RAYALASEEMA UNIVERSITY: KURNOOL

Dept. of OR & SQC

Minutes of meeting of Board of studies in MSc., OR&SQC held on 17.11.2021 at 10.30 am in the Vice Chancellor's Conference Hall , Administrative building, Rayalaseema University, Kurnool.

Members:

DR. K. SREENIVASA RAO Professor & Head, Dept. of OR&SQC	**Chairman**
DR. GVSR ANJANEYULU Professor, Dept. of Statistics, ANU, Guntur	External Member
DR. B. MUNI SWAMY Professor, Dept. of Statistics, Andhra University, Vizag	External Member
DR. UJJAL KUMAR BEHRA Supdt. Engineer, The Singareni Collieries Co. Ltd.,Kottagudem, Khammam	External Member
PROF.K.PUSHPANJALI Professor, Dept. of Statistics SK University, Anantapur	Special Invitee
DR. S. MADHUSUDANA VERMA Professor, Dept. of OR&SQC	Member

ITEM: **Modification of Syllabus**

RESOLUTIONS:

The syllabus has been thoroughly examined and it is unanimously resolved:

➤ There shall be four core theory papers in each semester, with practical examinations scheduled at the end of the each semester w.e.f academic year 2021-22.

➤ In the second semester, there will be three core papers and one elective paper, to be selected from two elective papers.

➢ The pattern of theory examinations is as
  ✓ Semester-end Examination   :   80 Marks
    ▪ Section A: 20 Marks
      (Four short answer questions, with internal choice within the units)
    ▪ Section B: 60 Marks
      (Four essay answer questions, with internal choice within the units)
  ✓ Internal Examination   :   20 Marks

➢ For I, II and III semesters practical examination, the division of marks is as follows:
  ✓ 75 marks for Practical questions (25 marks x 3 Questions)
  ✓ 25 marks for record
  ✓
➢ For IV Semester practical examination, the division of marks is as follows:
  ✓ 60 marks for Practical questions (20 marks x 3 Questions)
  ✓ 25 marks for record
  ✓ 15 marks for viva-voce examination

The revised course structure and syllabus is enclosed in Annexure – I, and is to be followed from the academic year 2021-22. It is also resolve to follow list of subject experts as in Annexure-II.

Signatures:

DR. K. SREENIVASA RAO   :

DR. GVSR ANJANEYULU   :

DR. B. MUNI SWAMY   :

DR. UJJAL KUMAR BEHRA   :

PROF.K.PUSHPANJALI   :   17·11·2021

DR. S. MADHUSUDANA VERMA   :   17/11/2021

RAYALASEEMA UNIVERSITY: KURNOOL

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Proposed Syllabus [CBCS] w.e.f academic year 2021-22:

Paper No	Title of the paper	Max. Marks	Credits	Theory Hours	Lab / Practical Hours
I Semester					
Paper 1.1:	Probability and Distribution Theory	100	4	4	2
Paper 1.2:	Statistical Inference-I	100	4	4	2
Paper 1.3:	Data Analysis & Numerical Methods	100	4	4	2
Paper 1.4:	Mathematical Programming-I (LPP, TP, Assignment Prob, IPP)	100	4	4	2
Practical I:	Practical – I (Paper: 1.1 & Paper: 1.3)	100	2		
Practical II:	Practical – II (Paper: 1.2 & Paper: 1.4)	100	2		
II Semester					
Paper 2.1:	Industrial Experimental Designs & Sampling	100	4	4	2
Paper 2.2:	Mathematical Programming-II (NLPP, QP, GP & Packages)	100	4	4	2
Paper 2.3:	Statistical Quality Control – I	100	4	4	2
Elective Papers (Select any 1 paper)					
Paper 2.4:	Statistical Inference-II	100	4	4	2
Paper 2.5:	Time Series Analysis and Forecasting Methods	100	4	4	2
Practical III:	Practical – III (Paper: 2.1 & Paper: 2.3)	100	2		
Practical IV:	Practical – IV (Paper: 2.2 & Paper: 2.4 or 2.5)	100	2		

HEAD
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RAYALASEEMA UNIVERSITY: KURNOOL

Dept. of OR & SQC

Proposed Syllabus [CBCS] w.e.f academic year 2021-22:

Paper No	Title of the paper	Max. Marks	Credits	Theory Hours	Lab / Practical Hours
I Semester					
Paper 1.1:	Probability and Distribution Theory	**100**	**4**	**4**	**2**
Paper 1.2:	Statistical Inference-I	**100**	**4**	**4**	**2**
Paper 1.3:	Data Analysis & Numerical Methods	**100**	**4**	**4**	**2**
Paper 1.4:	Mathematical Programming-I (LPP, TP, Assignment Prob, IPP)	**100**	**4**	**4**	**2**
Practical I:	Practical – I (Paper: 1.1 & Paper: 1.3)	**100**	**2**		
Practical II:	Practical – II (Paper: 1.2 & Paper: 1.4)	**100**	**2**		
II Semester					
Paper 2.1:	Industrial Experimental Designs & Sampling	**100**	**4**	**4**	**2**
Paper 2.2:	Statistical Inference-II	**100**	**4**	**4**	**2**
Paper 2.3:	Statistical Quality Control – I	**100**	**4**	**4**	**2**
Paper 2.4:	Mathematical Programming-II (NLPP, QP, GP & Packages)	**100**	**4**	**4**	**2**
Practical III:	Practical – III (Paper: 2.1 & Paper: 2.3)	**100**	**2**		
Practical IV:	Practical – IV (Paper: 2.2 & Paper: 2.4)	**100**	**2**		
III Semester					
Paper 3.1:	Stochastic Process	**100**	**4**	**4**	**2**
Paper 3.2:	Reliability Theory	**100**	**4**	**4**	**2**
Paper 3.3:	Inventory & Information Theory	**100**	**4**	**4**	**2**
Paper 3.4:	Statistical Quality Control – II	**100**	**4**	**4**	**2**
Practical V:	Practical – V (Paper: 3.1 & Paper: 3.3)	**100**	**2**		
Practical VI:	Practical – VI (Paper: 3.2 & Paper: 3.4)	**100**	**2**		
IV Semester					
Paper 4.1:	Queuing Theory & Network Analysis	**100**	**4**	**4**	**2**
Paper 4.2:	Mathematical Programming–III (Game theory & Simulation)	**100**	**4**	**4**	**2**
Elective Papers (Select any 2 papers)					
Paper 4.3:	Multivariate Analysis	**100**	**4**	**4**	**2**
Paper 4.4:	Total Quality Management	**100**	**4**	**4**	**2**
Paper 4.5:	Data Mining	**100**	**4**	**4**	**2**
Paper 4.6:	Supply Chain Management	**100**	**4**	**4**	**2**
Practical VII:	Practical VII: Paper 4.1 & Viva-voce	**100**	**2**		

PAPER 1.1 – PROBABILITY AND DISTRIBUTION THEORY

UNIT-I
Concept of Field – Sigma Field – Set function and Measure – Probability as a measure – Concept of MGF, CF and their properties – Uniqueness Theorem (Statement only) – Markov, Tchebycheff Holder and Jensen Inequalities – Weak and Strong Law of Large Numbers

UNIT-II
Convergence in Probability almost sure – Means Square convergence and its distribution – CLT For Sequence of Independent (Random Variable), CLT For IIDs – Lindeberg – Levy, Liapnov's Form

UNIT-III
Standard Distributions – Hyper Geometric, Multinomial, Weibull, Lognormal, Gamma and Beta Distributions (Concept and Applications without Derivations)

UNIT-IV
Multiple Linear Regression – Multiple Correlation – Partial Correlation – Sampling Distribution – Mean, Variance, t, F, χ^2 Distributions with their properties

References
- ❖ Robert B. Ash, **Real Analysis and Probability**, Academic Press (1972).
- ❖ Billingsley P., Probability and Measure, Wiley (1986).
- ❖ B.R. Bhat, **Modern Probability Theory**, New Academic Science; 4th Edition (2018).
- ❖ Rohatgi V.K., **An Introduction to Probability Theory and Mathematical Statistics**, Wiley-Blackwell (1976).
- ❖ A. M. Gun, M. K. Gupta, B. Dasgupta , **An Outline of Statistical Theory: Volume 1**, The World Press Private Ltd (2013).
- ❖ R. M. Dudley, **Real Analysis and Probability** (Wadsworth and Brooks/Cole Mathematics Series, Pacific Grove, California, 1989).
- ❖ Kingman, JFC and Taylor S.J., **Introduction to Measure and Probability**, Cambridge U.P., London (1966).
- ❖ Dudewicz E.J. and Mishra S.N., **Modern Mathematical Statistics**, John Wiley & Sons (1988).

PAPER 1.2 – STATISTICAL INFERENCE-I

Unit-I
Point Estimation – concept of Unbiasedness – Consistency – Minimum Variance Unbiased Estimation – Information in a Sample – Cramer-Rao Inequality – Efficiency of an Estimator – Bhattacharya bounds – Definition of CAN Estimator.

UNIT-II
Concept of sufficiency – Single Parameter Case – Minimal sufficient statistics – Exponential families – Distribution admitting sufficient Statistics – Rao-Blackwell Theorem – Completeness.

UNIT-III
Methods of Estimation – Minimum Variance method – M.L. Method of Estimation – For Complete samples, M.L. Estimation for Failure Censored and Time Censored Sample – Interval Estimation – Confidence Interval – Shortest Confidence Interval.

UNIT-IV
Elements of Decision Theory – Loss and Risk Functions and Admissibility – Minimum Decision Rules – Randomized Decision Rules.

References
- ❖ Alan Stuart, J. Keith Ord, **Kendall's Advanced Theory of Statistics, Distribution Theory, Volume 2; Classical Inference and Relationship**, 5th Edition, Oxford University Press (1991).
- ❖ Alexander M. Mood, Franklin A. Graybill , Duane C. Boes, **Introduction to the Theory of Statistics**, McGraw Hill; 3rd edition (1973).
- ❖ V. K. Rohatgi, **An Introduction to Probability Theory and Mathematical Statistics**, Wiley; Edition 1 (1976)
- ❖ M. K. Gupta, A. M. Gun, B. Dasgupta , **An Outline of Statistical Theory: Volume 2**, World Press Private Ltd (2013).
- ❖ Wilks S.S., **Mathematical Statistics**, Nabu Press (2011)
- ❖ S. K.; Kale, B. K. Sinha, **Life Testing and Reliability Estimation**, Wiley Eastern Limited (1980).

PAPER 1.3 – DATA ANALYSIS & NUMERICAL METHODS

UNIT-I :
Basics of SPSS – Editing, Printing – Creating And Editing Of Files – Managing Data, Listing Cases, Replacing Values, Computing New Variables, Rewriting Variables, Exploring Data, Selecting Cases, Sorting Cases, Merging Files.

UNIT-II :
SPSS Data Analysis: Graphs – creating and editing of graphs and charts – Bar Diagrams, Histograms, Percentiles, Statistical Application, Descriptive Statistics, Bi-Variate Correlation, Linear Models, Multiple Regression.

UNIT-III
Excel work sheet – Creating data files in Excel – Formatting cells, sorting – Graphs and charts – Curve fitting and Interpretation of the output – Statistical functions in Excel – Calculation of Theoretical probabilities using Binomial, Poisson and Normal Distributions – Mathematical Functions – Matrix Operation-Transpose product and Inverse Operations using Excel

UNIT-IV
Numerical Analysis and Statistical Applications – Programming skill in numerical methods, Matrix computations – Solving of equations using Newton-Raphson method - Solving Simultaneous Equations using Gauss Elimination and Gauss Siedel method. Numerical Integration – Simpson's 1/3 and 2/8 rules.

References
- ❖ Rajaraman V, **Computer-Oriented Numerical Methods**, PHI Learning Private Limited; 3rd Edition (2013).
- ❖ K.V.S. Sarma, **Statistics Made Simple Do it yourself on PC**, Prentice Hall India Learning Private Limited; 2 edition (2010).
- ❖ Anil Kumar Mishra, **A Hand Book on SPSS for Research Work**, Himalaya Publications, 2 edition (2019).

UNIT-I
Introduction - Definition and Scope of Operations Research (OR) – Different types of models and general methods of solution – Different types of Allocation Models – Concept of Optimal Solution.

UNIT-II
General LPP, Properties of the solution to LPP, generating extreme point solution, Graphical Method and some special cases. Simplex method – Duality – Dual Simplex method – Sensitivity Analysis.

UNIT-III
Revised Simplex procedure – problem of Degeneracy - Applications and examples – Transportation problem – Initial Basic Feasible Solution & Optimal solution (u,v) method – Assignment Problem – Solution by Hungarian.

UNIT–IV
Concept of Integer Programming Problem – Gomory's Cutting Plane algorithm for all integer & mixed Integer Programming Problems. Branch & Bound Method and applications of Zero-one Integer Programming.

References
- ❖ Man Mohan, P. K. Gupta, Kanti Swarup, **Introduction to Management Science Operations Research** , Sultan Chand & Sons (2014)

- ❖ Hadley, H.Addision, **Linear Programming** – Addison-Wesley Publishing Company, Reading, Mass. (1962)

- ❖ Murthy, K.G: **Linear Programming**; John Wiley & Sons; 1 edition (1983)

- ❖ Hiller, F.S., and Lieberman, **Introduction to Operations Research**, McGraw Hill Education India; 10 edition (2017)

- ❖ Willard I. Zangwill., **Nonlinear programming : A Unified Approach**, Prentice-Hall, [1969]

- ❖ Fletcher R., **Practical Methods of Optimization,** Wiley; 2nd Edition (2000)

- ❖ Hamdy A Taha, **Operations Research** : An Introduction 10th Edition, PEARSON Publications (2017).

PAPER 2.1 – INDUSTRIAL EXPERIMENTAL DESIGNS & SAMPLING

UNIT-I
Principle of Experimental design – Concepts of factorial Experiments – Construction of 2^n & 3^n Factorial Experiments. Treatment Combination in Standard Order for 2^n designs. The Table of Signs and Yate's Method.

UNIT-II
Concept of Confounding – Construction of Principle Block and Alternative Block using confounding interactions - Total and Partial Confounding in Factorial Experiments – Confounding Designs 2^n Design and Analysis.

Unit-III
Incomplete Block Designs - B.I.B.D, P.B.I.B.D. their analysis – Estimation of Parameters, tests of Hypothesis – Yuden Design – Inter block analysis – Factorial Designs – Analysis of Factorial Designs of 2^n Series Experiments.
Response Surface – Analysis using Central Composite and Rotatable and Design and Path of Steepest Ascent Method - Concept of Evop.

UNIT-IV
Sampling Techniques and Estimation – Simple random sampling with and without replacement – Stratified sampling – allocation problem – systematic sampling – Two stage sampling – Related estimation problems in the above cases.

References

- ❖ Douglas c and Montgomery, **Design and Analysis of Experiments**, 9th Edition John wiley & Sons, New York (2017).
- ❖ Cochran, W.G. and Cox, G.M., **Experimental Designs**, 2nd Edition, John Wiley and Sons, New York (1992).
- ❖ Chakrabarti M.C, **Mathematics of Design and Analysis of Experiments**, Asia Publishing House, UK (1962).
- ❖ Klaus Hinkelmann, Oscar Kempthorne, **Design and Analysis of Experiments**, Volume 1: Introduction to Experimental Design, 2nd Edition, John Wiley (2007).

PAPER 2.2 - STATISTICAL INFERENCE-II

UNIT-I
Testing of Hypothesis – Simple and Composite Hypotheses – Two types of Errors – Critical Region – Power Function, Most powerful tests – Neyman-Pearson lemma - Uniformly most powerful unbiased test.

UNIT-II
Concept of Similar Regions – Likelihood Ratio Test and it's asymptotic distribution – one sample, two sample and k sample problems.

UNIT-III
Wald's SPRT – Fundamental identity, Termination of SPRT in a finite number of steps with certainty, O.C. and ASN functions - SPRT for Binomial Proportion – Normal mean and variance – Advantage of SPRT

UNIT-IV
Non Parametric Tests: Sign, Median, Mann-Whitney and Run tests – Wilcoxon test for one and two samples – Kolmogorov-Smirnov test for one sample and two samples.

References

❖ E. L. Lehmann, **Testing Statistical Hypotheses**, John Wiley and Sons, Inc., New York, (1959).

❖ Alan Stuart, J. Keith Ord, **Kendall's Advanced Theory of Statistics, Distribution Theory, Volume 2; Classical Inference and Relationship**, 5th Edition, Oxford University Press (1991).

❖ Alexander M. Mood, Franklin A. Graybill , Duane C. Boes, **Introduction to the Theory of Statistics**, McGraw Hill; 3rd edition (1973).

❖ V. K. Rohatgi, **An Introduction to Probability Theory and Mathematical Statistics**, Wiley; Edition 1 (1976).

❖ M. K. Gupta, A. M. Gun, B. Dasgupta , **An Outline of Statistical Theory: Volume 2**, World Press Private Ltd (2013).

❖ Wilks S.S., **Mathematical Statistics**, Nabu Press (2011).

❖ Abraham Wald, **Sequential Analysis**, John Wiley and Sons, Inc. (1947).

❖ Sidney Siegel, **Nonparametric Statistic for the Behavioral Sciences**, McGraw Hill; Spine Lean/Underlining edition (1956).

PAPER 2.3 –STATISTICAL QUALITY CONTROL – I

UNIT-I
Introduction: Brief history of Quality Control– causes of Variation – Statistical Basis for Control Charts - Principles of Shewart's control chart.

UNIT-II
Control Charts for variables – Introduction - $\bar{X}$ and R Chart: Statistical Basis of the charts - development and use of $\bar{X}$ and R Charts - OC Curve of $\bar{X}$ and R chart.

UNIT-III
Control charts for Attributes – Development and Operation of 'p' and 'np' charts with constant and variable sample size, C and U charts – Operating Characteristic curve.

UNIT-IV
Special Control Charts for variables: Notion of ARL – CUSUM chart – Comparison of CUSUM charts with Shewart's control charts, V mask and decision interval methods – Control chart for Mid Ranges – Moving Averages & Moving ranges – Groups control and modified control charts – Exponential Weighted Average (EWMA) charts.

References
- ❖ Montgomery, Douglas C., **Introduction to Statistical Quality Control**, Sixth Edition. John Wiley (2009).
- ❖ Eugene Grant, **Statistical Quality Control**, McGraw Hill Education; 7th Edition (2017)
- ❖ Acheson J Duncan, **Quality Control and Industrial Statistics**, R. D. Irwin; 4th Edition (1974).
- ❖ Burr, I. W., Statistical Quality Control Methods, Volume 16, New York: Marcel Dekker, Inc (1976).
- ❖ J.M. Juran, Frank M. Gryna, **Juran's Quality Control Handbook**, McGraw-Hill; 4th Edition (1988).

PAPER 2.4 – MATHEMATICAL PROGRAMMING – II

UNIT – I
Non-Linear Programming (NLP) – NLPP with constrained and unconstrained optimization - Kuhn-Tucker necessary & sufficient condition Quadratic Programming (QP) and Wolfe's Modified Simplex Algorithm – Beale's Method of Solution to QP problem.

UNIT – II
Bellman's Principle of Optimality – Characteristics of Dynamic Programming Problem – Recursive relationship of Dynamic Programming for various Optimization problems of Shortest Path – Allocation problems – Cargo Loading – Production Scheduling – D.P. for Algebraic problems.

UNIT – III
Concept of Goal Programming (GP) – GP Model Formulation – Single Goal with multiple sub goals – Equally Ranked Multiple Goals – Ranking and Weighing of unequal Multiple Goals – General GP model – Graphical Solution method of GP – Modified Simplex method of GP.

UNIT – IV
Optimization using Spread Sheets - Stepwise procedure with examples – Solution to LPP, Transportation, Assignment problems using Excel Solver.

References

- Man Mohan, P. K. Gupta, Kanti Swarup, **Operations Research** , Sultan Chand & Sons (2014).

- Hiller, F.S., and Lieberman, **Introduction to Operations Research**, McGraw Hill Education India; 10 edition (2017).

- Katta G Murty, **Linear Complementarity Linear and Nonlinear Programming**, John Wiley & Sons (1983).

- Hamdy A Taha, **Operations Research** : An Introduction 10th Edition, PEARSON Publications (2017).

- Stuart E. Dreyfus, **The Art and Theory of Dynamic Programming**, Academic Press (1977).

- R. Fletcher, **Practical Methods of Optimization**, 2nd Edition, John Wiley (1987).

- Willard I. Zangwill., **Nonlinear programming : A Unified Approach**, Prentice-Hall, [1969].

PAPER 3.1 – STOCHASTIC PROCESS

UNIT-I
Introduction to Stochastic Process – Classifications of Stochastic processes according to State, Space and Time Domain – Countable state Markov Chain – Chapman-Kolmogorov equations – Calculation of – 'n' Step Transition Probabilities and its limit.

UNIT-II
Classification of states - Periodicity of state – Stationary Distribution of M.C. – Random walk in one and two dimension – Gambler's ruin problem – probability of ultimate ruin.

UNIT-III
Discrete State space continuous time MC – Poisson process and it's properties – Distribution of inter-arrival times, relationship between Exponential and Poisson distributions. Birth and Death process.

UNIT-IV
Wiener process as a limit of Random Walk and some elementary properties of Weiner process – Concept of renewal process – Weakly Stationary and Strongly Stationary Process.

References
- ❖ S. R. Adke, S. M. Manjunath, **An Introduction to Finite Markov Processes**, Wiley Eastern (1984).
- ❖ Erhan Cinlar, **Introduction to Stochastic Processes**, Dover Publications Inc. (2013).
- ❖ B.R Bhat, **Stochastic Models: Analysis and Applications**, New Age Publishers (2000).
- ❖ J Medhi, **Stochastic Processes**, John Wiley & Sons (1982).
- ❖ Sheldon M. Ross , **Stochastic Processes**, 2nd Edition Wiley; (2008).

PAPER 3.2: RELIABILITY THEORY

Unit-I

Reliability concepts and measures – life testing problems and procedures – chance and wear out failures and corresponding failure density function – Hazard functions and reliability function.

Unit-II

Estimation of Failure Density Parameters Interval Estimation of Reliability Function – General failure distributions – Exponential, Normal, Log-Normal, Gamma and Weibull laws – Estimation of parameters and tests in these models.

Unit-III

Reliability estimation based on failure times in various censored life tests and in tests with replacement of failure items.

Unit-IV

System Reliability – Series and Parallel configurations – k-out-of-n system – Markov models for System Reliability – Maintainability – System Availability measures – Reliability Allocation.

References
- ❖ E. Balaguruswamy, **Reliability Engineering**, McGraw Hill Education (2017).
- ❖ L.S.Sreenath, **Reliability Engineering**, East West Publications (2005).
- ❖ Arnljot Høyland, Marvin Rausand, **System Reliability Theory: Models, Statistical Methods, and Applications**, Wiley-Blackwell; 2nd edition (2004).
- ❖ S. K.; Kale, B. K. Sinha, **Life Testing and Reliability Estimation**, Wiley Eastern Limited (1980).
- ❖ Martin L. Shooman, **Probabilistic Reliability: An Engineering Approach**, Krieger Pub Co; Subsequent edition (1990).

PAPER 3.3 – INVENTORY & INFORMATION THEORY

Unit-I

Concept of Inventory – Costs associated with inventory – Classification of inventory models – deterministic inventory models with and without shortages.

Unit-II

Multi-item inventory model with constraint on Investment – Warehouse capacity and an average inventory EOQ models with quantity discounts and selection control techniques.

Unit-III

Probabilistic Inventory models – Instantaneous and uniform demand with and without setup cost models – (S, s) policy for inventory and its derivation in case of exponential demands. Forecasting Models – Brown's Single and Double Exponential Smoothing Methods.

Unit-IV

Axiomatic approach to the concept of information and entropy – Properties of Shannon entropy of a discrete probability distribution – Joint Entropy – Conditional Entropies – Channel Capacity of a Discrete Memoryless Channel.

References

- ❖ S D Sharma, **Operations Research**, Kedar Nath Ram Nath Publications (2003).
- ❖ Hamdy A Taha, **Operations Research**: **An Introduction,** PEARSON Publications, 10th Edition (2017).
- ❖ Man Mohan, P. K. Gupta, Kanti Swarup, **Operations Research**, Sultan Chand & Sons (2014).
- ❖ B.S. Goel, S.K. Mittal, Sudhir K. Pundir, **Operations Research**, Pragati Prakashan Publications (2017).
- ❖ R.G. Brown, **Smoothing, Forecasting and Prediction of Discrete Time Series**, Prentice Hall (1963).
- ❖ Johnson, L.A. and Montgomery, D.C., **Operations Research in Production Planning, Scheduling and Inventory Control**, Wiley, New York (1974).
- ❖ Robert B. Ash, **Information Theory (Dover Books on Mathematics)**, Dover Publications; New edition edition (1990)
- ❖ Fazlollah M. Reza, **An Introduction to Information Theory**, Dover Publications Inc.; New edition edition (2003).

PAPER 3.4 – STATISTICAL QUALITY CONTROL - II

UNIT-I
The notion of Product Control –Lot by Lot Inspection by Attributes– acceptance sampling plans – OC curve of an acceptance sampling plan – Type-A, type-B O.C. curves – AQL, LTPD, Producer's and consumer's risk – Single and double sampling plans for fraction defectives with specified AQL, LTPD, Producer's risk (α) and consumer's risk(β).

UNIT-II
Acceptance Sampling by Variables- with Quality Characteristics Single Sampling Plan following Normal Distribution with specified P_1^1, P_2^1, α and β (with single and double specification limits when the process standard deviation is known).

UNIT-III
Rectifying Inspection for lot-by-lot sampling – Single Sampling Plan with Rectifications, AOQ, AOQL, ATI curves – Design SSP with rectification using LTPD and β – Item-by-Item SPR plans for continuous productions.

UNIT-IV
Sampling Plan for Continuous Inspection – Continuous sampling plans for inspection by attributes - Dodge, CSP -1, CSP-2 and Chain Sampling Plan - Wald-Wolfowitz and Gischile Plans.

References
- Acheson J Duncan, **Quality Control and Industrial Statistics**, R. D. Irwin; 4th Edition (1974).
- H F & Romig, H G Dodge, **Sampling Inspection Tables**, John Wiley and Sons (1967) .
- Irving W. Burr, **Statistical Quality Control Methods (Statistics: A Series of Textbooks and Monographs),** CRC Press, 1st Edition (1976).
- William C Guenther, **Sampling Inspection in Statistical Quality Control**, C. Griffin Publisher (1977).
- Walter A. Shewhart, **Statistical Method from the Viewpoint of Quality Control**, Dover Publications Inc. (2003).
- Dudley J. Cowden , **Statistical Methods in Quality Control**, Prentice-Hall, Inc; 1st edition (1957).

PAPER 4.1: QUEUING THEORY AND NETWORK ANALYSIS

Unit – I
Elements of Queuing Theory – Characteristics of Queuing system – Classification of Queuing and Probability distribution of arrivals and inter-arrival times – M/M/I & M/M/C with finite and infinite capacities – Queue Discipline with Queue Characteristics – Birth and Death Processes and its applications.

Unit – II
Non-Poisson Queuing System – ELarnagian service time distributions $(M/E_k/1):(\infty/FIFO)$ and $(M/E_k/1):(1/FIFO)$ with its characteristics – M/G/1 Queuing system with Embedded Markov Chain Technique – Definition of Bulk and Priority Queues.

Unit – III
Introduction to Network Analysis – Definition of a Project, Job and Events – Drawing of Arrow Diagrams – Determination of Critical paths and calculation of floats – Resource allocation and least cost planning – Uncertain duration's PERT/CPM system and installation of a network system.

Unit – IV
Network flow problems and finding maximal flows – Combinatorial extensions – Minimal Cost flow problems and applications – Travelling Salesman problem.

References
- ❖ C. West Churchman, Russell L. Ackoff, E. Leonard Arnoff, **Introduction to Operations Research**, John Wiley & Sons (1959).
- ❖ Thomas L. Saaty, **Mathematical Methods of Operations Research**, Dover Publishers (1989).
- ❖ Maurice Sasieni, Arthur Yaspan, Lawrence Friedman, **Operations Research: Methods and Problems**, Literary Licensing, LLC (2013).
- ❖ Harvey M. Wagner, **Principles of Operations Research: With Applications to Managerial Decisions**, Prentice Hall; 2nd Edition (1975).
- ❖ Wah Chun Chan, **An Elementary Introduction to Queuing Systems**, World Scientific Publishing Co., Pvt. Ltd., (2014).
- ❖ D. R. and Walter L. Smith Cox, **Queues**, Mathuen & Co (1961).
- ❖ S D Sharma, **Operations Research**, Kedar Nath Ram Nath Publications (2003).

PAPER 4.2: MATHEMATICAL PROGRAMMING – II

Unit-I

Elements of Game Theory – Two person zero sum game – pay-off matrix – pure and mixed strategies – saddle point – minimax principle – rectangular games with and without saddle point – Dominance property – reducing of a two person zero sum game to a linear program – Fundamental theorem of rectangular games – graphical method for solution of a game – iterative technique for an approximate solution of a game.

Unit-II

Criteria for investment decision – Present value method – The concept of depreciation models consideration leading to replacement – Group vs. Individual replacement policies – replacement of items that fail when the value of money remains unchanged and when the value of money changes with time – Break down and preventive replacement.

Unit-III

Problems of sequence – measures of schedule and evaluation – finite sequencing for a single machine – 2 machines and n jobs – no. passing and K machines and n-jobs no passing – different routing – the general   n x m job shop problem – Branch and Bound Algorithm for flow shop scheduling.

Unit-IV

Simulation – Concept of simulation – Advantages and Limitations of Simulation – Monte Carlo techniques for queueing, inventory and sequencing models.

References

- ❖ Churchman and Arnof : Introduction to Operations Research
- ❖ Owen A(1968) : Game Theory, Samders
- ❖ Thomos L.C(1984) : Game Theory and its applications, John Wiley
- ❖ Luce R and Raiffa : Games and Decisiions
- ❖ Wagner H.M : Principles of O.R., Prentice-Hall of India
- ❖ Vaida S : The theory of Games and LPP
- ❖ Sasieni, Yaspina & Friedman : Operations Research-Methods & Problems
- ❖ Hamdy A.Taha (5th edition) : Operations Research-An Introduction
- ❖ Sharma J.K : Operations Research Theory & Application, Chapter 28

ELECTIVE PAPER [IV Semester]
PAPER 4.3: MULTIVARIATE ANALYSIS

Unit-I

Multivariate Normal Distribution, marginal and conditional distributions, characteristic functions, Maximum likelihood estimators of parameters, distribution of sample mean vector and dispersion matrix, distribution of quadratic form in the exponent of the multivariate normal density.

Unit-II

Hotelling's T^2 and its applications – T^2 distribution, application of T^2 to single sample, two sample and multiple sample problems, optimum properties of T^2 test. Mahalobis D^2 statistic and its distribution, Multivariate Analysis of Variance (MANOVA) of one and two-way classified data.

Unit-III

Classification and discrimination: procedures for classification into two multivariate normal populations, Fisher's Discriminant function, classification into more than two multivariate normal populations, Wishart distribution and its properties, concept of sample generalized variance and its distribution.

Unit-IV

Principal Component Analysis – properties, method of extraction of principal components; Canonical variables and canonical correlations; Factor Analysis – mathematical model, estimation of factor loading, concept of factor rotation; Cluster Analysis – similarities and dissimilarities, Hierarchical clustering: single and complete linkage method.

References

- ANDERSON, T.W, **AN INTRODUCTION TO MULTIVARIATE STATISTICAL ANALYSIS**, WILEY, 2ND EDITION(1983).
- RAO, C.R, **LINEAR STATISTICAL INFERENCE AND ITS APPLICATIONS**, 2ND EDITION, WILEY (1973).

ELECTIVE PAPER [IV Semester]

PAPER 4.4: TOTAL QUALITY MANAGEMENT

UNIT – I

Definitions of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework, Axioms, benefits - Barriers to TQM – Contributions of Deming, Juran and Crosby - Deming's Fourteen Points for Management - Deadly Sins & diseases.

UNIT – II

Concepts of Quality circle - Continuous process improvement – PDCA cycle. The Juran Quality Trilogy - Juran Ten Steps to Quality improvement - Crosby defined Four Absolutes of Quality Management .

UNIT – III

Management Methods: Cost benefit Analysis, Deming Wheel, ISO 9000, Just-in-time, Kaizen.

Analytical Methods: Cause and Effect Analysis, Hypothesis testing, Paired Comparisons, Design and Analysis of Experiments – Factorial experiments – Fractional designs, Robust Design, Taguchi Methods.

UNIT – IV

Idea Generation: Brainstorming, list of reduction, mind mapping, idea writing.

Data Collection & Display Method: Flow Charts, Bar charts, Histogram, Scatter Diagram, Basic Statistics - Measures of Central Tendency & Dispersion, Statistical Process control, Control charts – Variable & Attribute charts, Interpretation of Control charts, CUSUM charts

References
- ❖ "QUALITY IN TOTALITY", PARAS DIWAN, DEEP & DEEP, NP.
- ❖ "MANAGING FOR TOTAL QUALITY", N.LOGOTHETIS, PHI PUBLICATIONS.
- ❖ "TOTAL QUALITY" : BHARAT WAKHLAN, WHEELEN, ND.
- ❖ "TQM-TEXT, CASES AND READINGS", JOEL E.ROSS, DEEP & DEEP ND
- ❖ "100 METHODS FOR TOTAL QUALITY MANAGEMENT": GOPAL K.KANJI & MIKE ASHER

ELECTIVE PAPER [IV Semester]
PAPER 4.5: DATA MINING

UNIT – I

Data Mining – Meaning, Data Mining Functionalities classification – Data Mining Task Primitives – Integration of a Data Mining System with a Database – Major issues in Data Mining – Descriptive Data Summarization – Data Cleaning.

UNIT – II

Data Integration and transformation, Data reduction Data Discretization and concept Hierarchy Generation. What is Data Warehouse? Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, From Data Warehouse to data mining.

UNIT – III

Basic Concepts of frequent patterns, Frequent Item sets, mining methods, Association rules, what is classification and Prediction, Classification By decision Tree Induction, Bayesian Classification, and Rule - Based Classification.

UNIT – IV

Cluster analysis– Meaning, Types, Partitioning methods, Hierarchical methods, Density Based methods, Grid Based methods, and Model-Based Clustering methods, Outlier analysis

References

- DATA MINING CONCEPTS & TECHNIQUES BY JIAWEI HAN, MICHELINE & KAMBER (2ND EDI.) MORGAN KAUFMANN PUBLISHERS (ELSEVIER)
- DATA MINING INTRODUCTORY AND ADVANCED TOPICS –MARGARET H DUNHAM, PEARSON EDUCATION
- DATA MINING TECHNIQUES – ARUN K PUJARI, UNIVERSITY PRESS
- DATA WAREHOUSING IN THE REAL WORLD –SAM ANAHORY & DENNIS MURRAY PEARSON EDN ASIS.
- THE DATA WAREHOUSE LIFE CYCLE TOOL KIT – RALPH KIMBALL WILEY STUDENT EDITION
- DATA WAREHOUSING BY S MOHANTHY (TMH)

ELECTIVE PAPER [IV Semester]
PAPER 4.6 : **SUPPLY CHAIN MANAGEMENT**

UNIT I:

Supply Chain Management – Meaning – Definitions – Key Components of Supply Chain Management – Supply Chain Management Goals – Supply Chain Management Vs. Logistics Management.

UNIT II:

SCM – Opportunities enabled by SCM – Implementation Measures – SCL Levels: Strategic, Tactical and Operational – Problems of SCM – Bullwhip Effect – Factors Contributing for Bullwhip Effect.

UNIT III:

Forecasting : Methods – SC Integration : Pull Strategy, Push Strategy, Pull Strategy Vs. Push Strategy – SC Collaboration – SC Collaboration Spectrum – Benefits of SC Collaboration.

UNIT IV:

SCOR Model – Collaboration and the SCOR Model – Process Reference Model – SCOR Structure – SCOR Model Structure – SCOR Implementation – Examples of SCOR Adaptations- SCOR as a Context – Emerging Best Practices in SCM.

References
- MOHANTY R.P, S.G DESHMUKI "SUPPLY CHAIN MANAGEMENT" BIZTANTRA, NEW DELHI
- SHAH, J, "SUPPLY CHAIN MANAGEMENT", 2009, 1ST ED. PEARSON.
- CRANDALL, RICHARD E & OTHERS, "PRINCIPLES OF SUPPLY CHAIN MANAGEMENT", 2010, CRC PRESS.
- MOHANTY, R.P AND DESHMUKH, S.G, "ESSENTIALS OF SUPPLY CHAIN MANAGEMENT", 2009, 1ST ED. JAICO,
- CHANDRASEKARAN. N, "SUPPLY CHAIN MANAGEMENT PROCESS, SYSTEM AND PRACTICE", 2010, OXFORD, 1ST ED.