

As Per NEP 2020

University of Mumbai



Syllabus for Minor Vertical 2 (Scheme-III)

Faculty of Science.

Board of Studies in Statistics.

B.Sc. Second Year Programme in Minor (Statistics)

Semester	III & IV	
Title of Paper	Sem.	Total Credits 4
I) Operation Research-I	III	2
II) Practical based on operation Research-I		2
Title of Paper		Credits
I) Operation Research-II	IV	2
II) Practical based on Operation Research-II		2
From the Academic Year		2025-26

Semester-III

Minor-I
Name of the course: Operations Research -I

Sr. No.	Heading	Particulars
1	Description the course : Including but Not limited to :	Introduction: Operations Research (OR) is a discipline that deals with the application of advanced analytical methods to help make better decisions. This course provides an in-depth understanding of the fundamental concepts and techniques used in operations research, with a focus on linear programming problems, transportation problems, and assignment problems.
2	Vertical :	Minor
3	Type :	Theory
4	Credit:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives:	Students will be able to, 1. Understand the fundamental concepts and procedures of Linear Programming Problem 2. Study the Efficient Transportation schedule, 3. Optimal allocation or assignment of Jobs to machines
8	Course Outcomes:	Students Should be able to, 1. Optimize the cost, time profit or loss through Linear Programming Problem 2. Make best transportation schedule with minimum cost and to maximize profit 3. Optimal allocation or assignment of Jobs to machines

9	Modules:-	Lect ures
	Module 1: <u>Linear Programming Problem (L.P.P.)</u> :	10
	Mathematical Formulation: Maximization & Minimization. Concepts of Solution, Feasible Solution, Basic Feasible Solution, Optimal solution. Graphical Solution for problems with two variables. Simplex method of solving problems with two or more variables. Big M method. Concept of Duality. Its use in solving L.P.P. Relationship between optimum solutions to Primal and Dual. Economic interpretation of Dual.	
	Module 2: <u>Transportation Problem:</u>	10
	Concept, Mathematical Formulation. Concepts of Solution, Feasible Solution. Initial Basic Feasible Solution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method. Optimality test, Improvement procedure. Variants in Transportation Problem: Unbalanced, Maximization type.	
	Module 3: <u>Assignment Problem:</u>	10
	Concept. Mathematical Formulation Solution by: Complete Enumeration Method and Hungarian method. Variants in Assignment Problem: Unbalanced, Maximization type. Travelling Salesman Problem	

REFERENCES

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

Semester-III**Minor-I****Name of the course: Practical's based on Operations Research -I**

Sr. No.	Heading	Particulars
1	Description the course : Including but Not limited to :	Introduction: Operations Research (OR) is a discipline that deals with the application of advanced analytical methods to help make better decisions. This course provides an in-depth understanding of the fundamental concepts and techniques used in operations research, with a focus on linear programming problems, transportation problems, and assignment problems.
2	Vertical :	Minor
3	Type :	Practical
4	Credit:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted :	60 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives:	Students will be able to, 1. Understand to solve Linear Programming Problems. 2. To solve transportation problems. 3. Solve Optimal allocation or assignment of Jobs to machines
8	Course Outcomes:	Students Should be able to, 4. Optimize the cost, time profit or loss through Linear Programming Problem 5. Make best transportation schedule with minimum cost and to maximize profit 6. Optimal allocation or assignment of Jobs to machines

9	List of Practicals
	1. Formulation and Graphical Solution of L.P.P. 2. Simplex Method. 3. Big-M Method. 4. Duality. 5. Transportation Problems. 6. Assignment Problems. All above practical problems solving manual and using TORA/Excel Solver.

Format of Practical Question Paper:
Internal Continuous Assessment: (20 marks)

Journal	Assignment/Viva	Total
05	15	20

Semester End practical Examination: (30 marks)

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

Practical Question Paper Pattern:

Q 1	Practical based on practical 1 &2	Max. marks: 10
Q 2	Practical based on practical 3 &4	Max. marks: 10
Q 3	Practical based on practical 5 &6	Max. marks: 10

Semester-IV

Semester-IV**Minor-II****Name of the course: Operations Research -II**

Sr. No.	Heading	Particulars
1	Description the course : Including but Not limited to :	Introduction: Operations Research (OR) is a discipline that deals with the application of advanced analytical methods to help make better decisions. This course provides an in-depth understanding of the fundamental concepts and techniques used in operations research, with a focus on network management and project scheduling, analysis of competitive situation in Game Theory and optimal decision making in uncertainty and risk.
2	Vertical :	Minor
3	Type :	Theory
4	Credit:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted :	30 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives:	Students will be able to, 1. Learn Network Analysis Techniques and Optimize Project Schedules 2. Understand Game Theory Concept and Analyze Competitive Situations 3. Decision Analysis Techniques and Evaluate Uncertainty and Risk
8	Course Outcomes:	Students Should be able to, 1. Ability to Create Network Diagrams, Identification of Critical Path, and Project Scheduling Skills 2. Ability to Formulate Game Theory Problems, Strategic Decision Making and Optimal Strategy Identification 3. Analytical Decision-Making Skills, Optimal Decision Identification and Risk and Uncertainty Management

9	Modules:-	Lect ures
	Module 1: <u>CPM and PERT</u>	10
	Objective and Outline of the techniques. Diagrammatic representation of activities in a project: Gantt Chart and Network Diagram. Slack time and Float times. Determination of Critical path. Probability consideration in project scheduling. Project cost analysis. Updating.	
	Module 2: <u>Game Theory</u>	10
	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 (2×2) game. Graphical solution of $(2 \times n)$ and $(m \times 2)$ games, Reduction of game theory to LPP	
	Module 3: <u>Decision Theory</u>	10
	Decision making under uncertainty: Laplace criterion, Maximax (Minimin) criterion, Maximin (Minimax) criterion, Hurwitz α 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.	

REFERENCES

1. PERT and CPM, Principles and Applications: Srinath. 2nd edition, East-West Press Pvt. Ltd.
2. Quantitative Techniques For Managerial Decisions: J.K.Sharma, (2001), MacMillan India Ltd.
3. Mathematical Models in Operations Research: J K Sharma, (1989), Tata McGraw Hill Publishing Company Ltd.
4. Operations Research: S.D.Sharma.11th edition, KedarNath Ram Nath& Company.
5. Operations Research: Kantiswaroop and Manmohan, Gupta. 12thEdition; S Chand & Sons.
6. Schaum Series book in O.R. Richard Bronson. 2nd edition Tata Mcgraw Hill Publishing Company Ltd.
7. Bronson R. : Theory and problems of Operations research, First edition, Schaum's Outline series
8. Operations Research: Methods and Problems: Maurice Sasieni, Arthur Yaspan and Lawrence Friedman,(1959), John Wiley & Sons.
9. Operations Research: H. A.Taha., 6th edition, Prentice Hall of India.
- 10.Vora N. D. : Quantitative Techniques in Management, Third edition, McGraw Hill Companies.
- 11.Bannerjee B. : Operation Research Techniques for Management, First edition, Business Books

Format of Question Paper:**Internal Continuous Assessment: (20 marks)**

Assignment/viva Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	Class Test	Total
05	15	20

Semester End Examination: (30 marks)

Semester End Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

Theory Question Paper Pattern:

Q 1	Attempt any one question out of two questions (Module I and II)	Max. marks: 10
Q 2	Attempt any two questions out of three questions (Module I)	Max. marks: 10
Q 3	Attempt any two questions out of three questions (Module II)	Max. marks: 10

Semester-IV**Minor-II****Name of the course: Practical based on Operations Research -II**

Sr. No.	Heading	Particulars
1	Description the course : Including but Not limited to :	Introduction: Operations Research (OR) is a discipline that deals with the application of advanced analytical methods to help make better decisions. This course provides an in-depth understanding of the fundamental concepts and techniques used in operations research, with a focus on network management and project scheduling, analysis of competitive situation in Game Theory and optimal decision making in uncertainty and risk.
2	Vertical :	Minor
3	Type :	Practical
4	Credit:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted :	60 Hours
6	Marks Allotted:	50 Marks
7	Course Objectives:	Students will be able to, 4. Learn Network Analysis Techniques and Optimize Project Schedules 5. To Understand Game Theory Concept and Analyze Competitive Situations 6. Decision Analysis Techniques and Evaluate Uncertainty and Risk
8	Course Outcomes:	Students Should be able to, 4. Solve Network Diagrams, Identification of Critical Path, and Project Scheduling Skills 5. Formulate and solve Game Theory Problems, Strategic Decision Making and Optimal Strategy Identification 6. Understand Analytical Decision-Making Skills, Optimal Decision Identification and Risk and Uncertainty Management.

9	List of Practicals
	1. CPM-PERT : Construction of Network. 2. Finding Critical Path. Computing Probability of Project completion. 3. Project cost analysis. 4. Updating. 5. Game Theory 1 6. Game Theory 2 7. Decision Theory-1: Decisions Under Uncertainty 8. Decision Theory-2 : Decisions Under Risk 9. Decision Theory-3 : Decision Tree analysis.

Format of Practical Question Paper:
Internal Continuous Assessment: (20 marks)

Journal	Assignment/Viva	Total
05	15	20

Semester End practical Examination: (30 marks)

Semester End Practical Examination will be of 30 marks of 01 hour duration covering entire syllabus of the semester. All questions are Compulsory.

Practical Question Paper Pattern:

Q 1	Practical based on practical 1 , 2 &3	Max. marks: 10
Q 2	Practical based on practical 3 ,4 & 5	Max. marks: 10
Q 3	Practical based on practical 5 ,6 ,7,8 &9	Max. marks: 10


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