SIES Collegeof Arts, Science & Commerce
(Autonomous)
Department of Statistics

Faculty: Science
Program: B.Sc.
Course: Statistics

Syllabus for T.Y.B.Sc.
(Credit Based Semester and Grading System with effect from the academic year 2019–2020)

SEMESTER V

THEORY

Title of Course	PROBABILITYAND DISTRIBUTIONTHEORY			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER I SIUSSTA51	**I**	**PROBABILITY I**	**1**	**2.5**
	II	**PROBABILITY II**	**1**	
	III	**JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION**	**1**	
	IV	**BIVARIATE NORMAL DISTRIBUTION**	**1**	
Title of Course	**THEORY OF ESTIMATION**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPERII SIUSSTA52	**I**	**POINT ESTIMATION AND PROPERTIES OF ESTIMATOR**	**1**	**2.5**
	II	**MVUE AND METHODS OF ESTIMATION**	**1**	
	III	**BAYESIAN ESTIMATION**	**1**	
	IV	**CONFIDENCE INTERVAL**	**1**	
Title of Course	**BIOSTATISTICS**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER III SIUSSTA53	**I**	**EPIDEMIC MODELS**	**1**	**2.5**
	II	**BIOASSAYS**	**1**	
	III	**CLINICAL TRIALS**	**1**	
	IV	**BIOEQUIVALENCE**	**1**	
Title of Course	**ELEMENTS OF ACTUARIAL SCIENCE**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER IV SIUSSTA54	**I**	**MORTALITY TABLES**	**1**	**2.5**
	II	**COMPOUND INTEREST AND ANNUITIES CERTAIN**	**1**	
	III	**LIFE ANNUITIES**	**1**	
	IV	**ASSURANCE BENEFITS**	**1**	

PRACTICALS

Course Code	Practicals based on	Lectures/ Week	Credits
SIUSSTAP51	**SIUSSTA51**	**4**	**3**
	SIUSSTA52	**4**	
SIUSSTAP52	**SIUSSTA53**	**4**	**3**
	SIUSSTA54	**4**	

SEMESTER VI
THEORY

Title of Course	DISTRIBUTIONTHEORY AND STOCHASTIC PROCESSES			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER I SIUSSTA61	**I**	**ORDER STATISTICS**	**1**	**2.5**
	II	**GENERATING FUNCTIONS**	**1**	
	III	**STOCHASTIC PROCESSES**	**1**	
	IV	**QUEUING THEORY**	**1**	
Title of Course	**TESTING OF HYPOTHESES**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER II SIUSSTA62	**I**	**MOST POWERFUL TESTS**	**1**	**2.5**
	II	**UNIFORMLY MOST POWERFUL & LIKELIHOOD RATIO TESTS**	**1**	
	III	**SEQUENTIAL PROBABILITY RATIO TESTS**	**1**	
	IV	**NON-PARAMETRIC TESTS**	**1**	
Title of Course	**OPERATIONS RESEARCH TECHNIQUES**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER III SIUSSTA63	**I**	**INVENTORY CONTROL**	**1**	**2.5**
	II	**REPLACEMENT**	**1**	
	III	**SIMULATION**	**1**	
	IV	**CONTROL CHARTS & ACCEPTANCE SAMPLING**	**1**	
Title of Course	**PREDICTIVE MODELLING**			
Course Code	**Unit**	**Topics**	**Lectures/ Week**	**Credits**
PAPER IV SIUSSTA64	**I**	**LINEAR MODELS**	**1**	**2.5**
	II	**LINEAR REGRESSION I**	**1**	
	III	**LINEAR REGRESSION II**	**1**	
	IV	**CLASSIFICATION**	**1**	

PRACTICALS

Course Code	Practicals based on	Lectures/ Week	Credits
SIUSSTAP61	**SIUSSTA61**	**4**	**3**
	SIUSSTA62	**4**	
SIUSSTAP62	**SIUSSTA63**	**4**	**3**
	SIUSSTA64	**4**	

TYBSc SYLLABUS UNDER AUTONOMY

SEMESTER V
PAPER I

Objectives:

- To acquire in-depth knowledge of probability theory.
- To understand significance of correlation using bivariate normal distribution.

Course Code	Title	Credits
SIUSSTA51	**PROBABILITY AND DISTRIBUTION THEORY**	**2.5 Credits (60 lectures)**
Unit I : PROBABILITY I Basic definitions: Random Experiment, Outcome, Event, Sample Space, Complementary, Mutually Exclusive, Exhaustive and Equally Likely Events. Mathematical, Statistical, Axiomatic and Subjective probability. Sub populations and partitions. Probabilities based on Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics. Ordered samples and runs. Addition Theorem for two & three events.		**15 Lectures**
Unit II :PROBABILITY II Theorems on Probability of realization of : At least one, Exactly m, At least m of N events A_1, A_2, A_3…A_N. Matching and Guessing problems. Conditional Probability: Multiplication Theorem for two and three events. Independence of two and three events - complete and pair wise. Polya's urn model Bayes' theorem.		**15 Lectures**
Unit III: JOINT MOMENT GENERATING FUNCTION, TRINOMIAL AND MULTINOMIAL DISTRIBUTION Definition and properties of Moment Generating Function (MGF) of two random variables of discrete and continuous type. Necessary condition for independence of two random variables. Concept and definition of Multivariate MGF. Trinomial distribution**:** Definition of joint probability distribution of (X, Y). Joint moment generating function, moments μ_{rs} where r=0, 1, 2 and s=0, 1, 2. Marginal &Conditional distributions. Means & Variances. Correlation coefficient between (X, Y). Distribution of the Sum X+Y. 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, X_j). Conditional probability distribution of X_i given $X_j = x_j$		**15 Lectures**

Unit IV: BIVARIATE NORMAL DISTRIBUTION	**15 Lectures**
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. 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. Distribution of sample correlation coefficient. Testing the significance of a correlation coefficient. Fisher's z – transformation. Tests for H_0:$\rho = 0$, H_0: $\rho = \rho_0$ & H_0: $\rho_1 = \rho_2$ Confidence interval for ρ.	

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA51

1. Probability-1
2. Probability -2
3. Probability -3
4.Joint Moment Generating function
5.Trinomial &Multinomial Distribution
6. Bivariate Normal Distribution
7. Tests for correlation and Interval estimation

REFERENCES

1. Biswas S.(1991). *Topics in Statistical Methodology*,First edition: Wiley Eastern Ltd.
2. ChandraT.K.&ChatterjeeD.(2005). *A First Course in Probability*,Third Edition: Narosa Publishing House.
3. Feller W. (1968). *An introduction to probability theory and it's applications,* Volume 1, Third edition :Wiley Eastern Limited.
4. Gupta S C & KapoorV K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons.
5. Hogg R V. & CraigA. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
6. Hogg R. V. &Tanis E.A..(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
7. KapurJ. N.&Saxena H. C.(2010). *Mathematical Statistics*, Fifteenth edition: S. Chand and Company.
8. MoodA. M., GraybillF. A.&BoyesD. C. (1974).*Introduction to the theory of Statistics*, Third edition, McGraw- Hill Series.

PAPER II

Objectives:

- To learn methods of estimation and properties of estimators.
- To use Bayesian approach in estimation.

Course Code	Title	Credits
SIUSSTA52	**THEORY OF ESTIMATION**	**2.5 Credits (60 lectures)**
Unit I: POINT ESTIMATION AND PROPERTIES OF ESTIMATOR Notion of a parameter and parameter space. Problem of Estimation, Definitions of Statistic, Estimator and Estimate. Properties of a good estimator. Unbiasedness: Definition of an unbiased estimator, biasedestimator, positive and negative bias, Results on unbiased estimators. Consistency: Definition, Condition for consistency Sufficiency: Definition,Neyman Factorization Theoremand Sufficient statistic for Exponential family of probability distributions. Relative efficiency of an estimator.		**15 Lectures**
Unit II: MVUE AND METHODS OF ESTIMATION Minimum variance unbiased estimator (MVUE), Uniqueness property of MVUE.Fisher information function**,** Cramer-Rao inequality, Cramer–Rao Lower Bound (CRLB), Definition of Efficient estimator using CRLB. Method of Maximum Likelihood Estimation (M.L.E.), Definition of likelihood as a function of unknown parameter, Properties of M.L.E. Method of Moments, Method of Minimum Chi-square and Modified Minimum Chi-square.		**15 Lectures**
Unit III: BAYESIAN ESTIMATION Bayesian Estimation: Prior distribution, Posterior distribution, Loss function, Risk function, Bayes' solution under Squared Error Loss Function (SELF) and Absolute Error Loss function.		**15 Lectures**
Unit IV:CONFIDENCE INTERVALESTIMATION Interval Estimation: Confidence Interval. Definition of pivotal quantity and its use in obtaining confidence limits. Confidence Intervals based on asymptotic property of M.L.E. Equidistant confidence interval for the parameters of standard distributions.		**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA52

1. Properties of Estimator
2. Minimum Variance Unbiased Estimator
3.Method of Estimation -1
4. Method of Estimation -2
5. Bayes' Estimation
6. Confidence Interval

REFERENCES:

1. Arora S. &Bansi Lal (1989) *New Mathematical Statistics*: Satya Prakashan, New Delhi
2. Gupta S C & Kapoor V K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons
3. HoelP.G.(1966). *Introduction to Mathematical Statistics*, Fourth Edition: John Wiley & Sons Inc.
4. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
5. Hogg R. V.&Tannis E. A. (2014). *Probability and Statistical Inference*, Ninth Edition: Collier McMillan Publishers.
6. Kapur J. N.&Saxena H.C. (2010) *Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Rohatgi V.K.&Ehsanes Saleh A.K. Md.(2008). *An introduction to Probability Theory and Mathematical Statistics* , Second Edition: Wiley series in Probability and Statistics. Miller I., Miller M.& Freund J.E. (1999) *John E. Freund's Mathematical Statistics*, Sixth Edition: Pearson Education Inc.

PAPER III

Objectives:

- To appreciate role of Statistics in Biology.
- To understand need, ethics and norms of clinical trials.

Course Code	Title	Credits
SIUSSTA53	**BIOSTATISTICS**	**2.5 Credits (60 lectures)**
Unit I : EPIDEMIC MODELS The features of Epidemic spread. Definitions of various terms involved. Simple mathematical models for epidemics: Deterministic model with and without removals, Host Vector model, Carrier model. 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 four.		**15 Lectures**
Unit II: BIOASSAYS Meaning and scope of bioassays. Relative potency. Direct assays. Fieller's theorem. Quantal Response assays. Tolerance distribution. Median effective dose ED50 and LD50. Probit analysis. Indirect assays. Dose-response relationship. Condition 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.		**15 Lectures**
Unit III: CLINICAL TRIALS Introduction to clinical trials: The need and ethics of clinical trials. Common terminology used in clinical trials. Over view of phases (I-IV) 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, Multi-centric Trial. Inclusion/Exclusion Criteria. Statistical tools: Analysis of Parallel Design using Analysis of Variance. Concept of odds ratio. Sample size estimation.		**15 Lectures**
Unit IV: BIOEQUIVALENCE Definitions of Generic Drug product. Bioavailability, Bioequivalence, Pharmakokinetic (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).		**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA53

1. Epidemic models
2. Direct Assays
3. QuantalResponse Assays
4. Parallel line Assay
5. Clinical Trials
6. Bioequivalence

REFERENCES:

1. Bailey N.T.J. (1975). *The Mathematical theory of infectious diseases*, Second edition: Charles Griffin and Co. London.
2. Bolton S. & Bon C. (2009). *Pharmaceutical Statistics*, Fifth edition: Marcel Dekker Inc.
3. Das M.N &Giri N.C.(1986). *Design and Analysis of Experiments*, Second edition: Wiley Eastern
4. Finney D.J. (1964). *Statistical Methods in Biological Assays*, First edition: Charles Griffin and Co. London
5. Fleiss J.L. (1999). *The Design and Analysis of Clinical Experiments*. Second edition: Wiley and Sons
6. Friedman L. M., Furburg C. D. ,Demets D. L.(2015). *Fundamentals of Clinical Trials*. Fifth edition: Springer Verlag.
7. Shein-Chung-Chow:(2008)*Design and Analysis of Bioavailability & Bioequivalence studies*, Third Edition: Chapman & Hall/CRC Biostatistics series.
8. Wayne D. W. (2013). *Biostatistics- A Foundation for Analysis in the Health Sciences,*Tenth Edition: Wiley Series in Probability and Statistics.
9. Zar Jerrold H. (2013). *Biostatistical Analysis,* Fifth edition: Pearson's education.

PAPER IV

Objectives:

- To comprehend Vital statistics
- To study formulation of policies in insurance industry

Course Code	Title	Credits
SIUSSTA54	**ELEMENTS OF ACTUARIALSCIENCE**	**2.5 Credits (60 lectures)**
Unit I : MORTALITY TABLES Vital statistics: Meaning, Uses, Methods of obtaining Vital statistics.Various mortality functions. Probabilities of living and dying. The force of mortality. Estimation of μ_x from the mortality table. Central Mortality Rate. Laws of mortality: Gompertz's and Makeham's first law. Select, Ultimate and Aggregate mortality tables. Stationary and stable population. Expectation of life and Average life at death.		**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 increasing annuity, increasing annuity whensuccessive installments form arithmetic progression, annuity with frequencydifferent from that with which interest is convertible. Redemption of loan.		**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).		**15 Lectures**
Unit IV:ASSURANCE BENEFITS Present value of Assurance benefits in terms of commutation functions of : Pure endowment assurance, Temporary assurance, Endowment assurance, Whole life assurance, Special endowment assurance, Deferred temporary assurance Net premiums: Net level annual premiums (including limited period of payment) for various assurance plans. Office premiums.		**15 Lectures**

SEMESTER V: PRACTICALS BASED ON COURSE SIUSSTA54

1.	Mortality tables 1
2.	Mortality tables 2
3.	Annuities 1
4.	Annuities 2
5.	Life annuities
6.	Assurance benefits

REFERENCES:

1. Dixit S.P., Modi C.S.&Joshi R.V.(1991). *Mathematical Basis of Life Assurance*, First edition (Reprint): Insurance Institute of India.
2. Gupta S. C. &. Kapoor V. K. (2014). *Fundamentals of Applied Statistics*, Fourth edition: Sultan Chand& Sons.
3. Neill A. (1977). *Life Contingencies*, First edition: Heineman educational books, London

TYBSc SYLLABUS UNDER AUTONOMY

SEMESTER VI
PAPER I

Objectives:

- To study order statistics and generating functions useful in research
- To learn stochastic processes to understand its application in queuing theory

Course Code	Title	Credits
SIUSSTA61	**DISTRIBUTIONTHEORY AND STOCHASTIC PROCESSES**	**2.5 Credits (60 lectures)**
Unit I :ORDER STATISTICS Definition of Order Statistics based on a random sample. Derivation of:Cumulative distribution function of r^{th}order statistic, Probability density functions of the r^{th} order statistic, Joint Probability density function of the r^{th} and the s^{th} order statistic (r<s),Joint Probability density function of all n ordered statistics, Probability density function of Median (in the case of odd sample sizes) and Range.		**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: Bernoulli and Binomial distributions, Geometric and Negative Binomial distributions in terms of convolutions.		**15 Lectures**
Unit III: STOCHASTIC PROCESSES Definition of stochastic process. Postulates and difference differential equations for:Pure birth process, Poisson process with initially 'a' members, for a =0 and a >0,Yule-Furry process, Pure death process, Death process with $\mu_n=\mu$, Death process with $\mu_n=n\mu$, Birth and death process, Linear growth model. Derivation of P_n (t), mean and variance where ever applicable.		**15 Lectures**
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: (M/M/1) : (GD/ ∞ /∞), (M/M/1) : (GD/ N /∞), (M/M/c) : (GD/∞/∞), (M/M/c) : (GD/ N /∞), (M/M/∞) : (GD/ ∞ /∞), (M/M/R) : (GD/ k /k)		**15 Lectures**

SEMESTER VI: PRACTICALS BASED ON COURSE SIUSSTA61

1. Order Statistics – 1
2. Order statistics – 2
3. Generating Function
4. Stochastic Processes
5. Queuing Theory -1
6. Queuing Theory -2

REFERENCES:

1. Biswas S.(1991). *Topics in Statistical Methodology* ,First edition: Wiley Eastern Ltd.
2. Feller W. (1968). *An introduction to probability theory and it's applications*, Volume 1, Third edition :Wiley Eastern Limited.
3. Gupta S. C.& Kapoor V. K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh Edition, Sultan Chand & Sons.
4. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
5. Hogg R. V. & Tanis E.A..(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
6. Kapur J. N.&Saxena H. C.(2010). *Mathematical Statistics*, Fifteenth edition: S. Chand and company.
7. Medhi J: (2013). *Stochastic Processes*, Second edition: Wiley Eastern Ltd.
8. Mood A. M., Graybill F. A.&Boyes D. C. (1974).*Introduction to the theory of Statistics*, Third edition, McGraw- Hill Series.
9. Taha H.A.(2010). *Operations Research: An introduction*, Ninth edition: Prentice Hall of India Pvt. Ltd.

PAPER II

Objectives:

- To study testing statistical hypotheses for fixed and variable sample sizes
- To understand applications non parametric tests used in social sciences

Course Code	Title	Credits
SIUSSTA62	**TESTING OF HYPOTHESES**	**2.5 Credits (60 lectures)**
Unit I : MOST POWERFUL TESTS Problem of testing of hypothesis. Definitions of Simple hypothesis, Composite hypothesis, Null Hypothesis, Alternative Hypothesis, Test of hypothesis, Critical region, Type I and Type II errors, Level of significance, p-value, size of the test, Power of the test, Power function of a test, Power curve. Definition of most powerful test of size α for a simple hypothesis against a simple alternative hypothesis. Neyman-Pearson fundamental lemma.		**15 Lectures**
Unit II : UNIFORMLY MOST POWERFUL & LIKELIHOOD RATIO TESTS Definition, Existence and Construction of uniformly most powerful (UMP) test. Likelihood ratio principle. Definition of test statistic and its asymptotic distribution (statement only).		**15 Lectures**
Unit III: SEQUENTIAL PROBABILITY RATIO TESTS Sequential test procedure for testing a simple null hypothesis against a simple alternative hypothesis. Its comparison with fixed sample size test procedure. Definition of Wald's SPRT of strength (α, β).		**15 Lectures**
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: Sign test, Wilcoxon's signed rank test, Run test, Mann–Whitney test, Median test, Kruskal Wallis test, Friedman test, Fisher's exact test. Assumptions, justification of the test procedure for small & large samples.		**15 Lectures**

SEMESTER VI: PRACTICALS BASED ON COURSE SIUSSTA62

1. Testing of Hypothesis 1
2. Testing of Hypothesis 2
3. Likelihood Ratio Tests
4. SPRT
5. Non Parametric test 1
6. Non Parametric test 2

REFERENCES:

1. Arora S. & Lal B. (1989) *New Mathematical Statistics*: Satya Prakashan, New Delhi
2. Biswas S.(1991). *Topics in Statistical Methodology* First edition: Wiley Eastern Ltd.
3. Daniel W.W..(2000)*Applied Non Parametric Statistics* Second edition Boston-Houghton Mifflin Company
4. Gupta S C & Kapoor V K. (2014). *Fundamentals of Mathematical Statistics*, Eleventh edition, Sultan Chand & Sons.
5. Hogg R V. & Craig A. T. (2012).*Introduction to Mathematical Statistics*, Seventh edition: Pearson Education (Singapore) Pvt. Ltd.
6. Hogg R. V. &Tanis E.A. .(2014). *Probability and Statistical Inference*, Ninth edition: McMillan Publishing Company
7. Lehmann, E. L.(2008). *Testing of Statistical Hypothesis*, Third edition: Wiley &sons
8. Pawagi V.R.&Ranade S.A. *Statistical Methods Using R Software:*Nirali Publication
9. Siegal S. , Castellan N. J. (1988). *Non Parametric Statistics for Behavioral Science*,Second edition : Mc Graw Hill Publishing Co.
10. Wald A. (1947). *Sequential Analysis* .First edition: John Wiley & Sons , New York

PAPER III

Objectives:

- To comprehend knowledge of industry problems such as inventory, replacement
- To study the techniques used to check and control quality of the product

Course Code	Title	Credits
SIUSSTA63	**OPERATIONS RESEARCH TECHNIQUES**	**2.5 Credits (60 lectures)**
Unit I:INVENTORY CONTROL Introduction to Inventory Problem Deterministic Models:Single item static EOQ models forConstant rate of demand with instantaneous replenishment, with and without shortages. Constant rate of demand with uniform rate of replenishment, with andwithout shortages. Constant rate of demand with instantaneous replenishment withoutshortages, with at most two price breaks. Price break model. Probabilistic models: Single period with Instantaneous demand (discrete and continuous) without setup cost. Uniform demand (discrete and continuous) without set up cost.		**15 Lectures**
Unit II: REPLACEMENT Replacement of items that deteriorate with time and value of money remains constant & changes with time. Replacement of items that fail completely: Individual replacement and Group replacement policies.		**15 Lectures**
Unit III: SIMULATION Scope of simulation applications. Types of simulation. Monte Carlo Technique of Simulation. Elements of discrete event simulation. Generation of random numbers. Sampling from probability distribution. Inverse method. Generation of random observations from standard distributions. Simulation techniques applied to inventory and Queuing models.		**15 Lectures**
Unit IV: CONTROL CHARTS & ACCEPTANCE SAMPLING: Principles of control. Process quality control of variables. Xbar and R, Xbar and Sigma Chart. Exponentially weighted moving average (EWMA) control charts, Cumulative Sum (CUSUM) control chart, Process quality control of attributes: p, c, np charts. P-chart and c-chart with variable sample size. Setting up standards for future use. Concept of Natural Tolerance Limits, Specification Limits and Detection of shift. Acceptance sampling plan- Single Sampling Plans: OC function and OC curves. AQL, LTPD, ASN, ATI, AOQ, Consumer's risk, Producer's risk. Double Sampling Plan: OC function and OC curves. Introduction to Six sigma limits.		**15 Lectures**

SEMESTER VI : PRACTICALS BASED ON COURSE SIUSSTA63

1. Inventory1
2. Inventory2
3. Replacement
4. Simulation
5. Control Charts
6. Acceptance Sampling

REFERENCES:

1. Bannerjee B. : *Operation Research Techniques for Management*, First edition, BusinessBooks
2. Bronson R. (1997).*Schaum Series book in Operations Research,* Second edition: Tata McGraw Hill Publishing Company Ltd.
3. Kantiswaroop& Gupta M. (2010). *Operations Research,* Twelfth Edition: Sultan Chand & Sons
4. Sharma J. K. (2013). *Operations Research theory and applications,* Fifth edition : Macmillan India Ltd.
5. Sharma J.K. (2010). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
6. Sharma S.D. *Operations Research,* Eleventh Edition: KedarNath Ram Nath& Co.
7. Vora N. D. (2015). *Quantitative Techniques in Management*, Fourth edition: McGraw Hill Co. Wiley & Sons, Inc.

8. Burr J. T.(2004). *Elementary Statistical Quality Control*, Second Edition ,CRC Press: Taylor & Francis Group.
9. Duncan A.J. (1965). *Quality Control & Industrial Statistics*, Third Edition
10. E.L. Grant. (1988). *Statistical Quality Control*, Second edition: McGraw Hill.
11. Greene W. (2017). *Econometric Analysis*, Eighth edition: McMillan Publishing Company.
12. Hansen B. L., (1973), *Quality Control: Theory and Applications:* Prentice Hall of India Pvt. Ltd
13. Montgomery D. , (2009) *Statistical Quality Control*, Sixth Edition :Arizona State University.John Wiley & Sons, Inc.

PAPER IV

Objectives:

- To distribute data into different classes on the basis of their characteristics.
- To comprehend modelling techniques used in prediction.

Course Code	Title	Credits
SIUSSTA64	**PREDICTIVE MODELLING**	**2.5 Credits (60 lectures)**
Unit I:LINEAR MODELS Linear Regression Model $Y = X\beta + e$ where e follows Independent N(0, σ^2). Maximum Likelihood and Least square Estimators of β and σ^2. Properties of the estimators. Confidence Intervals for β and σ^2. Testing Significance of the regression coefficient β. Gauss-Markoff Theorem for Full rank Model. Properties of the Estimator, Estimation of Linear function of parameters $l'\beta$. Mean and variance. Confidence Interval and Testing of significance of $l'\beta$.		**15 Lectures**
Unit II: LINEAR REGRESSION I Linear regression model with one or more explanatory variables. Assumptions of the model, Derivation of Ordinary Least Square (OLS) estimators of regression coefficients, (for one and two explanatory variables models). Properties of least square estimators (without proof). Coefficient of determination R^2 and adjusted R^2. Procedure of testing :Overall significance of the model, Significance of individual coefficients, Significance of incremental contribution of explanatory variable for two explanatory variables model. Confidence intervals for the regression coefficients.		**15 Lectures**
Unit III: LINEAR REGRESSION II Autocorrelation: Concept, Detection using Run Test, Durbin Watson Test, Generalized Least Square (GLS) method. Heteroscedasticity: Detection using Spearman's Rank correlation test,Breusch-Pagan-Godfrey test. Weighted Least Square (WLS) estimators Multicollinearity: Detection usingR square & t ratios,Variance Inflation Factor (VIF), Pairwise Correlation between regressors, Consequences of using OLS estimators in presence of autocorrelation, heteroscedasticity and multicollinearity. Multiple Linear Regression with Qualitative Independent Variable.		**15 Lectures**
Unit IV: CLASSIFICATION Logistic Regression Models: Introduction to Binary Logistic Regression, Statistical Model, Estimation of Parameters using MLE, Odds Ratio, Hosmer-Lemeshaw Test for goodness of fit, Classification Table. Concept of Multinomial and ordinal logistic regression. K-nearest-neighbor (kNN) Algorithm, Weighted kNN, Naïve Bayes. Decision Trees		**15 Lectures**

SEMESTER VI: PRACTICALS BASED ON COURSE SIUSSTA64

1. Linear Models
2. Linear regression model 1
3. Linear regression model 2
4. Logistic Regression
5. kNN and Naïve Bayes
6. Decision Trees

REFERENCES:

1. Hastie, R. Tibshirani&J. Friedman. (2009) *The Elements of Statistical Learning, Data Mining, Inference and Prediction,*:Springer Series in Statistics.
2. HosmerD. W., LemeshowJr.& SturdivantS, R. X.(2013). *Applied Logistic Regression*: John Wiley & Sons,
3. Montgomery D., Peck E. & Vining G. (2012).*Introduction to linear regression analysis,* Fifth Edition :Arizona State University. John Wiley & Sons, Inc.

5. Kshirsagar A.M.(1983).*A course in Linear Models*

EXAMINATION PATTERN

Internal Assessment of Theory per Course per Semester

1. Class Test 20 Marks.
2. Project / Assignment / Presentation etc. 20 Marks.

Semester End Theory Examination per Course

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 questionpaper:
There shall be four compulsory questions of 15 marks each (with Internal Option). Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit IIIQuestion 4 based on Unit IV.

Semester End Practical Examination per Course

1. Journal 5 Marks.
2. Viva Voce 5 Marks.
3. Practical Examination 40 Marks.

At the end of the semester, examination of 1hour 30 minutes duration and 40 marks shall be held for each course.

Pattern of Practical question paper:

There shall be four compulsory questions of 10 marks each (with Internal Option). Question 1 based on Unit I, Question 2 based on Unit II, Question 3 based on Unit III, Question 4 based on Unit IV.