Academic Council Meeting No. and Date : April 21, 2023

Agenda Number : 4 **Resolution Number : 23,24 / 4.6 & 4.13**

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme : Bachelor of Science
Specific Programme : Statistics

[T.Y.B.Sc. (Statistics)]

Revised under Autonomy

From academic year 2023 - 2024

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Preamble

The B.Sc. Statistics programme is aimed to develop theoretical and analytical skills of the students so that they may be absorbed in the corporate world or able to pursue higher studies at the Master level in Statistics. The main objectives of the course are:

- To get introduced to some statistical concepts that are relevant in the interpretation of measurements made on individual, and in the interpretation of statistical study materials.
- To apply their knowledge and skills to be employed and excel in Statistics professional careers and/or to continue their education in Statistics and/or related post graduate programmes.
- To get Knowledge and understanding of basic statistical methods such as sampling and collecting data, probability, distributions, Regression Analysis.
- To gain Knowledge and understanding to confidently read statistics and apply statistical methods within their working environment.
- To be capable of managing Statistics projects with consideration of the human, financial and environmental factors.
- To work effectively as a part of a team to achieve a common stated goal.
- To communicate effectively with a range of audiences both technical and non-technical.
- To develop an aptitude to engage in continuing professional development.

The syllabus is aimed to achieve the objectives. The syllabus spanning three years covers the industry relevant courses. The students will be ready for the jobs available in different fields like:

- Statistician
- Analyst
- Biostatistician
- Actuaries
- Banking sector
- Risk Analyst
- Machine Learning and Artificial Intelligence
- Data Analytics
- Academics
- Government organizations like NSSO, NSO, ISS, SSC etc.

The students will also be trained in communication skills and knowledge related toExcel, R software and Python.

Eligibility:

Cleared S.Y.B.Sc with a Combination MS/PS from any recognized/ Affiliated University can adopt for T.Y.B.Sc with the Statistics subject.

Duration: 1 year

Mode of Conduct:

Statistics Practical's / Practical's are related to R software,Python & Excels / Offline lectures.

Program Specific Outcome

By the end of the programme, Learner Enhance knowledge of Statistical tools, able to relate real life situation with statistical technique, enable efficient use of electronic devices to solve statistical problems, Develop the ability to use statistical knowledge and skills in other disciplines.

VPM's B. N. Bandodkar College of Science (Autonomous), Thane

T.Y.B.Sc. (Statistics)

STRUCTURE OF PROGRAMME

SEMESTER V

Course	UNIT	TOPICS	Lectures
BNBUSST5T1	I	PROBABILITY AND DISTRIBUTION THEORY	15
	II	JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION	15
	III	INEQUALITIES AND LAW OF LARGE NUMBERS	15
	IV	ORDER STATISTICS	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST5T2	I	POINT ESTIMATION AND PROPERTIES OF ESTIMATORS	15
	II	METHODS OF POINT ESTIMATION	15
	III	BAYESIAN ESTIMATION METHOD & INTERVAL ESTIMATION	15
	IV	INTRODUCTION TO LINEAR MODELS	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST5T3	I	EPIDEMIC MODELS	15
	II	BIOASSAYS	15
	III	BIOEQUIVALENCE	15
	IV	CLINICAL TRIALS	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST5T4	I	SIMPLE LINEAR REGRESSION MODEL	15
	II	MULTIPLE LINEAR REGRESION MODEL	15
	III	VALIDITY OF ASSUMPTIONS	15
	IV	LOGISTICS REGRESSION MODEL	15
Course	**UNIT**	**TOPICS**	**Lectures**

BNBUSACOR5T5(A)	I	LINERA PROGRAMMING PROBLEM	15
	II	GAME THEORY	15
	III	DECISION THEROY	15
	IV	DYNAMIC PROGRAMMING PROBLEM	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSCP5T5(B)	I	INTRODUCTION TO C PROGRAMMING	15
	II	FUNCTIONS, POINTERS AND STRUCTURES	15
	III	RELATIONAL DATABASE MANAGEMENT SYSTEM	15
	IV	INTRODUCTION TO PL/SQL	15
Course	**PAPER**	**TOPICS**	**Lectures Per Week**
BNBUSST5P1	I & II	Practical's of course BNUSST5T1+BNBUSST5T2	8
BNBUSST5P2	III & IV	Practical's of course BNBUSST5T3+BNBUSST5T4	8
BNBUSST5P3	V	Practical's of course BNBUSACOR5T5(A)/ BNBUSCP5T5(B)	4

SEMESTER VI

Course	UNIT	TOPICS	Lectures
BNBUSST6T1	I	BIVARIATE NORMAL DISTRIBUTION	15
	II	GENERATING FUNCTIONS	15
	III	STOCHASTIC PROCESSES	15
	IV	QUEUING THEORY	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST6T2	I	MOST POWERFUL TEST	15
	II	UNIFORMLY MOST POWERFUL TEST & LIKELIHOOD RATIO TEST	15
	III	SEQUENTIAL PROBABILITY RATIO TEST	15
	IV	NON PARAMETRIC TEST	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST6T3	I	INVENTORY CONTROL	15
	II	REPLACEMENT	15
	III	RELIABILITY	15
	IV	LINEAR PROGRAMMING PROBLEM	15
Course	**UNIT**	**TOPICS**	**Lectures**
BNBUSST6T4	I	MORTALITY TABLES	15
	II	COMPOUND INTEREST AND ANNUITIES CERTAIN	15
	III	LIFE ANNUITIES	15
	IV	ASSURANCE BENEFITS	15
Course	**PAPER**	**TOPICS**	**Lectures**
BNBUSACOR6T5(A)	I	SIMULATION	15

	II	DUAL SIMPLEX &INTEGER PROGRAMING PROBLEM	15
	III	INVESTMENT ANALYSIS	15
	IV	INTRODUCATION TO SIX SIGMA	15
Course	**PAPER**	**TOPICS**	**Lectures**
BNBUSCP6T5(B)	I	INTRODUCTION TO JAVA PROGRAMMING	15
	II	INHERITANCE, EXCEPTION HANDLING	15
	III	JAVA APPLETS &GRAPHICSPROGRAMMING	15
	IV	PYTHON 3X	15
Course	**PAPER**	**TOPICS**	**Lectures Per Week**
BNBUSST6P1	I & II	Practical's of course BNUSST6T1+BNBUSST6T2	8
BNBUSST6P2	III & IV	Practical's of course BNBUSST6T3+BNBUSST6T4	8
BNBUSST6P3	V	Practical's of course BNBUSACOR6T5(A)/ BNBUSCP6T5(B)	4

SEMESTER V

Course Code	Title	Credits
BNBUSST5T1	**PROBABILITY AND DISTRIBUTION THEORY**	**2.5 credits (60 Lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand the basic counting rules and understand basic probability concepts.
- Get knowledge about joint moment generating function.
- Study trinomial and multinomial distribution and different characterstics of distribution.
- Learn concept of order statics and able to find distributions of order statistics.

Unit I : Probability (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) Addition Theorem for (a) two (b) three events (iv) Conditional Probability: Multiplication Theorem for two, three events. (v) Bayes' theorem. (vi) 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…A_N. Classical occupancy problems, Matching and Guessing problems. Problems based on them.	**15**
Unit II: Joint Moment Generating Function, Trinomial Distribution And Multinomial Distribution 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 Bivariate MGF. Trinomial distribution Definition of joint probability distribution of (X, Y). Joint moment generating function, moments $\mu_{rs}$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 Extension to Multinomial distribution with parameters (n, p1, p2,…pk-1) where p1+ p2,+…pk-1+ pk = 1. Expression for joint MGF. Derivation of: joint probability distribution of (Xi, Xj). Conditional probability distribution of Xi.	**15**
Unit III: Inequalities and Law of Large Numbers: a. Markov Inequality b. Tchebyshev's Inequality c. Boole's Inequality d. Cauchy Schwartz's Inequality e. Weak Law of Large Numbers.	**15**

Unit IV: Order Statistics (i) Definition of Order Statistics based on a random sample. (ii) Derivation of: (a) Cumulative distribution functions of rth order statistic. (b) Probability density functions of the rth order statistic. (c) Joint Probability density function of the rth and the sth order statistic (r<s) (d) Joint Probability density functions of all n ordered statistics. (e) Distribution of Maximum observation (nth order statistic) and Minimum observation (first order statistic) in case of uniform and Exponential distribution. (f) Probability density function of the difference between rth and sth order statistic (r<s) in case of uniform and Exponential distribution	**15**

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.

Course Code	Title	Credits
BNBUSST5T2	**THEORY OF ESTIMATION**	**2.5 credits (60 Lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to Recollect the concepts:

- About the properties of good estimators.
- How to estimates a parameter using different methods of point estimation.
- By which method we can treat parameters as random variable.
- How to estimate interval for parameters.
- To fit general linear model, to estimates unknown parameters of model and to estimate interval for linear combination of parameters.

Unit I : Point Estimation And Properties Of Estimators — **15**

Notion of a Parameter and Parameter Space.
Problem of Point estimation.
Definitions: Statistic, Estimator and Estimate.
Properties of a good estimator :
1) Unbiasedness: Definition of an unbiased estimator, Illustrations and examples.
Proofs of the following results:

i. Two distinct unbiased estimators of U(θ) give rise to infinitely many unbiased estimators.
ii. If T is an unbiased estimator of then U(T) is an unbiased estimator of U(θ) provided U(θ) is a linear function.

2) Consistency: Definition of Consistency.
Sufficient condition for consistency , proof & Illustrations
3) Sufficiency: Concept and Definition of sufficient statistic. Neyman's Factorization theorem (without proof).Exponential family of probability distributions and sufficient statistics.
4)Relative efficiencyof an estimator & illustrative examples.
Minimum variance unbiased estimator(MVUE) and Cramer Rao Inequality:
Definition of MVUE, Uniqueness property of MVUE (proof)., 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

UNIT II : Methods Of Point Estimation: — **15**

Method of Maximum Likelihood Estimation (M.L.E.) :

1. Definition of likelihood as a function of unknown parameter for a random sample from: Discrete distribution & Continuous distribution.
2. Derivation of Maximum likelihood estimator (M.L.E.) for parameters of Standard distributions (case of one and two unknown parameters).
3. Properties of MLE (without proof).

Method of Moments :

1. Derivation of Moment estimators for standard distributions (case of one and two unknown parameters)
2. llustrations of situations where MLE and Moment Estimators are distinct and their comparison using Mean Square error.

Method of Minimum Chi-square and Modified Minimum Chi- Square

Ref: 1,2,3	
UNIT III: Bayesian Estimation Method & Interval Estimation **Bayes Estimation:** 1. Prior distribution, Posterior distribution 2. Loss function, Risk function 3. Types of Loss function: Squared error Loss function (SELF), Absolute error Loss function (AELF) 4. Bayes' risk. 5. Bayes' method of finding Point estimator (assuming SELF) **Examples :** (i) Binomial- Beta (ii) Poisson- Gamma (iii) Gamma-Gamma (iv) Normal-Normal **Interval Estimation**: 1. Concept of confidence interval & confidence limits. 2. Definition of Pivotal quantity and its use in obtaining confidence limits. 3. Derivation of 100(1-α) % equal tailed confidence interval for : 4. The population mean :μ , $\mu_1 \div \mu_2$(population variance known/ unknown) 5. The population variance:$\sigma^2, \frac{\sigma_1^2}{\sigma_2^2}$(Normal distribution). 6. Confidence interval for the parameters of Binomial, Poisson and Exponential distributions. Ref. 1,3,8	**15**
UNIT IV: Introduction To Linear Models **Linear Model** Explanation of General Linear Model of full rank with assumptions. Model Y: $X\beta$+ e where e N (0, I) Derivation of : 1) Least squares estimator of β 2) E($\hat{\beta}$) 3) V($\hat{\beta}$) GuassMarkoff theorem for full rank Model: Y = Xβ + e. Derivation of: 1) E($\lambda'\hat{\beta}$)2) V ($\lambda'\hat{\beta}$). Confidence interval for $\lambda'\beta$ when $\sigma^2$is known. Confidence interval $\beta$of when $\sigma^2$is known.	**15**

REFERENCES:

1. HoggR.V.,CraigA.T.: Introduction to Mathematical Statistics, Fourth Edition; Collier McMillan Publishers.
2. HoggR.V.,TannisE. A.: Probability and Statistical Inference, Third Edition; Collier McMillan Publishers.
3. Rohatgi, V. K, EhsanesSaleh 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. HoelP.G.: Introduction to Mathematical Statistics; Fourth Edition; John Wiley & Sons Inc.
6. GuptaS.C.,KapoorV.K.: Fundamentals of Mathematical Statistics; Eighth Edition; Sultan Chand & Sons.
7. KapurJ.N.,SaxenaH.C.: Mathematical Statistics; Fifteenth Edition; S. Chand & Company Ltd.
8. AroraSanjay and BansiLal : New Mathematical Statistics, SatyaPrakashan, New Market, New Delhi,5(1989)
9. A.M.Kshirsagar; Linear Models
10. F.A. Graybill; An Introduction to Linear Models.

Course Code	Title	Credits
BNBUSST5T3	**BIOSTATISTICS**	**2.5 credits (60 Lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Define the meaning and scope of bioassays and relative potency.
- Understand the need and ethics of clinical trials and common terminology used in clinical trials.
- Define and explain the features of epidemic spread and various terms involved.

Unit I : Epidemic Models — **15**

(i) The features of Epidemic spread. Definitions of various terms involved. Simple mathematical models for epidemics: Deterministic model without removals (for 'a' introductions), 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)

Unit II : Bioassays — **15**

(i) Meaning and scope of bioassays. Relative potency. Direct assays. 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 LD50. Probit and Logit analysis. (Ref.2, 3)

Unit III : Bioequivalence — **15**

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, Cross over (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)

Unit III : Clinical Trials — **15**

The need and ethics of clinical trials. Common terminology used in clinical trials. Over view 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, Multicentric.

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 (Ref. 4, 5, 6, 7, 8)

REFERENCES

1. Bailey N.TJ. : 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 Biostatistics series.

Course Code	Title	Credits
BNBUSST5T4	**INTRODUCTION TO REGRESSION ANALYSIS**	**2.5 credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Recollect the concepts of the fitting of models and estimating of parameters using least square method.
- Analyses the multiple linear models and logistics models.
- Compare residual diagnostics and apply corrective measures.
- Determine the testing of hypothesis of model parameters, LR test, AIC and BIC criteria.

Unit I : Fundamentals of R (have certificate course for this unit) 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, five numetc 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 of variables. Data Processing : Data import and export, setting working directory, checking structure of Data :Str(), Class(), Changing type of variable (for egas.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	**15**

Unit I : Simple linear regression model Review of Simple linear Regression Model: $Y = \beta_0 + \beta_1 X + \varepsilon$ Assumptions of the model, Derivation of ordinary least square (OLS) estimators of regression coefficients for simple, Properties of least square estimators (without proof), Estimation of σ^2, Coefficient of determination R^2 and adjusted R^2, Procedure of testing Overall significance of the models Significance of individual coefficients Confidence intervals for the regression coefficients Residual analysis: Standardized residuals, Studentized residuals, residual plots, Interpretation of four plots of, Interpretation output produced by plot command in R Software. Data Pre-processing: Detection and treatment of missing value(s)and outliers. (Ref.1,2,3,5)	**15**
Unit II : Multiple linear regression model & Validity of Assumptions Review of Simple linear Regression Model: $Y = \beta_0 + \beta_1 X_1 + \cdots + \beta_p X_p + \varepsilon$ 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 Overall significance of the models Significance of individual coefficients Confidence intervals for the regression coefficients Residual Diagnostics and corrective measures such as transformation of response variable, testing normality of data. (Ref.1,2,3,5)	**15**
Unit III : Validity of Assumptions: Autocorrelation: Concept anddetection 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 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, and Brief introduction to ridge regression Data Pre-processing: Variable selection and Model building.	**15**
Unit III: Logistics regression model Binary response variable, Logit transform, estimation of parameter, interpretation of parameters, Tests of hypotheses of model parameters, model deviance, LR test , AIC and BIC criteria for model selection, Multiple logistic regression (Ref. 4,6)	**15**

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. Hosmer, D.W and lameshow, S.(1989). Applied Logistic Regression (Wiley).
5. Chatterjee S. and Hadi A.S.(2012): Regression Analysis by Examples, 5th Edition, Wiley.
6. Kleinbaum G. and Klein M.(2011): Logistic Regression, IIIrd Edition a self-learning text, Springer.

Course Code	Title	Credits
BNBUSACOR5T5(A)	**OPTIMIZATION TECHNIQUE I**	**2.5 Credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Learn graphical, Simplex method and Big M method to solve linear programming problem.
- Read solution of LPP using primal and Dual problem.
- Understand different types of games and its optimization technique.
- Get knowledge of different decision criteria and its application to get optimum decision.
- Understand normal distribution and able to learn Bivariate normal distribution and its properties, applications.

Unit I : Linear Programming Problem Mathematical Formulation : Maximization and Minimization type problems. Concepts of solution, Feasible solution, Basic solution, Basic feasible solution, Optimal solution. Graphical solution to problems. Simplex method of solving problems with two or more variables. Big M method. Concept of Duality, Properties of Duality. Its use in solving L.P.P. Relationship between optimum solutions to Primal and Dual. Economic interpretation of Dual.	**20**
Unit II : Game theory Definitions of Two persons 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 (2x2) game.Graphical solution of (2xn) and (mx2) games, Reduction of game theory to LPP.	**15**
Unit III : Decision theory Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz criterion, Minimax Regret criterion. Decision making under risk: Expected Monetary Value criterion, Expected Opportunity Loss criterion, EPPI, EVPI. Bayesian Decision rule for Posterior analysis. Decision tree analysis along with Posterior probabilities.	**15**
UnitIV :DynamicProgrammingProblem Multistage decision processes, Recursive nature of computations, Forward and Backwardrecursion,Bellman'sprincipleofoptimality,Selectivedynamicprogrammingapplicationsinvolving additive and multiplicative separable returns for objective as well as constraintfunctions,Problemof dimensionality. GoalProgramming:BasicsofGoalprogramming,Weightedandpre-emptivegoalprogramming,FormulationofGoalprogramming problemandgraphicalsolution.	**15**

REFERENCES

1. PERT and CPM, Principles and Applications: Srinath. 2nd edition, East-West Press Pvt. Ltd.
2. Bronson R. : Theory and problems of Operations research, First edition, Schaum's Outline series
3. Vora N. D. : Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
4. Bannerjee B. : Operation Research Techniques for Management, First edition, Business Books.
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.

Course Code	Title	Credits
BNBUSCP5T5(B)	**COMPUTING PROGRAMING I**	**2.5 Credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to
- Write C programs using loops, conditionals, switch, break and continue statements.
- Understand the concept of functional hierarchical code
- Handle pointers and structures
- Retrieve data from single or multiple tables
- Process data with date, string and aggregate functions
- Write simple PL/SQL block codes with and without loops.

Unit I :Introduction to C Programming (a) Structure of C program: Header and body, Concept of header files, Use ofcomments, Compilation of a program. (b) Data Concepts: Variables, Constants, data types like: int, float char, double and void. Qualifiers: short and long size qualifiers, signed and unsignedqualifiers. Declaring variables, Scope of the variables according to block,Hierarchy of data types. (c) Types of operators: Arithmetic, Relational, Logical, Compound Assignment,Increment and decrement, Conditional or ternary operators. Precedence andorder of evaluation. Statements and Expressions. (d) Mathematical functions : sin(), cos(), tan(), exp(), ceil(), floor(), log(),log10(), pow(), sqrt(). (e) Type conversions: Automatic and Explicit type conversion. (f) Data Input and Output functions: Formatted I/O: printf(), scanf(). CharacterI/O format: getch(), getche(), getchar(), getc(), gets(), putchar(), putc(), puts(). (g) Arrays: (One and two dimensional), declaring array variables, initialization ofarrays, accessing array elements. (h) Strings: Declaring and initializing String variables, Character and stringhandling functions (strcpy, strcat, strchr, strcmp, strlen, strstr). (i) Iterations: Control statements for decision making: (a) Branching: ifstatement, if...else statement, else... if statement, nested if statement, switchstatement. (b) Looping: while loop, do while, for loop, nested loop. (c) Loopinterruption statements: break, continue.	**15**
Unit II :Functions, Pointers and Structures (a) Functions: Global and local variables, Function definition, return statement,calling a function. (b) Recursion: Definition, Recursion functions for factorial, Fibonacci sequence,exponential function, G.C.D. (c) Storage classes: Automatic variables, External variables, Static variables,Register variables. (d) Pointer: Fundamentals, Pointer variables, Referencing and de-referencing,Pointer Arithmetic, Pointers and Arrays, Array of Pointers, Pointers as functionarguments.	**15**

(e)Structure: Declaration of structure, reading and assignment of structurevariables, Array of structures.	
Unit III : Relational Database Management System (a) Introduction to Database Concepts: Database, Overview of databasemanagement system. Three levels of Architecture, Database design, Logicaland physical data independence, DBMS Models, Database Languages- DataDefinition Language (DDL) and Data Manipulation Languages (DML). (b) Entity Relationship Model: Entity, entity sets, attributes, mappingcardinalities, keys, relations, Designing ER diagram, integrity constraints overrelations, Conversion of ER to relations with and without constraints. (c) SQL commands and Functions: (i) Creating and altering tables: CREATE statement with constraintslike KEY, CHECK, DEFAULT, ALTER and DROP statement. (ii) Handling data using SQL: selecting data using SELECT statement,FROM clause, WHERE clause, IN, BETWEEN, LIKE, HAVING clause,ORDER BY, GROUP BY,DISTINCT and ALL predicates, Adding datawith INSERT statement, changing data with UPDATE statement,removing data with DELETE statement. (iii) 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(), LTRIM(), RTRIM(), TRIM(), INSTR(), RIGHT(), LEFT(),LENGTH(), SUBSTR(). Numeric functions: ABS (), EXP (), LOG (),SQRT (), POWER (), SIGN (), ROUND (number). (iv) Joining tables: Inner, outer, full and cross joins, union.	**15**
Unit IV : Introduction to PL/SQL (a) Fundamentals of PL/SQL: Defining variables and constants, PL/SQL expressions and comparisons: Logical Operators, Boolean Expressions, CASEExpressions Handling, Null values in Comparisons and ConditionalStatements. (b) PL/SQL data types:-Number types, Character types, and Boolean type,datetime and interval types. (c) Overview of PL/SQL Control Structures: Conditional control: IF and CASEStatements, IF-THEN Statement,IF-THEN-ELSE Statement, IF-THEN-ELSIFStatement, CASE Statement. (d) Iterative Control: LOOP and EXIT Statements, WHILE LOOP,FORLOOP,Sequential control: GOTO and NULL Statements.	**15**

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(1) E Balagurusamy,(2004)Programming in ANSI C (Third Edition) :TMH
(2)George Koch and Kevin Loney(2002),ORACLE ―The Complete Reference‖, Tata McGraw Hill,New Delhi.
(3)Ivan Bayross, (2012) ―SQL, PL/SQL -The Programming language of Oracle‖, B.P.B.Publications, 3rd Revised Edition.
(4) Ramakrishnam, Gehrke, (2003) Database Management Systems, McGraw-Hill.
(5)YashwantKanetkar,(2010)Let us C: BPB

DISRIBUTION OF TOPICS FOR PRACTICALS
SEMESTER V
COURSE CODE BNBUSST5P1

Sr. No.	Practical topics from BNBUSST5T1		Sr. No.	Practical topics from BNBUSST5T2
5.1.1	Probability-I		5.2.1	MVUE and MVBUE
5.1.2	Probability-II ?		5.2.2	Methods of Estimation
5.1.3	Trinomial and Multinomial Distribution		5.2.3	Confidence Interval
5.1.4	Order statistics-I		5.2.4	Baye's Estimaion
5.1.5	Order statistics-II		5.2.5	Linear model
			5.2.6	Use of R software

COURSE CODE BNBUSST5P2

Sr. No.	Practical topics from BNBUSST5T3		Sr. No.	Practical topics from BNBUSST5T4
5.3.1	Epidemic Models		5.4.1	Simple Linear Regression using R
5.3.2	Direct Assays		5.4.2	Multiple Linear Regression using R
5.3.3	Parallel Line Assays		5.4.3	Weighted Least Square using R
5.3.4	Quantal Response Assays		5.4.4	Ordinary logistic Regression using R
5.3.5	Bioequivalence		5.4.5	Multiple Logistic Regression using R
5.3.6	Clinical Trials			?

COURSE CODE BNBUSACOR5P3

Sr.No.	Practical topics from USACOR5T5(A)	Sr. No.	Practical topics from BNBUSCPA5T5(B)
5.5A.1	Practical's based on unit I	5.5B.1	Practical's based on unit I
5.5A.2	Practical's based on unit I	5.5B.2	Practical's based on unit I
5.5A.3	Practical's based on unit II	5.5B.3	Practical's based on unit II
5.5A.4	Practical's based on unit II	5.5B.4	Practical's based on unit II
5.5A.5	Practical's based on unit III	5.5B.5	Practical's based on unit III
5.5A.6	Practical's based on unit III	5.5B.6	Practical's based on unit III

SEMESTER VI

Course Code	Title	Credits
BNBUSST6T1	**DISTRIBUTION THEORY AND STOCHASTIC PROCESSES**	**2.5 Credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand generating function and probability generating function.
- Find convolution for different sequences.
- Learn different stochastically processes and distribution of stochastically variable for different stochastic process.
- Understand different queuing models and basic element of queue.
- Find distribution for different queuing models.

UNIT I : Bivariate Normal distribution (i) Definition of joint probability distribution (X, Y). Joint Moment Generating function, moments $\mu_{rs}$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.	**15**
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**
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**

UNIT IV: Queuing Theory 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)	**15**

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

Course Code	Title	Credits
BNBUSST6T2	**TESTING OF HYPOTHESIS**	**2.5 credits (60 lectures)**

Course Outcomes:

Upon completion of this course, students will acquire knowledge about and able to Recollect the concepts of:

- Difference between parametric and non-parametric tests.
- How to test simple verses simple hypothesis, simple verses composite hypothesis and which method should be used for testing such type of testing.
- By which method sample size is treated as random variable in testing of hypothesis.
- When we opt for non-parametric method.

Unit I :Most Powerful Test 1) Problem of testing of hypothesis. 2) Definitions and illustrations of i) Simple hypothesis ii) Composite	**15**

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. 3) Definition of most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Neyman-Pearson fundamental lemma. Randomised test 4) Definition, Existence and Construction of Uniformly most powerful (UMP) test. (Ref. 1,2,10)	
Unit II : Uniformly Most Powerful Test & Likelihood Ratio Test 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 hypothesis) (Ref. 1,2,3,4,6,7,8)	**15**
Unit III : Sequential Probability Ratio Test Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size (Neyman-Pearson) test procedure. Definition of Wald's SPRT of strength (α, β). Graphical/Tabular procedure for carrying out SPRT. Problems based on Bernoulli, Binomial. Poisson, Normal & Exponential distributions.	**15**
Unit IV: Non-Parametric Tests Need for non parametric tests. Distinction between a parametric and a non parametric test. Concept of a distribution free statistic. Single sample and two sample Nonparametric tests. (i) Sign test (ii) Wilcoxon's signed rank test (iii) Median test (iv) Mann–Whitney test (v) Run test (vi) Fisher exact test (vii) Kruskal -Wallis test (viii) Friedman test	**15**

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 AroraandBansiLal: New Mathematical Statistics, SatyaPrakashan, New Market, New Delhi, 5(1989).
9. Sidney Siegal& N John Castellan Jr.:Non parametric test for behavioral sciences, McGraw Hill c-1988 Mood , F. Graybill& D. Boes:Introduction to the theory of Statistics- McGraw Hill

Course Code	Title	Credits
BNBUSST6T3	**OPERATIONS RESEARCH TECHNIQUES**	**2.5 credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand the importance and challenges of inventory management.
- Develop the ability to analyze and optimize inventory systems using mathematical models and algorithms.
- Understand the different policies for replacement of items that deteriorate over time and those that fail completely, including individual and group replacement policies.
- Develop the ability to conduct post optimality sensitivity analysis to evaluate the impact of changes on the optimal solution and the feasibility of the problem.
- When we opt for non-parametric method.

UNIT I : Inventory Control 1) Introduction to InventoryProblem 2) Deterministic Models: Single item static EOQ models for a. Constant rate of demand with instantaneous replenishment, with and without shortages. b. Constant rate of demand with uniform rate of replenishment, with and without shortages. c. Constant rate of demand with instantaneous replenishment without shortages, with at most two price breaks. 3) Probabilistic models: Single period with Instantaneous demand (discrete and continuous) without setup cost. Uniform demand (discrete and continuous) without setup cost. (Ref.1, 2,3)	**15**
UNIT II: Replacement 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.	**15**
UNIT III: Reliability: Concept of reliability, Hazard-rate.Bathtub 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). **SIMULATION** (INCLUDE THIS IN SEM6 OR)	**15**

Conceptand Scopeofsimulation.MonteCarloTechniquofSimulation. 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)	
UNIT IV: Linear Programming Problem Two-Phase Simplex Method, Algorithm. DualSimplex Method,Algorithm.(it is in SEM 5 OR) 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 expressions without proof) (Ref.2,3,5,6)	**15**

References:

1. VoraN.D.:QuantitativeTechniquesinManagement,Thirdedition,McGrawHillCompanies.
2. Kantiswarup,P.K.Gupta,Manmohan:OperationsResearch,Twelfthedition,SultanChand&sons.
3. SharmaS.D.:OperationsResearch,Eighthedition,KedarnathRamnath&Co.
4. TahaHamdyA.:OperationsResearch:Eighthedition,PrenticeHallof IndiaPvt.Ltd.
5. BarlowR.E.andProchanFrank:StatisticalTheoryofReliabilityandLifeTestingReprint,Firstedition, Holt, Reinhart and Winston.
6. MannN.R.,SchaferR.E.,SingapurwallaN.D.:MethodsforStatisticalAnalysisofReliabilityandLifeData.First edition, John Wiley&Sons.

Course Code	Title	Credits
BNBUSST6T4	**ACTUARIAL SCIENCE**	**2.5 credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand the concepts of rate of mortality and its applications.
- Construct life tables for different age groups of people.
- Calculate the present values and accumulated values of different payments concepts.
- Calculate the Actuarial present value and amount of premium for insurance policy.

Unit I: MORTALITY TABLES Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μx from the mortality table. Central Mortality Rate. Laws of mortality: Gompertz's and Makeham's first law. Select, Ultimate and Aggregate mortality tables. Stationary population. Expectation of life and Average life at death. (Ref.2,3)	**15**
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**
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**
Unit IV ASSURANCE BENEFITS 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.	**15**

REFERENCES:

1. Neill A. : Life Contingencies, First edition, Heinemann 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.

Course Code	Title	Credits
BNBUSACOR6T5(A)	**OPTIMIZATION TECHNIQUE II**	**2.5 credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand Monte Carlo simulation technique.
- Generate random sample from different standard distribution using simulation technique.
- Solve linear programming problem using dual simplex method.
- Learn six sigma limit to obtain scatter plot, control chart.

UNIT I : SIMULATION Concept and Scope of simulation. Monte Carlo Technique of Simulation.Generation of random numbers using (i) Mid. Square Method and (ii) MultiplicativeCongruential 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 queuing model. (Ref. 1, 5)	**15**
UNIT II : DUAL SIMPLEX AND INTEGER PROGRAMMING PROBLEM Dual Simplex Method Algorithm. Solution of LPP using Dual Simplex Algorithm. Integer programming problem (IPP) : Introduction, solution of IPP using (i) Graphical method, (ii) Gomory's Method. (Ref.2,3,4)	**15**
Unit III : SIX SIGMA History and concept, Basic Principles, Goals, six sigma v/s TQM, ISO 9000, Traditional Management, Quality defined, VOC and CTQ, Quality measurement to six sigma, Seven tools of quality and its application: 1) Histogram or Stem and Leaf display. 2) Check sheet. 3) Pareto Chart. 4) Cause and Effect diagram (Fish bone Diagram) 5) Defect concentration diagram. 6) Scatter diagram. 7) Control charts (**Only concept of control chart**), DMAIC with case study, introduction to Lean Six Sigma. (Ref. 6,7,8,9,10,11,12)	**15**
Unit IV : INVESTMENT ANALYSIS (i) Introduction (ii) Investment Decision Analysis Phase of Investment Decision	**15**

Factors Influencing Investment Decision (iii) Time Value of money (iv) Technique of investment analysis Deterministic Methods Probabilistic Methods	

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, KedarnathRamnath& Co.
4. TahaHamdyA. : Operations Research : Eighth edition, Prentice Hall of India Pvt. Ltd.
5. TahaHamdy A. : Operations Research : Eighth edition, Prentice Hall of India Pvt. Ltd.
6. Six Sigma For Business Excellence, (2005), Penelope Przekop, McGraw-Hill Six Sigma Handbook, by Pyzdek, McGraw Hill Education; 4 edition (1 July 2017).
7. The Certified Six Sigma Green Belt Handbook, Roderick A. Munro and Govindarajan Ramu , American Society for Quality (ASQ),
8. What Is Design For Six Sigma,(2005), Roland Cavanagh, Robert Neuman, Peter Pande, Tata McGraw-Hill
9. The Six Sigma Way: How GE, Motorola, And Other Top Companies Are Honing Their Performance, (2000), Peter S. Pande, Robert P. Neuman, Roland R. Cavanagh, McGraw Hill
10. What Is Lean Six Sigma,(2004), Mike George, Dave Rowlands, Bill Kastle, McGraw Hill
11. Six Sigma Deployment,(2003), Cary W. Adams, Charles E Wilson Jrs, Praveen Gupta, Elsevier Science.
12. Six Sigma For Beginners: Pocket Book (2018), Rajiv Tiwari Kindle Edition 10. Introduction to Statistical Quality Control(2009), Montgomery, Douglas, C ,Sixth Edition, John Wiley &Sons.Inc.:.

Course Code	Title	Credits
BNBUSCP6T5(B)	**COMPUTING PROGRAMING II**	**2.5 credits (60 lectures)**

Course Outcomes: Upon completion of this course, students will acquire knowledge about and able to

- Understand the concept of arrays, constructors and Overloading methods
- Understand error handling using exceptions and inheritance by creating suitable classes
- Write java applets to demonstrate graphics, Font and color classes
- Learn core Python scripting elements such as variables and flow control structures

Unit I : Introduction to Java Programming (a) Object-Oriented approach: Features of object-orientations, Abstraction, Inheritance, Encapsulation and Polymorphism. (b) Introduction: History of Java, Java features, different types of Java programs, Differentiate Java with C. Java Virtual Machine. (c) 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 ControlsNo Questions are to be asked on this topic. (d) 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; overloadingmethod; 'this' keyword, constructor and Finalizer: Basic Constructor; parameterized constructor; calling another constructor; finalize () method; overloading constructor.(e) Arrays: one and two-dimensional array, declaring array variables, creating array objects, accessing array elements. (f) Access control: public access, friendly access, protected access, private access.	**15**
Unit II : Inheritance, Exception Handling and Java Applets and Graphics Programming **Inheritance, Exception Handling** (a) Inheritance: Various types of inheritance, super and subclasses,keywords-extends'; 'super', overriding method, final and abstract class:final variables and methods; final classes, abstract methods and classes.Concept of interface. (b) Exception Handling and Packages: Need for Exception Handling,Exception Handling techniques: try and catch; multiple catch statements;finally block; usage of throw and throws. Concept of packages. Inter classmethod: parseInt().	**15**
Unit III: Java Applets and Graphics Programming Inheritance, Exception Handling (a) Applets: Difference of applet and application, creating applets, applet life cycle, passing parameters to applets. (b) Graphics, Fonts and Color: The graphics class, painting, repainting andupdating an applet, sizing graphics. Font class, draw graphical figures – lines and rectangle, circle and ellipse, drawing arcs, drawing polygons. Workingwith Colors: Color methods, setting the paint mode. (c) AWT package: Containers: Frame and Dialog classes, Components: Label; Button;	**15**

Checkbox; TextField, TextArea.	
Unit IV : PYTHON 3.x (a) 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, SemanticErrors. Experimental Debugging. (b) Data types and expressions: Variables and the assignment statement,Program Comments and Docstrings, Data types:- Numeric integers and Floatingpoint numbers, Boolean, string. Mathematical operators +,-,*,**,%.PEMDAS.Arithmetic expressions, Mixed-Mode Arithmetic and type Conversion,type(),Input(),print(),program comments.id(),int(),str(),float(). (c) Loops and selection statements:-Definite Iteration: the for loop, Executingstatements a given number of times, Specifying the steps using range(),Loopsthat 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. (d) Strings: Assessing characters, indexing, slicing, replacing. Concatenation (+),Repetition (*).Searching a substring with the 'in' operator, Traversing stringusing while and for. String methods:- find, join, split, lower, upper, len()	**15**

References :

(1) E. Balagurusamy(2009), Programming with Java: A Primer 4th Edition by TataMcGraw Hill.

(2) E. Balagurusamy(2017), Problem Solving and PythonProgrammingby Tata McGrawHill.

(3) Herbert Schildt,(2013)Java The Complete Reference, 8th Edition, Tata McGraw Hill

(4) Ivan Bayross,(2006),Web Enabled Commercial Applications Development Using Java2,BPB Publications, Revised Edition

(5) Kenneth A Lambert chapters 1,2 and 3.(2018)Fundamentals of Python First Programs2nd edition.

DISRIBUTION OF TOPICS FOR PRACTICALS

SEMESTER VI

COURSE CODE BNBUSST6P1

Sr. No.	Practical topics from BNBUSST6T1		Sr. No.	Practical topics from BNBUSST6T2
6.1.1	Generating Function		6.2.1	Testing of Hypothesis - I
6.1.2	Stochastic Process I		6.2.2	Testing of Hypothesis - II
6.1.3	Stochastic Process II		6.2.3	SPRT
6.1.4	Queuing Theory - I		6.2.4	Non-parametric Test - I
6.1.5	Queuing Theory - II		6.2.5	Non-parametric Test - II
			6.2.6	Use of R software

COURSE CODE BNBUSST6P2

Sr. No.	Practical topics from BNBUSST6T3		Sr. No.	Practical topics from BNBUSST6T4
6.3.1	L.P.P.		6.4A.1	Mortality table I
6.3.2	Inventory I		6.4A.2	Mortality table II
6.3.3	Inventory II		6.4A.3	Annuities I
6.3.4	Replacement		6.4A.4	Annuities II
6.3.5	Simulation		6.4A.5	Life Annuities

COURSE CODE BNBUSACOR6P3

Sr.No.	Practical topics from BNBUSACOR6T5(A)	Sr. No.	Practical topics from BNBUSCP6T5(B)
6.5A.1	Practical's based on unit I	6.5B.1	Practical's based on unit I
6.5A.2	Practical's based on unit I	6.5B.2	Practical's based on unit I
6.5A.3	Practical's based on unit II	6.5B.3	Practical's based on unit II
6.5A.4	Practical's based on unit II	6.5B.4	Practical's based on unit II
6.5A.5	Practical's based on unit III	6.5B.5	Practical's based on unit III
6.5A.6	Practical's based on unit III	6.5B.6	Practical's based on unit III

Evaluation Scheme

Internals Examination:

Internal Test	Case Study/ Mini Research Project	Total
20	**20**	**40**

Internal Examination:

Based on Unit 1 / Unit 2 / Unit3 / Unit 4

Duration: 1Hour **Total Marks:20**

	Answer the following	**20**
Q. 1		
Q. 2		
Q. 3		
Q. 4		

Theory Examination

Suggested Format of Question paper

Duration:2 Hour **Total Marks:60**

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**12**
	a	Based on Unit III	
	b	Based on Unit III	

	c	Based on Unit III	
Q. 4	Answer ***any two*** of the following		**12**
	a	Based on Unit IV	
	b	Based on Unit IV	
	c	Based on Unit IV	
Q. 5	Answer the following		**12**
	a	State True or False :	**4**
	(i)	Based on Unit I	
	(ii)	Based on Unit II	
	(iii)	Based on Unit III	
	(iv)	Based on Unit IV	
	b	Answer in one sentence:	**8**
	(i)	Based on Unit I	
	(ii)	Based on Unit II	
	(iii)	Based on Unit III	
	(iv)	Based on Unit IV	

Marks Distribution and Passing Criterion for Each Semester

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSST5T1	**40**	**16**	60	**24**	BNBUSST5P1	**100**	**40**
BNBUSST5T2	**40**	**16**	60	**24**			
BNBUSST5T3	**40**	**16**	60	**24**	BNBUSST5P2	**100**	**40**
BNBUSST5T4	**40**	**16**	60	**24**			
BNBUSACOR5T5(A)	**40**	**16**	60	**24**	BNBUSST5P3	**100**	**40**
BNBUSCPA5T5(B)	**40**	**16**	60	**24**	BNBUSST5P3	**100**	**40**

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSST6T1	**40**	**16**	60	**24**	BNBUSST6P1	**100**	**40**
BNBUSST6T2	**40**	**16**	60	**24**			
BNBUSST6T3	**40**	**16**	60	**24**	BNBUSST6P2	**100**	**40**
BNBUSST6T4	**40**	**16**	60	**24**			
BNBUSACOR6T5(A)	**40**	**16**	60	**24**	BNBUSST6P3	**100**	**40**
BNBUSCP6T5(B)	**40**	**16**	60	**24**	BNBUSST6P3	**100**	**40**