Unit III :Assignment Problem: Concept. Mathematical Formulation Solution by: Complete Enumeration Method and Hungarian method. Variants in Assignment Problem: Unbalanced, Maximization type. Travelling Salesman Problem **Sequencing :** Processing n Jobs through 2 and 3 Machines & 2 Jobs through m Machines.		**15 Lectures**

REFERENCES

1. Operations Research: Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons.
2. Schaum Series book in O.R. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
3. Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.
4. Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
5. Principles of Operations Research with Applications to Management Decisions: Harvey M. Wagner, 2nd Edition, Prentice Hall of India Ltd.
6. Operations Research: S.D.Sharma.11th edition, Kedar Nath Ram Nath & Company.
7. Operations Research: H. A.Taha.6th edition, Prentice Hall of India.
8. Quantitative Techniques For Managerial Decisions: J.K.Sharma , (2001), MacMillan India Ltd.

DISTRIBUTION OF TOPICS FOR PRACTICALS

SEMESTER-III

COURSE CODE USSTP3

Sr. No	Semester III .Course USSTP3(A)
1	Moment Generating Function, Moments.
2	Cumulant generating Function, Cumulants, Characteristic function.
3	Standard Discrete Distributions.
4	Fitting Standard Discrete Distributions.
5	Bivariate Probability Distributions, Marginal & Conditional distributions, Conditional Mean, Conditional Variance, Correlation.
6	Transformation of discrete & continuous random variables.
7	Applications of R.

Sr. No	Semester III .Course USSTP3(B)
1	Designing of Questionnaire.
2	Simple Random Sampling for Variables.
3	Simple Random Sampling for Attributes.
4	Estimation of Sample Size in Simple Random Sampling.
5	Stratified Random Sampling.
6	Ratio Estimation.
7	Regression Estimation.

Sr. No	Semester III .Course USSTP3(C)
1	Formulation and Graphical Solution of L.P.P.
2	Simplex Method.
3	Duality.
4	Transportation.
5	Assignment.
6	Sequencing.
7	Problems solving using TORA.

Course Code	Title	Credits
USST401	**PROBABILITY AND SAMPLING DISTRIBUTIONS**	**2 Credits (45 lectures)**
Unit I : **Standard Continuous Probability Distributions:** Rectangular, Triangular, Exponential, Cauchy (with Single & Double parameter), Gamma (with Single & Double parameter), Beta (Type I & Type II). The following aspects of the above distributions(wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation. Moment Generating Function, Additive property, Cumulant Generating Function. Skewness and Kurtosis (without proof). Fitting of Distribution. Interrelation between the distributions.		**15 Lectures**
Unit II : **Normal Distribution:** Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order). Recurrence relation for central moments, skewness & kurtosis, Mean absolute deviation. Distribution of linear function of independent Normal variables. Fitting of Normal Distribution. Central Limit theorem for i.i.d. random variables. Log Normal Distribution: Derivation of mean & variance.		**15 Lectures**
Unit III: **Exact Sampling Distributions:** **Chi-Square Distribution:** Concept of degrees of freedom. Mean, Median, Mode & Standard deviation. Moment generating function, Cumulant generating function. Additive property, Distribution of the sum of squares of independent Standard Normal variables. Sampling distributions of sample mean and sample variance and their independence for a sample drawn from Normal distribution (without proof). **Applications of Chi-Square:** Confidence interval for the variance of a Normal population, Test of significance for specified value of variance of a Normal population. Test for goodness of fit, Test for independence of attributes. Yates' correction. **t-distribution:** Mean, Median, Mode & Standard deviation. Distribution of ratio of a Standard Normal variable to the square root of an independent Chi-square divided by its degrees of freedom. Asymptotic properties. Student's t. **Applications of t:** Confidence interval for: Mean of Normal population, difference between means of two independent Normal populations having the same variance. Test of significance of: mean of a Normal population, difference in means of two Normal populations (based on: (i) independent samples with equal variances. (ii) dependent samples). **F-distribution:** Mean, Mode & Standard deviation. Distribution of : Reciprocal of an F variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with: t-distribution, Chi-square distribution & Normal distribution. **Applications of F:** Confidence interval for ratio of variances of two independent Normal populations. Test for equality of variances of two independent Normal populations.		**15 Lectures**

REFERENCES:

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.Tannis, Third Edition; Collier McMillan Publishers.
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. 1: A.M. Goon, M.K. Gupta, B. DasGupta; Third Edition; The World Press Pvt. Ltd.

Course Code	Title	Credits
USST402	**ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS**	**2 Credits (45 lectures)**
Unit I : Analysis of Variance: Introduction, Uses, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two way classification with one observation per cell. Mathematical Model, Assumptions, Expectation of various sums of squares, F- test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts.		**15 Lectures**
Unit II : Design Of Experiments: Concepts of Experiments, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Design of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots & blocks in agricultural & non agricultural experiments. **Completely Randomized Design (CRD) & Randomized Block Design (RBD):** Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of RBD relative to a CRD.		**15 Lectures**
Unit III : Latin Square Design (LSD): Mathematical Model, Assumptions, Expectation of various sums of squares, F-test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of the design relative to RBD, CRD. Missing plot technique for one missing observation in case of CRD, RBD & LSD. **Factorial Experiments:** Definition, Purpose & Advantages. 2^2, 2^3 Experiments. Calculation of Main & interaction Effects. Yates' method. Analysis of 2^2 & 2^3 factorial Experiments.		**15 Lectures**

REFERENCES

1. Experimental Designs: W.G. Cochran and G.M.Cox; Second Edition;John Wiley and Sons.
2. The Design and Analysis of Experiments: Oscar Kempthorne, John Wiley and Sons.
3. Design and Analysis of Experiments: Douglas C Montgomery; 6th Edition;John Wiley & Sons.
4. Design and Analysis of Experiments: M.N.Das and N.C.Giri, 2nd Edition; New Age International (P) Limited;1986.
5. Experimental Design, Theory and Application: Walter T Federer; Oxford & IBH Publishing Co. Pvt. Ltd.
6. Fundamentals of Applied Statistics: S.C.Gupta and V.K.Kapoor; 3rd Edition; Sultan Chand and Sons (2001).
7. Statistical Principles in Experimental Design: B.J. Winer, McGraw Hill Book Company.

Course Code	Title	Credits
USST403	**PROJECT MANAGEMENT AND INDUSTRIAL STATISTICS**	**2 Credits (45 lectures)**
Unit I : CPM and PERT: Objective and Outline of the techniques. Diagrammatic representation of activities in a project: Gantt Chart and Network Diagram. Slack time and Float times. Determination of Critical path. Probability consideration in project scheduling. Project cost analysis. Updating.		**15 Lectures**
Unit II : Control Charts : Principles of control. Process quality control of attributes and variables. $\bar{X}$, R, p, c, np charts, their uses. p-chart with variable sample size. Problems involving setting up standards for future use.		**15 Lectures**
Unit III : Lot Acceptance Sampling Plans by Attributes: Single Sampling Plans (without curtailment). OC function and OC curves. AQL, LTPD, ASN, ATI, AOQ, Consumer's risk, Producer's risk. Double Sampling Plan (without curtailment). OC function and OC curves. Introduction to Six sigma limits.		**15 Lectures**

REFERENCES

1. Statistical Quality Control: E.L.Grant. 2nd edition, McGraw Hill, 1988.
2. Quality Control and Industrial Statistics: Duncan. 3rd edition, D.Taraporewala sons & company.
3. Quality Control: Theory and Applications: Bertrand L. Hansen, (1973),Prentice Hall of India Pvt. Ltd..
4. Quality Control: I.V. Burr, Mardekkar, New York, 1976.
5. PERT and CPM, Principles and Applications: Srinath. 2nd edition, East-west press Pvt. Ltd.
6. Operations Research: Kantiswaroop and Manmohan Gupta. 4th Edition; S Chand & Sons.
7. Schaum Series book in O.R. Richard Broson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
8. Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman, (1959), John Wiley & Sons.
9. Mathematical Models in Operations Research : J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
10. Operations Research: S.D.Sharma.11th edition, Kedar Nath Ram Nath & Company.
11. Operations Research: H. A.Taha., 6th edition, Prentice Hall of India.
12. Quantitative Techniques For Managerial Decisions: J.K.Sharma , (2001), MacMillan India Ltd.

DISTRIBUTION OF TOPICS FOR PRACTICALS

SEMESTER-IV
COURSE CODE USSTP4

Sr. No	Semester IV. Course USSTP4(A)
1	Standard Continuous distributions.
2	Normal Distribution.
3	Central Limit Theorem.
4	Chi Square distribution.
5	t distribution.
6	F distribution.
7	Application of R.

Sr. No	Semester IV .Course USSTP4(B)
1	Analysis of Variance- One Way.
2	Analysis of Variance- Two Way.
3	Completely Randomized Design.
4	Randomized Block Design.
5	Latin Square Design.
6	Missing Observations in CRD, RBD & LSD.
7	Factorial Experiments.

Sr. No	Semester IV .Course USSTP4(C)
1	CPM-PERT : Construction of Network.
2	Finding Critical Path. Computing Probability of Project completion.
3	Project cost analysis.
4	Updating.
5	Control Charts for attributes.
6	Control Charts for variables.
7	Acceptance Sampling Plans.

Internal Assessment of Theory Core Courses Per Semester Per Course

1. Two Assignments: …….. 10 Marks **each.**
2. One Class Test: ……..…. 10 Marks.
3. Active participation in class instructional deliveries:……..…05 Marks.
4. Overall conduct as a responsible student, mannerism etc :…. .05 Marks.

Internal Assessment of Practical Core Courses Per Semester per course

1. Semester work, Documentation, Journal …….05 Marks.
2. Viva: ……05 Marks.
3. For any one or the combinations of the following activities…..10 Marks.

- Data collection and /or analysis.
- Assignments using R software/ TORA software/other statistical soft ware package.
- Case study/project.
- Seminar based on any topic preferably not covered in syllabus.
- Industrial visit and its report.

Semester End Examination

Theory: At the end of the semester, examination of two hours duration and 60 marks based on the three units shall be held for each course.

Pattern of **Theory question** paper at the end of the semester for ***each course*** :

There shall be Four Questions of fifteen marks each. All Questions Should be Compulsory.
Question1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III, Question4 based on all Three Units combined.
Each question will have sub questions as given below:

- Attempt any ONE Out of Two questions carrying 1 Mark each.
- Attempt any TWO Out of Three questions carrying 7 Marks each**.**

Practicals: At the end of the semester, examination of 1 ½ hours duration and 30 marks shall be held for **each course**.

Pattern of **Practical question** paper at the end of the semester for **each course** :

There shall be Four Questions of ten marks each. Students should attempt **any three** out of the four Questions.
Question1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III, Question4 based on all Three Units combined.

Workload

Theory : 3 lectures per week per course.
Practicals: 3 lecture periods per course per week per batch. All three lecture periods of the practicals shall be conducted in succession together on a single day

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