Hindi vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the T.Y.B.Sc.

Program: B.Sc. Statistics

Program Code: RJSUSTA

Choice based Credit System (CBCS)

With effect from the academic year 2018-19

T.Y.B.Sc. STATISTICS Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2018-2019

SEMESTER V

Theory

Course	UNIT	TOPICS	Credits	L / Week
RJSUSTA501	I	Probability-I	2.5	1
	II	Probability-II		1
	III	Joint Moment Generating Function Trinomial & Multinomial Distribution		1
	IV	Order Statistics		1
RJSUSTA502	I	Point Estimation & Properties Of Estimators	2.5	1
	II	Methods of Estimation		1
	III	Bayesian Estimation Method & Interval Estimation		1
	IV	Introduction to Linear Models		1
RJSUSTA503	I	Epidemic Models	2.5	1
	II	Bioassay		1
	III	Clinical Trials		1
	IV	Clinical Trials and Bioequivalence		1
RJSUSTA504	I	Fundamental of R	2.5	1
	II	Simple Linear Regression Model		1
	III	Multiple Linear Regression Model		1
	IV	Validity Of Assumptions		1

Course	PRACTICALS	Credits	L / Week
RJSUSTAP501	Practicals of Course RJSUSTA501 + Course RJSUSTA502	3	8
RJSUSTAP502	Practicals of Course RJSUSTA503 + Course RJSUSTA504	3	8

Learning Objectives:

- To strengthen the concepts in mathematical statistics.
- To prepare students to develop their own models.

Course Code	Title	Credits
RJSUSTA501	**PROBABILITY AND DISTRIBUTION THEORY**	**2.5 Credits (60 lectures)**
Unit I : PROBABILITY I (i) Basic definitions: Random Experiment, Outcome, Event, Sample Space, Complementary, Mutually Exclusive, Exhaustive and Equally Likely Events. (ii) Mathematical, Statistical, Axiomatic and Subjective probability. (iii) Sub populations and partitions. Derivation of a) $A_{r,n}$: Number of distinguishable distributions of putting r indistinguishable balls in n cells; b) Number of distinguishable distributions of putting r indistinguishable balls in n cells such that no cell is empty. (iv) Ordered samples and runs. (v) Probabilities based on a) Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics. (vi) Addition Theorem for (a) two (b) three events. (Ref. 1,2,5,7,8)		**15 Lectures**
Unit II : PROBABILITY II (i) Theorems on Probability of realization of : (a) At least one (b) Exactly m (c) At least m of N events $A_1, A_2, A_3 \ldots A_N$. Matching and Guessing problems. (ii) Conditional Probability: Multiplication Theorem for two, three events. Independence of two/three events - complete and pair wise. (iii) Bayes' theorem. (Ref. 1,2,5,8)		**15 Lectures**
Unit III: JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION (i) Definition and properties of Moment Generating Function (MGF) of two random variables of discrete and continuous type. Necessary and Sufficient condition for independence of two random variables. Concept and definition of Multivariate MGF. (ii) **Trinomial distribution:** Definition of joint probability distribution of (X, Y). Joint moment generating		**15 Lectures**

function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal & Conditional distributions. Their Means & Variances. Correlation coefficient between (X, Y). Distribution of the Sum X+Y. (iii) Extension to Multinomial distribution with parameters (n, p_1, p_2,…p_{k-1}) where $p_1+ p_2,+…p_{k-1}+ p_k = 1$. Expression for joint MGF. Derivation of: joint probability distribution of (X_i, Xj). Conditional probability distribution of X_i given $X_j = x_j$. (Ref.2,3,6,7)	
Unit IV: ORDER STATISTICS (i) Definition of Order Statistics based on a random sample. (ii) Derivation of: (a) Cumulative distribution function of r^{th} order statistic. (b) Probability density function of the r^{th} order statistic. (c) Joint Probability density function of the r^{th} and the s^{th} order statistic (r<s) (d) Joint Probability density function of all n ordered statistics. (iii) Probability density function of Median (in the case of odd sample sizes) and Range for Uniform and Exponential distributions. (Ref.2,3,4)	**15 Lectures**

REFERENCES

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited.
2. Hogg R V. & Craig Allen T.: Introduction to Mathematical Statistics, Fifth edition, Pearson Education (Singapore) Pvt. Ltd.
3. Mood A. M., Graybill F. A., Boes D. C.: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series.
4. Hogg R. V. and Tanis E.A. : Probability and Statistical Inference, Fourth edition, McMillan Publishing Company.
5. Gupta S C & Kapoor V K: Fundamentals of Mathematical statistics, Eleventh edition, Sultan Chand & Sons.
6. Biswas S.: Topics in Statistical Methodology, First edition, Wiley Eastern Ltd.
7. Kapur J. N. & Saxena H. C.: Mathematical Statistics, Fifteenth edition, S. Chand and Company.
8. Chandra T.K. & Chatterjee D.: A First Course in Probability, Second Edition, Narosa Publishing House.
9. Gupta S.C., Kapoor V.K.: Fundamentals of Mathematical Statistics; Eighth Edition; Sultan Chand & Sons.
10. V.K Rohatgi: An Introduction to probability and Mathematical Statistics.

Learning Objective:

To empower students with methods of estimation and inference in order to predict future trend on the basis of current data with enhanced decisions.

Course Code	Title	Credits
RJSUSTA502	**THEORY OF ESTIMATION**	**2.5 Credits (60 lectures)**
Unit I : POINT ESTIMATION AND PROPERTIES OF ESTIMATOR- I • **Notion of a Parameter and Parameter Space.** • **Problem of Point estimation.** • **Properties of a good estimator** (i) Unbiasedness: Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples (these should include unbiased and biased estimators for the same parameters). Proofs of the following results regarding unbiased estimators. (a) Two distinct unbiased estimators of $\varphi(\theta)$ give rise to infinitely many unbiased estimators. (b) If T is an unbiased estimator of θ , then $\varphi(T)$ is unbiased estimator of $\varphi(\theta)$ provided $\varphi(.)$ is a linear function. (ii) Consistency **:**Definition of Consistency Sufficient condition for consistency , proof & Illustrations (iii) Sufficiency: Concept and definition of Sufficiency, Neymann Factorization Theorem (without proof). Exponential family of probability distributions and Sufficient statistic. (iv) Relative efficiency of an estimator. Illustrative examples. (v) Minimum variance unbiased estimator(MVUE) and Cramer Rao Inequality: Definition of MVUE, Uniqueness property of MVUE (proof).Fisher's information function Regularity conditions, Statement and proof of Cramer-Rao inequality, Cramer-Rao lower bound (CRLB), Efficiency of an estimator using CRLB. Condition when equality is attained in Cramer Rao Inequality and its use in finding MVUE. (Ref. 1,3,8)	**15 Lectures**
Unit II : METHODS OF POINT ESTIMATION i) Method of Maximum Likelihood Estimation (M.L.E.), Definition of likelihood as a function of unknown parameter, for a random sample from i) discrete distribution ii) continuous distribution. Distinction between likelihood function and joint p.d.f. / p.m.f. Derivation of Maximum Likelihood Estimator (M.L.E.) for parameters of standard distributions (case of one and two unknown parameters). Properties of M.L.E(without proof)	**15 Lectures**

ii) Method of Moments, Derivation of moment estimators for standard distributions (case of one and two unknown parameters). Illustrations of situations where M.L.E. and Moment Estimators are distinct and their comparison using Mean Square Error. iii) Method of Minimum Chi-square and Modified Minimum Chi-square. (Ref. 1,3,8)	
Unit III: BAYESIAN ESTIMATION AND CONFIDENCE INTERVAL i) Bayesian Estimation: Prior distribution, Posterior distribution, Types of Loss function : Squared error Loss function, Absolute error Loss function (AELF), Bayes' risk, Bayes' method of finding Point estimator (assuming SELF) **Examples** : (a) Binomial- Beta (b) Poisson- Gamma (c) Gamma-Gamma (d) Normal-Normal ii) Interval Estimation: Concept of confidence interval & confidence limits. Definition of Pivotal quantity and its use in obtaining confidence limits. Derivation of 100(1-α) % equal tailed confidence interval for : (a)The population mean : μ_1, $\mu_1-\mu_2$ (population variance known/ unknown) (b) the population variance: σ_1, σ_1/σ_2(Normal distribution). iii) Confidence interval for the parameters of Binomial, Poisson and Exponential distributions. (Ref. 1, 3, 8).	**15 Lectures**
Unit IV:INTRODUCTION TO LINEAR MODELS: i) Explanation of General Linear Model of full rank with assumptions. Model Y= $X\beta + e$, $e \sim N(0, I\sigma^2)$ ii) Derivation of : 1) Least squares estimator of $\underline{\beta}$ E(β) 3) V(β) iii) Guass Markoff theorem for full rank Model: Y = Xβ + e. iv) Derivation of : 1) E(l'β) 2) V(l'β) v) Confidence interval for l'β when σ^2 is known. vi) Confidence interval of β when σ^2 is known. (Ref. 9)	**15 Lectures**

REFERENCES:

1.Hogg R.V., Craig A.T.: Introduction to Mathematical Statistics, Fourth Edition; Collier McMillan Publishers.
2.Hogg R.V., Tannis E. A.: Probability and Statistical Inference, Third Edition; Collier McMillan Publishers.
3. Rohatgi, V. K, Ehsanes Saleh A.K. Md.: An introduction to Probability Theory and Mathematical Statistics , Second Edition, Wiley series in Probability and Statistics.
4.John E. Freund's Mathematical Statistics: I. Miller, M. Miller; Sixth Edition; Pearson Education Inc.
5.Hoel P.G.: Introduction to Mathematical Statistics; Fourth Edition; John Wiley & Sons Inc.
6.Gupta S.C., Kapoor V.K.: Fundamentals of Mathematical Statistics; Eighth Edition; Sultan Chand & Sons.
7.Kapur J.N., Saxena H.C.: Mathematical Statistics; Fifteenth Edition; S. Chand & Company Ltd.
8.Arora Sanjay and Bansi Lal : New Mathematical Statistics, Satya Prakashan, New Market, New Delhi,5(1989
9. A.M.Kshirsagar , Linear Models
10. F.A. Graybill , An Introduction to Linear Models

Learning Objective: To apply statistics to Biological sciences.

Course Code	Title	Credits
RJSUSTA503	**BIOSTATISTICS**	**2.5 Credits (60 lectures)**
Unit I : EPIDEMIC MODELS (i) The features of Epidemic spread. Definitions of various terms involved. Simple mathematical models for epidemics: Deterministic model without removals, Carrier model. (ii) Chain binomial models. Reed - Frost and Greenwood models. Distribution of individual chains and total number of cases. Maximum likelihood estimator of 'p' and its asymptotic variance for households of sizes up to 4. (Ref.1)		**15 Lectures**
Unit II: BIOASSAYS i) Meaning and scope of bioassays. Relative potency. Direct assays. Point estimate and Interval estimate of relative potency, Fieller's theorem. ii) Indirect assays. Dose-response relationship .Conditions of similarity and Monotony. Linearizing transformations. Parallel line assays. Symmetrical (2, 2) and (3, 3) parallel line assays. Validity tests using orthogonal contrasts. Point Estimate and Interval Estimate of Relative potency. iii) Quantal Response assays. Tolerance distribution. Median effective dose ED50 and Median lethal dose LD50. Probit and Logit analysis. (Ref.2,3)		**15 Lectures**
Unit III: CLINICAL TRIALS : Introduction to clinical trials: The need and ethics of clinical trials. Common terminology used in clinical trials. Overview of phases (I-IV) , Introduction to ICH E9 guidelines, Study Protocol, Case record/Report form, Blinding (Single/Double) Randomized controlled (Placebo/Active controlled), Study Designs (Parallel, Cross Over). Types of Trials: Inferiority, Superiority and Equivalence, Multicentre Trial. Inclusion/Exclusion Criteria. Sample size estimation. (Ref. 4,5,6,7,8)		**15 Lectures**
Unit IV : CLINICAL TRIALS and BIOEQUIVALENCE : Statistical tools : Analysis of parallel Design using Analysis of Variance. Concept of odds ratio. Concept of Repeated Measures ANOVA. Survival analysis for estimating Median survival time, Kaplan-Meire approach for survival analysis. BIOEQUIVALENCE :		**15 Lectures**

Definitions of Generic Drug product. Bioavailability, Bioequivalence, Pharmacokinetic (PK) parameters : C_{max}, AUC_t , $AUC_{0-\infty}$, T_{max}, K_{el}, T_{half}. Estimation of PK parameters using `time vs. concentration' profiles. Designs in Bioequivalence: Parallel, Crossover (Concept only). Advantages of Crossover design over Parallel design. Analysis of Parallel design using logarithmic transformation (Summary statistics, ANOVA and 90% confidence interval). Confidence Interval approach to establish bioequivalence (80/125 rule) (Ref. 4,5,6,7,8,9)	

***REFERENCES*:**

1. Bailey N.T.J.: The Mathematical theory of infectious diseases, Second edition, Charles Griffin and Co. London.
2. Das M.N and Giri N.C. : Design and Analysis of Experiments, Second edition, Wiley Eastern
3. Finney D.J. : Statistical Methods in Biological Assays, First edition, Charles Griffin and Co. London
4. Sanford Boltan and Charles Bon: Pharmaceutical Statistics, Fourth edition, Marcel Dekker Inc.
5. Zar Jerrold H.: Biostatistical Analysis, Fourth edition, Pearson's education.
6. Daniel Wayne W: Biostatistics- A Foundation for Analysis in the Health Sciences, 7th Edition, Wiley Series in Probability and Statistics.
7. Friedman L. M., Furburg C., Demets D. L.: Fundamentals of Clinical Trials, First edition, Springer Verlag.
8. Fleiss J. L. The Design and Analysis of Clinical Experiments, Second edition, Wiley and Sons
9. Shein-Chung-Chow: Design and Analysis of Bioavailability & Bioequivalence studies, Third Edition, Chapman & Hall/CRC Biotatistics series.

Learning Objective: To enable students to develop the technique of model building using software.

Course Code	Title	Credits

RJSUSTA504	Regression Analysis using R software	2.5 Credits (60 lectures)

Unit I : Fundamentals of R — **15 Lectures**

Introduction to R features of R, installation of R, Starting and ending R session, getting help in R , Value assigning to variables

Basic Operations : +, -, *, ÷, ^, sqrt

Numerical functions : log 10, log , sort, max, unique, range, length, var, prod, sum, summary, dim, sort, etc

Data Types : Vector, list, matrices, array and data frame

Variable Type : logical, numeric, integer, complex, character and factor

Data Manipulation : Selecting random N rows, removing duplicate row(s), dropping a variable(s) , Renaming variable(s), sub setting data, creating a new variable(s), selecting of random fraction of row(s), appending of row(s) and column(s), simulation variable

Data Processing : Data import and export, setting working directory, checking structure of Data :Str(), Class(), Changing type of variable (for eg as.factor, as.numeric)

Data Visualisation using ggplot: Simple bar diagram, subdivided bar diagram, multiple bar diagram pie diagram, Box plot for one and more variables, histogram, frequency polygon, scatter plot eg plot().

(Ref. 6,7,8,9,10)

Unit II : Simple Linear Regression Model Assumptions of the model, Derivation of ordinary least square (OLS) estimators of regression coefficients for simple, Properties of least square estimators (without proof), Coefficient of determination R^2 and adjusted R^2 , Procedure of testing a) Overall significance of the models b) Significance of individual coefficients c) Confidence intervals for the regression coefficients Data Pre-processing: Detection and treatment of missing value(s)and outliers, Variable selection and Model building, Interpretation of output produced by lm command in R. Polynomial Regression Models. (Ref. 1,2,3,4,5)	**15 Lectures**
Unit III : Multiple Linear Regression Model Derivation of ordinary least square (OLS) estimators of regression coefficients for multiple regression models, Coefficient of determination R^2 and adjusted R^2 , Procedure of testing a) Overall significance of the models b) Significance of individual coefficients c) Confidence intervals for the regression coefficients Data Pre-processing: Detection and treatment of missing value(s) and outliers, Variable selection and Model building, Interpretation of output produced by lm command in R. (Ref.1,2,3,4,5)	**15 Lectures**
Unit IV : Validity of Assumptions Residual Diagnostics: Standardized residuals, Studentized residuals, residual plots, Interpretation of four plots of ,Interpretation output produced by plot command in R and corrective measures such as transformation of response variable, testing normality of data .	**15 Lectures**

Autocorrelation: Concept and detection using Durbin Watson Test, Interpretation of output produced by DW-test function in R, Heteroscedasticity: Concept and detection using Breusch –Pagan-Godfrey Test, Interpretation of output produced by bptest function in R, Multicollinearity: Concept and detection using R^2 and t-ratios ii) pairwise correlation between repressors iii) Variance Inflation Factor(VIF), Interpretation of output produced by mctest function in R, Consequences of using OLS estimators in presence of Autocorrelation, Heteroscedasticity and Multicollinearity, Remedial measures. (Ref.1,2,3,4,5)	

***REFERENCES*:**

1) Draper, N. R. and Smith, H. (1998), Applied Regression Analysis (John Wiley), Third Edition.

2) Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003), Introduction to Linear Regression Analysis (Wiley).

3) Neter, J., W., Kutner, M. H. ;Nachtsheim, C.J. and Wasserman, W.(1996), Applied Linear Statistical Models, fourth edition, Irwin USA.

4) DamodarGujrati, Sangetha,Basic Econometrics, fourth edition, McGraw Hill Companies.

5) William Geene (1991), Econometrics Analysis, first edition, Mc Millan Publishing Company.

6) Crawley, M. J. (2006). Statistics - An introduction using R. John Wiley, London

7) Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R, second edition. Narosa Publishing House, New Delhi.

8) Shahababa , B. (2011). Biostatistics with R, Springer, New York

9) Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall /CRC Press, New York

10) Asha Jindal (Ed.)(2018), Analysing and Visualising Data with R software- A Practical Manual, Shailja Prakashan, K.C.College.

DISTRIBUTION OF TOPICS FOR PRACTICALS

SEMESTER-V

Sr. No.	Course Code: **RJSUSTA501**
1	Probability-1
2	Probability -2
3	Probability -3
4	Multinomial Distribution
5	Order Statistics -1
6	Order Statistics -2

Sr. No.	Course Code: **RJSUSTA502**
1	MVUE and MVBUE
2	Method of Estimation -1
3	Method of Estimation -2
4	Bayes' Estimation
5	Confidence Interval
6	Linear model

Sr. No.	Course Code: **RJSUSTA503**
1	Epidemic models
2	Direct Assays
3	Quantal Response Assays
4	Parallel line Assay
5	Clinical Trials
6	Bioequivalence

Sr. No.	Course Code: **RJSUSTA504**
1	Fundamentals of R
2	Graphs using R
3	Diagrams using R
4	Simple Linear Regression using R
5	Multiple Linear Regression using R
6	Weighted Least Square using R

T.Y.B.Sc. STATISTICS Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2018-2019

SEMESTER VI

Theory

Course	UNIT	TOPICS	Credits	L / Week
RJSUSTA601	I	Bivariate Normal Distribution	2.5	1
	II	Generating Functions		1
	III	Stochastic Processes		1
	IV	Queueing Theory		1
RJSUSTA602	I	Most Powerful Tests	2.5	1
	II	Uniformly Most Powerful & Likelihood Ratio Tests		1
	III	Sequential Probability Ratio Test (SPRT)		1
	IV	Non-Parametric Tests		1
RJSUSTA603	I	Linear Programming Problem	2.5	1
	II	Inventory Control		1
	III	Replacement Theory		1
	IV	Simulation And Reliability		1
RJSUSTA604	I	Mortality Tables	2.5	1
	II	Compound Interest And Annuities Certain		1
	III	Life Annuities		1
	IV	Assurance Benefits		1

Course	PRACTICALS	Credits	L / Week
RJSUSTAP601	Practicals of Course RJSUSTA601 + Course RJSUSTA602	3	8
RJSUSTAP602	Practicals of Course RJSUSTA603 + Course RJSUSTA604	3	8

Learning Objectives:

- To strengthen the concepts in mathematical statistics.
- To prepare students to develop stochastics and queueing models.

Course Code	Title	Credits
RJSUSTA601	**DISTRIBUTION THEORY AND STOCHASTIC PROCESSES**	**2.5 Credits (60 lectures)**
Unit I : BIVARIATE NORMAL DISTRIBUTION i) Definition of joint probability distribution (X, Y). Joint Moment Generating function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal & Conditional distributions. Their Means & Variances. Correlation coefficient between the random variables. Necessary and sufficient condition for the independence of X and Y. Distribution of aX + bY, where 'a' and 'b' are constants. ii) Distribution of sample correlation coefficient when $\rho = 0$. Testing the significance of a correlation coefficient. Fisher's z – transformation. Tests for i) $H_0: \rho = \rho_0$ ii) $H_0: \rho_1 = \rho_2$ Confidence interval for ρ. (Ref. 2,3,5,9)		**15 Lectures**
Unit II : GENERATING FUNCTIONS Definitions of generating function and probability generating function. Expression for mean and variance in terms of generating functions. Definition of a convolution of two or more sequences. Generating function of a convolution. Generating functions of the standard discrete distributions. Relation between: i) Bernoulli and Binomial distributions ii) Geometric and Negative Binomial distributions in terms of convolutions. (Ref.1,5)		**15 Lectures**
Unit III: STOCHASTIC PROCESSES Definition of stochastic process. Postulates and difference differential equations for : (i) Pure birth process (ii) Poisson process with initially 'a' members, for a =0 and a >0 (iii) Yule Furry process (iv)Pure death process (v) Death process with $\mu_n=\mu$ (vi) Death process with $\mu_n=n\mu$ (vii) Birth and death process (viii) Linear growth model. Derivation of P_n (t), mean and variance where ever applicable. (Ref.1,7,9)		**15 Lectures**

Unit IV: QUEUEING THEORY	**15 Lectures**
Basic elements of the Queuing model. Roles of the Poisson and Exponential distributions. Derivation of Steady state probabilities for birth and death process. Steady state probabilities and various average characteristics for the following models: (i) (M/M/1) : (GD/ ∞ /∞) (ii) (M/M/1) : (GD/ N /∞) (iii) (M/M/c) : (GD/∞/∞) (iv) (M/M/c) : (GD/ N /∞) (v) (M/M/∞) : (GD/ ∞ /∞) (Ref.6)	

REFERENCES:

1. Feller W: An introduction to probability theory and it's applications, Volume: 1, Third edition, Wiley Eastern Limited.
2. Hogg R. V. & Craig A.T.: Introduction to Mathematical Statistics, Fifth edition, Pearson Education (Singapore) Pvt Ltd.
3. Mood A M, Graybill F A, Bose D C: Introduction to the theory of statistics, Third edition, Mcgraw- Hill Series.
4. Hogg R. V. and Tanis E.A.: Probability and Statistical Inference, Fourth edition, McMillan Publishing Company
5. Gupta S C & Kapoor V K: Fundamentals of Mathematical statistics, Eleventh edition, Sultan Chand & Sons.
6. Taha H.A.: Operations Research: An introduction, Eighth edition, Prentice Hall of India Pvt. Ltd.
7. Medhi J: Stochastic Processes, Second edition, Wiley Eastern Ltd.
8. Biswas S.: Topics in Statistical Methodology (1992), First edition, Wiley Eastern Ltd.
9. Kapur J. N., Saxena H. C.: Mathematical Statistics, Fifteenth edition, S. Chand and Company

Learning Objective:

To empower students to validate assumption made on population parameters.

Course Code	Title	Credits
RJSUSTA602	**TESTING OF HYPOTHESES**	**2.5 Credits (60 lectures)**
Unit I : MOST POWERFUL TESTS i. Problem of testing of hypothesis. ii. Definitions and illustrations of i) Simple hypothesis ii) Composite hypothesis iii)Null Hypothesis iv) Alternative Hypothesis v)Test of hypothesis vi) Critical region vii) Type I and Type II errors viii) Level of significance ix) p-value x) size of the test xi) Power of the test xii) Power function of a test xiii) Power curve. iii. Definition of most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Neyman-Pearson fundamental lemma. Randomized test (Ref. 1,2,10)		**15 Lectures**
Unit II : UNIFORMLY MOST POWERFUL & LIKELIHOOD RATIO TESTS i. Definition, Existence and Construction of uniformly most powerful (UMP) test. (Ref 1,2,10) ii. Likelihood ratio principle. Definition of test statistic and its asymptotic distribution (statement only). Construction of LRT for the mean of normal distribution for i) known σ^2 ii) unknown σ^2 (two sided alternatives). LRT for variance of normal distribution for i) known μ ii) unknown μ (two sided alternatives hypotheses). i. Ref. (1,2,3,4)		**15 Lectures**
Unit III: SEQUENTIAL PROBABILITY RATIO TEST (SPRT) i. i)Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size (Neyman-Pearson) test procedure. ii. Definition of Wald's SPRT of strength (α, β). Graphical / Tabular procedure for carrying out the tests. Problems based on Bernoulli, Binomial, Poisson, Normal and Exponential distributions. (Ref. 1,6,7,8)		**15 Lectures**
Unit IV: NON-PARAMETRIC TESTS i. Need for non parametric tests. ii. Distinction between a parametric and a non parametric test. iii. Concept of a distribution free statistic. Single sample and two sample Nonparametric tests. (i) Sign test (ii) Wilcoxon's signed rank test (iii)		**15 Lectures**

Median test (iv) Mann–Whitney test (v) Run test (vi) Fisher exact test (vii) Kruskal -Wallis test (viii) Friedman test. iv. Assumptions, justification of the test procedure for small & large samples. (Ref.5,9)	

REFERENCES:

1. Hogg R.V. and Craig A.T: Introduction to Mathematical Statistics, Fourth edition London Macmillan Co. Ltd.
2. Hogg R.V. and Tanis E.A.: Probability and Statistical Inference, Third edition Delhi Pearson Education.
3. Lehmann, E. L: Testing of Statistical Hypothesis, Wiley &Sons
4. Rao, C. R.: Linear Statistical Inference and its applications, Second Edition Wiley Series in Probability and Statistics.
5. Daniel W.W.:Applied Non Parametric Statistics, First edition Boston-Houghton Mifflin Company.
6. Wald A.: Sequential Analysis, First edition New York John Wiley & Sons
7. Gupta S.C. and Kapoor V.K.: Fundamentals of Mathematical Statistics, Tenth edition New Delhi S. Chand & Company Ltd.
8. Sanjay Arora and Bansi Lal: New Mathematical Statistics, SatyaPrakashan, New Market, New Delhi, 5(1989).
9. Sidney Siegal and N John Castellan Jr.:Non parametric test for behavioral sciences, McGraw Hill c-1988
10. A. Mood, F. Graybill and D. Boes: Introduction to theory of Statistics – McGraw Hill

Learning Objective:

To orient students on various application of statistics in industry.

Course Code	Title	Credits
RJSUSTA603	**OPERATIONS RESEARCH TECHNIQUES**	**2.5 Credits (60 lectures)**
Unit I : LINEAR PROGRAMMING PROBLEM Two-Phase Simplex Method, Algorithm. Dual Simplex Method, Algorithm. Post Optimality Sensitivity Analysis. Effect on optimal solution to the LPP and improvement in the solution due to (i) Change in cost coefficient, (ii) Change in the element of requirement vector, (iii) Addition/deletion of a variable,(iv) Addition/deletion of a constraint (All expression without proof) (Ref. 2,3)		**15 Lectures**
Unit II : INVENTORY CONTROL Introduction to Inventory Problem Deterministic Models : Single item static EOQ models for (i) Constant rate of demand with instantaneous replenishment, with and without shortages. (ii) Constant rate of demand with uniform rate of replenishment, with and without shortages. (iii) Constant rate of demand with instantaneous replenishment without shortages, with at most two price breaks. Probabilistic models : Single period with (i) Instantaneous demand (discrete and continuous) without setup cost. (ii) Uniform demand (discrete and continuous) without set up cost. (Ref. 1, 2, 3)		**15 Lectures**
Unit III: REPLACEMENT THEORY Replacement of items that deteriorate with time and value of money i) remains constant ii) changes with time. Replacement of items that fail completely: Individual replacement and Group replacement policies. (Ref. 3)		**15 Lectures**
Unit IV : SIMULATION AND RELIABILITY Concept and Scope of simulation. Monte Carlo Technique of Simulation.Generation of random numbers using (i) Mid. Square Method and (ii) Multiplicative Congruential Method. Inverse method of generation of random observations from (i) Uniform distribution, (ii) Exponential distribution, (iii) Gamma distribution, (iv) Normal distribution. Simulation techniques applied to inventory and queueing model. (Ref.1,4)		**15 Lectures**

Reliability: Concept of reliability, Hazard-rate. Bath tub curve. Failure time distributions : (i) Exponential, (ii) Gamma,(iii) Weibull, (iv) Gumbel. Definitions of increasing (decreasing) failure rate. System Reliability. Reliability of (i) series ; (ii) parallel system of independent components having exponential life distributions. Mean Time to Failure of a system (MTTF). (Ref.5,6)	

REFERENCES:

1. Vora N. D. : Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
2. Kantiswarup, P.K. Gupta, Manmohan: Operations Research, Twelfth edition, Sultan Chand & sons.
3. Sharma S. D. : Operations Research, Eighth edition, Kedarnath Ramnath & Co.
4. Taha Hamdy A. : Operations Research : Eighth edition, Prentice Hall of India Pvt. Ltd.
5. Barlow R. E. and Prochan Frank : Statistical Theory of Reliability and Life Testing Reprint, First edition, Holt, Reinhart and Winston.
6. Mann N. R., Schafer R.E., Singapurwalla N. D.: Methods for Statistical Analysis of Reliability and Life Data. First edition, John Wiley & Sons.

Learning Objective:

To apply statistics insurance industry.

Course Code	Title	Credits
RJSUSTA604	**ELEMENTS OF ACTUARIAL SCIENCE**	**2.5 Credits (60 lectures)**
UNIT 1: MORTALITY TABLES: Definitions of (i) Crude Death Rate (ii)Specific Death Rates (iii) Standardised Death Rates (iv)Crude Birth Rate (v)General Fertility Rate (vi)Specific Fertility Rate (vii) Total Fertility Rate (viii) Pearl's Vital Index (ix)Gross Reproduction rate (x)Net Reproduction rate. Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μ_x from the mortality table.Laws of mortality: Gompertz's and Makeham's first law. Select, Ultimate andAggregate mortality tables. Stationary population. Central Mortality Rate Expectation of life and Average life at death. (Ref.2,3)		**15 Lectures**
Unit II: COMPOUND INTEREST AND ANNUITIES CERTAIN: Accumulated value and present value, nominal and effective rates of interest. 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 value for perpetuity (immediate and due) with and without deferment Period. Present and accumulated values of (i) increasing annuity (ii) increasing annuity when successive installments form arithmetic progression (iii) annuity with frequency different from that with which interest is convertible. Redemption of loan. (Ref.2)		**15 Lectures**
Unit III: LIFE ANNUITIES: 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, increasing life annuities and increasing Temporary life annuities (immediate and due). (Ref:1,2)		**15 Lectures**

Unit IV: ASSURANCE BENEFITS:	**15 Lectures**
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) special endowment assurance (vii) deferred temporary assurance Net premiums: Net level annual premiums (including limited period of payment) for various assurance plans .Natural and Office premiums. (Ref:1,2)	

***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.

DISTRIBUTION OF TOPICS FOR PRACTICALS

SEMESTER-VI

Sr. No.	Course Code: **RJSUSTA601**
1	Bivariate Normal Distribution
2	Tests for correlation and Interval estimation
3	Generating Function
4	Stochastic Process
5	Queuing Theory -1
6	Queuing Theory -2

Sr. No.	Course Code: **RJSUSTA602**
1	Testing of Hypothesis- 1
2	Testing of Hypothesis-2
3	SPRT
4	Non Parametric test-1
5	Non Parametric test-2

Sr. No.	Course Code: **RJSUSTA603**
1	L.P.P.
2	Inventory I
3	Inventory II
4	Replacement
5	Simulation
6	Reliability

Sr. No.	Course Code: **RJSUSTA604**
1	Mortality table I
2	Mortality table II
3	Annuities I
4	Annuities II
5	Life Annuities
6	Assurance benefits

Semester End Examination- THEORY

At the end of the semester, examination of two hours duration and 60 marks based on the four 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** compulsory Questions of **Fifteen** marks each with internal option. Question1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III, Question 4 based on Unit IV.

Internal Examination

The paper pattern of the question paper of IA1 and IA2 will be as follows:

Question 1: 5 questions of one mark each,

Question 2: (a) 1 question of two marks, (b) 1 question of three marks,

Question 3: Attempt any two out of three questions, each of five marks.

Semester End Examination- PRACTICALS

At end of the semester, examination of one and half hours duration and 50 marks shall be held for each course.
Students will attempt 1 question out of 2 questions, each of 40 marks. Each question will have atleast four sub-questions. Journal-05 marks, Viva-05 marks.

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Syllabus for Semester V and Semester VI
Program: B.Sc.
Course: Computer Programming and System Analysis
(APPLIED COMPONENT)

Learning Objective:

- To create the learners with the ability & skill to analyze & resolve information technology problems.
- Prepare the students to extend current knowledge & skill to computing environment.

Course Code: RJSUMATSAC501 2 CREDITS

UNIT I : RELATIONAL DATA BASE MANAGEMENT SYSTEM – 15 Lectures

1. Introduction to Data base Concepts: Database, Overview of data base management system. Data base Languages- Data Definition Languages (DDL) and Data Manipulation Languages (DML).
2. Entity Relation Model : Entity, artibutes, keys, relations, Designing ER diagram, integrity Constraints over relations, conversion of ER to relations with and without constrains.
3. SQL Commands and functions
a) Creating and altering tables: CREATE statement with constraints like KEY, CHECK, DEFAULT, ALTER and DROP statement.
b) Handling data using SQL: selecting data using SELECT statement, FROM clause, WHERE clause, HAVING clause, ORDERBY, GROUP BY, DISTINCT and ALL predicates, Adding data with INSERT statement, changing data with UPDATE statement, removing data with DELETE statement.
c) Functions: Aggregate functions- AVG, SUM, MIN, MAX and COUNT, Date functions- ADD_MONTHS(), CURRENT_DATE(), LAST_DAY(), MONTHS_BETWEEN(), NEXT_DAY(). String functions- LOWER(), UPPER(), LTRIN(), RTRIM(), TRIN(), INSERT(), RIGHT(), LEFT(), LENGTH(), SUBSTR(). Numeric functions: ABS(), EXP(), LOG(), SQRT(), POWER(), SIGN(), ROUND(number).
d) Joining tables: Inner, outer and cross joins, union.

UNIT II Algorithm & Flowcharts – 15 Lectures

1.Logic Building : Brain storming ,Mind map creation, Logic building
2.Flow- Charts : Various symbols used in flow charts, creating simple flow charts.
3. Conditional branching in flow charts, multiple condition handling in Flow charts, Iteration or Loops in flow charts.
4. Algorithm: Introduction & uses of Algorithm.
5. Making Algorithm for simple logic based questions.
6. Algorithm for Sorting- Bubble sorting, Searching – Linear search & Binary Search

UNIT III : INTRODUCTION TO JAVA PROGRAMMING – 15 Lectures

1. Object-Oriented approach: Features of object-orientations: Abstraction, Inheritance, Encapsulation and Polymorphism.
2. Introduction: History of Java features, different types of Java programs, Differentiate Java with C. Java Virtual Machine.
3. Java Basics: Variables and data types, declaring variables, literals numeric, Boolean, character and string literals, keywords, type conversion and casting. Standard default values. Java Operators, Loops and Controls
4. Classes: Defining a class, creating instance and class members: creating object of a class, accessing instance variables of a class, creating method, naming method of a class, accessing method of a class,
5. Access control: public access, friendly access, protected access, private access.

UNIT IV : JAVA PROGRAMMING CONCEPTS – 15 Lectures

1. Arrays: one and two – dimensional array, declaring array variables, creating array objects, accessing array elements.
2. overloading method,'this' keyword, constructor and Finalizer: Basic Constructor, parameterized constructor, calling another constructor, finalize() method, overloading constructor.
3. Inheritance **–** Various types so inheritance, super and sub classes **,** Extend keyword, Super keyword, creating abstract class, creating abstract methods, method overriding
4. Interface- creating interface, implementing interface
5. Final – Final variables, Final methods & Final classes

References:

1. Data base management system, RamKrishnam, Gehrke, McGraw-Hill
2.Ivan Bayross, "SQL, C PROGRAMMING – The Programming languages of Oracle" B.P.B. Publications, 3rd Revised Edition.
3.George Koch and Kevin Loney, ORACLE "The complete Reference", Tata McGraw Hill, New Delhi.
4.Elsmasri and Navathe, "Fundamentals of Database Systems" Pearson Education.
5.Peter Roband Coronel, "Database System, Design, Implementation and Management", Thomson Learning.
6.C.J. Date, Longman, "Introduction database system", Pearson Education.
7.Jeffrey D. Ullman, Jennifer Widsom, "A First Course in Database Systems", Pearson Education.
8. Java the complete Reference, 8th Edition, Herbert Schildt, Tata McGraw Hill.

SEMESTER VI

Course code: RJSUMATSAC601 2 CREDITS

UNIT I : JAVA EXCEPTION HANDLING & APPLETS 15 LECTURES

1) Exception Handling and Packages: Need for Expectional Hndling, Exception Handlig techniques: try and catch, multiple catch statements, finally block, us age of throw and throws.
2) Concept of packages. Inter class method: parseInt().
3) Applets: Difference of applet and application, creating applets, applet life cycle, passing parameters to applets.
4) Graphics, Fonts and Color: The graphics class, painting, repainting and updating an applet, sizing graphics. Font class, draw graphical figures-lines and rectangle, circle and ellipse, drawing arcs, drawing polygons.Working with Colors: Color methods, setting the paint mode.

UNIT II : JAVA AWT & EVENT HANDLING 15 LECTURES

1) AWT package: Components for Graphical User Interface: Label, Button, List , Checkbox; Text Field, Text Area, Radio button.
2) Layout Managers – Arranging controls with FlowLayout, BorderLayout, GridLayout. Arranging controls with fixed locations.
3) Container classes – Creating Panel and adding various components to it.
4) Event Handlers- Using ActionListener for Button click event, ItemListener for Checkbox control, ItemListener for Radio Button, MouseListener For mouse events.

UNIT III : PYTHON 3.x 15 LECTURES

1. Introduction: The Python Programming Language, History, features, Installing Python.
Running Code in the Interactive Shell, IDLE. Input, Processing, and Output , Editing, Saving, and Running a Script, Debugging : Syntax Errors, Runtime Errors, Semantic Errors, Experimental Debugging.
2. Data types and expressions: Variables and the Assignment Statement , Program Comments and Docstrings . Data Types-Numericintegers & Floating-point numbers. Boolean, string. Mathematical operators +, - *, ** , %. PEMDAS.Arithmetic expressions, Mixed-Mode Arithmetic and type Conversion, type( ). Input( ), print( ), program comments. id( ), int( ), str( ), float( ).
3. Loops and selection statements: Definite Iteration: The for Loop, Executing statements a given number of times , Specifying the steps usingrange( ) , Loops that count down, Boolean and Comparison operators and Expressions, Conditional and alternative statements- Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else. Compound Boolean Expressions , Conditional Iteration: The while Loop –with True condition, the break Statement. Random Numbers. Loop Logic, errors, and testing.
Reference Fundamentals of Python First programs 2nd edition by Kenneth A Lambert chapter 1,2,3

Unit IV STRINGS, LIST AND DICTIONARIES. 15 LECTURES

1. Strings, Lists, Tuple, Dictionary: Accessing characters, indexing, slicing, replacing.Concatenation (+), Repetition (*).Searching a substring with the 'in' Operator, Traversing string using while and for. String methods- find, join, split, lower, upper. len( ).
2. Lists – Accessing and slicing, Basic Operations (Comparison, +),List membership and for loop.Replacing element (list is mutable). List methods- append, extend, insert, pop, sort. Max( ), min( ). Tuples.
Dictionaries-Creating a Dictionary, Adding keys and replacing Values , dictionary - key( ), value( ), get( ), pop( ) , Traversing a Dictionary.
Math module: sin(), cos(),exp(), sqrt(), constants- pi, e.
3. Design with functions : Defining Simple Functions- Parameters and Arguments, the return Statement, tuple as return value. Boolean Functions. Defining a main function. Defining and tracing recursive functions.
4. Exception handling: try- except.

References:
Reference Fundamentals of Python First programs 2nd edition by Kenneth A Lambert chapter 4,5,6.

1. Programming with Java:A Primer 4th Edition by E.Balagurusamy, Tata McGraw Hill.
2. JavaTheCompleteReference,8thEdition,HerbertSchildt,TataMcGrawHill
3. Fundamentals of Python First programs 2nd edition - Kenneth A Lambert, Cengage Learning India.
4. Doing Math with Python - Amit Saha, No starch ptress,
Additional References:
5. Eric Jendrock, JenniferBall, DCarsonandothers,TheJavaEE5Tutorial, PearsonEducation,Third Edition,2003.
6. Ivan Bay Ross, Web Enabled Commercial Applications Development UsingJava2, BPB Publications, Revised Edition, 2006
7. Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics, Thomson Course Technology(SPD),ThirdEdition,2004
8. The Java Tutorials of Sun Microsystems Inc. http://docs.oracle.com/javase/tutorial
9. Problem solving and Python programming- E. Balgurusamy, TataMcGrawHill.
Suggested Practical:
1. Write a program that demonstrates the use of input from the user using parse Int().
2. Write a Java applet to demonstrate graphics, Font and Color classes.
3. Write a Java program to illustrate AWT package.
4. Preparing investment report by calculating compound interest, computing approximate value of by using the = 1 − + − + ⋯ (Gottfried Leibniz)
5. Convert decimal to binary, octal using string, Write the encrypted text of each of the following words using a Caesar cipher with a distance value of 3.
6. Hexadecimal to binary using dictionary, finding median of list of numbers.
7. Enhanced Multiplication Table Generator, Unit Converter, Fraction Calculator .
8. Factor Finder, Graphical Equation Solver
9. Summing a Series, Solving Single-Variable Inequalities

Pattern of Theory question paper at the end of the semester for each course:
Total Marks : 60 Duration : 2:00 hrs

Q.1) Based on Unit 1 [marks : 12]

a) Solve any 2 of 3 (6 marks)

b) Solve any 2 of 3 (6 marks)

Q.2) Based on Unit 2 [marks : 12]

a) Solve any 2 of 3 (6 marks)

b) Solve any 2 of 3 (6 marks)

Q.3) Based on Unit 3 [marks : 12]

a) Solve any 2 of 3 (6 marks)

b) Solve any 2 of 3 (6 marks)

Q.4) Based on Unit 4 [marks : 12]

a) Solve any 2 of 3 (6 marks)

b) Solve any 2 of 3 (6 marks)

Q.5) Based on Unit 1,2,3,4 [marks : 12]

a) Solve any 2 of 3 (6 marks)

b) Solve any 2 of 3 (6 marks)

Pattern of Internal Test paper of 30mins duration and 20 marks

Q.1) Objective Questions [solve 5 out of 6] – 5marks

Q.2) Answer in brief [Any 3 out of 4]- 9 marks

Q.3) Code based question [Attempt any 2 out of 3] – 6 marks

Semester End Practical Examination (Total 100 marks)
Semester V:
Total evaluation is of 100 marks-
(a) One Question on Unit 1 and Unit 2 -40 Marks
(b) One Question on Unit 3 and Unit 4 -40 Marks
(c) Journal -10 Marks
(d) Viva Voce -10 Marks
Semester VI:
Total evaluation is of 100 marks-
(a) One Question on Unit 1 and Unit 2 -40 Marks

(b) One Question on Unit 3 and Unit 4 -40 Marks
(c) Journal -10 Marks
(d) Viva Voce -10 Marks