|  |  |  |
| --- | --- | --- |
|  | **P.R.GOVERNMENT COLLEGE(A), KAKINADA** | **Program & Semester****III B.Sc. (V Sem)****Paper-VI** |
| **Course Code** | **TITLE OF THE COURSE**OPERATIONS RESEARCH – I |
| **Theory** | **Hours Allocated: 30 hrs** | **L** | **T** | **P** | **C** |
| **Pre-requisites:** |  **Basic knowledge in Statistical functions** | **4** | **-** | **-** | **4** |

# Objectives:

The Objective of the paper is to introduce the basic concepts of Operational Research and linear programming to the students*.*

# Course Outcomes:

|  |
| --- |
| On Completion of the course, the students will be able to- |
| **CO1** | **Students would be able to learn about basics of Operation research** |
| **CO2** |  **Students would be able to know concepts of optimization techniques** |
| **CO3** | **Students would be able to know about Transportation problems** |
| **CO4** | **Students must be able to know about different types of assignment problems** |
| **CO5** | **Students would able to learn Sequencing methods.** |

**Course with focus on employability / entrepreneurship / Skill Development modules**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Skill Development |  |  | Employability |  |  | Entrepreneurship |  |

**UNIT-I**

Introduction of OR – Origin and development of OR – Nature and features of OR –Scientific Method in OR – Modeling in OR – Advantages and limitations of Models-General Solution methods of OR models – Applications of Operation Research. Linear programming problem (LPP) - Mathematical formulation of the problem - illustrations on Mathematical formulation of Linear programming of problem. Graphical solution of linear programming problems. Some exceptional cases - Alternative solutions, Unbounded solutions, non-existing feasible solutions by Graphical method.

UNIT-II

General linear programming Problem (GLP) – Definition and Matrix form of GLP problem, Slack variable, Surplus variable, unrestricted Variable, Standard form of LPP and Canonical form of LPP. Definitions of Solution, Basic Solution, Degenerate Solution, Basic feasible Solution and Optimum Basic Feasible Solution. Introduction to Simplex method and Computational procedure of simplex algorithm. Solving LPP by Simplex method (Maximization case and Minimization case)

UNIT-III

Artificial variable technique - Big-M method and Two-phase simplex method, Degeneracy in LPP and method to resolve degeneracy. Alternative solution, Unbounded solution, Non existing feasible solution and Solution of simultaneous equations by Simplex method.

UNIT-IV

Duality in Linear Programming –Concept of duality - Definition of Primal and Dual Problems, General rules for converting any primal into its Dual, Economic interpretation of duality, Relation between the solution of Primal and Dual problem (statements only). Using duality to solve primal problem. Dual Simplex Method.

UNIT-V

Post Optimal Analysis - Changes in cost Vector C , Changes in the Requirement Vector b

and changes in the Coefficient Matrix A. Structural Changes in a LPP.

# Textbooks:

**1) Operations Research by Kanthi Swaroop k.GUPTA AND ManMohan –Sultan Chand**

**2 )Operation Research- S.D Sharma**

# Reference books:

**3) Operation Research – Taha**

# Web Links:

 1. <https://youtu.be/k3lUo0XYG3E>

 2. <https://youtu.be/qSUjVDbKLWQ>

# CO-PO Mapping:

**(1:Slight[Low]; 2:Moderate[Medium]; 3:Substantial[High} '-':No Correlation)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | 3 | 2 | 1 | 2 | 2 |
| CO2 | 2 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 3 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO5 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |

|  |  |  |
| --- | --- | --- |
|  | **P.R.GOVERNMENT COLLEGE(A), KAKINADA** | **Program & Semester** **III B.Sc. (V Sem)****Paper-VI** |
| **Course****Code** | **TITLE OF THE COURSE**OPERATIONS RESEARCH – I |
| **Practical** | **Hours Allocated: 30 hrs** | **L** | **T** | **P** | **C** |
| **Pre-requisites:** |  **Basic knowledge in Statistical functions** | **-** | **-** | **2** | **1** |

## Practical/Lab to be performed on a computer using OR/Statistical packages

* 1. **To solve Linear Programming Problem using Graphical Method with**
		1. **Unbounded solution**
		2. **Infeasible solution**
		3. **Alternative or multiple solutions.**
	2. **Solution of LPP with simplex method.**
	3. **Problem solving using Charnes-M method.**
	4. **Problem solving using Two Phase method.**
	5. **Illustration of following special cases in LPP using Simplex method**
		1. **Unrestricted variables**
		2. **Unbounded solution**
		3. **Infeasible solution**
		4. **Alternative or multiple solutions.**
	6. **Problems based on Principle of Duality.**
	7. **Problems based on Dual simplex method.**
	8. **Problems based on Post Optimal Analysis.**

# Reference books:

**1) Operations Research by Kanthi Swaroop k.GUPTA AND ManMohan –Sultan Chand**

**2 )Operation Research- S.D Sharma**

# Virtual Lab Links:

1. <https://youtu.be/k3lUo0XYG3E>

2. <https://youtu.be/qSUjVDbKLWQ>

3. <https://youtu.be/8DaOIjuF4BY>

**Model blue print for the Question Paper setter**

**Course VI -** **OPERATIONS RESEARCH – I**

**Max. Marks: 60 Time : 2 ½ Hrs.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Module** | **Short Answer Questions** | **Essay Questions** | **Marks allotted to the Unit/Chapter** |
| **I** | **2** | **2** | **30** |
| **II** | **1** | **2** | **25** |
|  **III** | **1** | **1** | **15** |
| **IV** | **1** | **2** | **25** |
| **V** | **1** | **1** | **15** |
| **Total including choice**  | **6** | **8** | **110** |

**Question Bank**

**SHORT QUESTIONS**

1. Nature and meaning of O.R.
2. Applications of O.R.
3. Mathematical formation of LPP.
4. Write a procedure on Graphical method.
5. Define slack, surplus and A.V.
6. What is degeneracy and how to resolve Degeneracy using LPP.
7. What is the difference between primal and it’s dual.
8. The dual of the dual of a given primal is the primal or duality theorem.
9. Explain the concept of duality.
10. State and prove that fundamental theorem of duality.
11. Structure changes in LPP.

 **ESSAY QUESTIONS**

1. Explain the nature and scope of O.R.
2. Explain about models in O.R.
3. Write a procedure on simplex method.
4. Solve the following LPP using Graphical method.

 Max Z =3X1+5X2

Subject to constraints;

 X1+2 X2 ≤ 2000

 X1+ X2 ≤ 1500

 X2 ≤ 600 and X1 ≥ 0, X2 ≥ 0

1. Write a procedure on Big –M and two phase methods.
2. Use penalty method to solve the following LPP.

 Min Z =5X1+10X2 +8 X3

Subject to constraints;

 6 X1+8 X2 >100

 7X1+ 12X2 > 120 and X1 , X2 >0

1. Explain the concept of degeneracy and how do you solve it.
2. State and prove fundamental theorem of duality.
3. Solve the following using LPP using two phase method.

 Min Z =X1 -2X2 - 3 X3

Subject to constraints;

 -2 X1+X2+3 X3 =2

 2X1+ 3X2+4 X3 =1> and X1, X2, X3 > 0

1. Explain a bout post optimal analysis.
2. Explain about the requirement vectors b, c using post optimal analysis.

**P.R. Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations IV Semester (w.e.f 2022-23)**

**for 2021-22 Batch**

**Statistics Course 6A:OPERATIONS RESEARCH**

**(Model paper)**

**Time: 2 1/2 Hrs. Max. Marks: 50**

**Section – A 4x5 = 20 M**

**Answer any four of the following questions. Each question carries five marks.**

1. Define Nature and meaning of O.R.
2. Explain about Mathematical formation of LPP.
3. Define slack, surplus and A.V.
4. What is degeneracy and how to resolve Degeneracy using LPP.
5. Explain the concept of duality
6. Explain about Structure changes in LPP

**Section – B**

Answer any two of the following questions 2X10 = 20 M

.

1. Explain about models in O.R
2. . Explain the nature and scope of O.R.
3. Solve the following LPP using Graphical method.

 Max Z =3X1+5X2

Subject to constraints X1+2 X2 ≤ 2000

 X1+ X2 ≤ 1500 , X2 ≤ 600 and X1 ≥ 0, X2 ≥ 0

1. Write a procedure on simplex method

**Section – B**

Answer any two of the following questions 2X10 = 20 M

**11.**State and prove fundamental theorem of duality.

 12.Solve the following using LPP using two phase method.

 Min Z =X1 -2X2 - 3 X3

Subject to constraints;

 -2 X1+X2+3 X3 =2

 2X1+ 3X2+4 X3 =1> and X1, X2, X3 > 0

13. Explain a bout post optimal analysis.

14.Explain about the requirement vectors b, c using post optimal analysis

|  |  |  |
| --- | --- | --- |
|  | **P.R.GOVERNMENT COLLEGE(A), KAKINADA** | **Program & Semester****III B.Sc. (V Sem)****Paper-VII** |
| **Course Code** | **TITLE OF THE COURSE**OPERATIONS RESEARCH – II |
| **Theory** | **Hours Allocated: 30 hrs** | **L** | **T** | **P** | **C** |
| **Pre-requisites:** |  **Basic knowledge in Statistical functions** | **4** | **-** | **-** | **4** |

# Objectives:

 **After completion of this paper the students would be able to learn the applied part of statistics in various disciplines and also learn the opportunities of statistician in different fields.**

**To enrich the knowledge of students with advanced techniques of linear programming problem along with real life applications.**

# Course Outcomes:

|  |
| --- |
| On Completion of the course, the students will be able to- |
| **CO1** | **Students would be able to learn about game theory and its problems** |
| **CO2** |  **Students would be able to know concepts of Inventories** |
| **CO3** | **Students would be able to know about Networking** |
| **CO4** | **Students must be able to know about different networking models** |
| **CO5** | **Students would able to learn queuing models** |

**Course with focus on employability / entrepreneurship / Skill Development modules**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Skill Development |  |  | Employability |  |  | Entrepreneurship |  |

UNIT-I

Transportation Problem - Introduction, Mathematical formulation of Transportation problem. Initial Basic feasible solution of Transportation problem - North-West corner rule, Lowest cost entry method, Vogel’s approximation method. Method of finding optimal solution-MODI method(U-V method). Degeneracy in transportation problem, Resolution of degeneracy, Unbalanced transportation problem. Maximization TP. Transhipment Problem.

UNIT-II

Assignment Problem - Introduction, Mathematical formulation of Assignment problem, Reduction theorem (statement only), Hungarian Method for solving Assignment problem, Unbalanced Assignment problem. The Traveling salesman problem, Formulation of Traveling salesman problem as an Assignment problem and Solution procedure.

UNIT-III

Sequencing problem: Introduction and assumptions of sequencing problem, Sequencing of n jobs and one machine problem. Johnson’s algorithm for n jobs and two machines problem- problems with n-jobs on two machines, algorithm for n jobs on three machines problem- problems with n- jobs on three machines, algorithm for n jobs on m machines problem, problems with n- jobs on m-machines.

UNIT-IV

Network Scheduling: Basic Components of a network, nodes and arcs, events and activities– Rules of Network construction – Time calculations in networks - Critical Path Method (CPM) and PERT.

UNIT-V

Game Theory: Two- person zero-sum games. Pure and Mixed strategies. Maxmin and Minimax Principles - Saddle point and its existence. Games without Saddle point-Mixed strategies. Solution of 2 x 2 rectangular games. Graphical method of solving 2 x n and m x 2 games. Dominance Property.

# Textbooks:

1. **Kanti Swaroop, P.K.Gupta and Man Mohan: Operations Research. Sultan Chand.**
2. **Taha: Operations Research: An Introduction: Mac Millan.**

# Reference books:

**3) Operation Research – Taha**

# Web Links:

 1. <https://youtu.be/k3lUo0XYG3E>

 2. <https://youtu.be/qSUjVDbKLWQ>

# CO-PO Mapping:

**(1:Slight[Low]; 2:Moderate[Medium]; 3:Substantial[High} '-':No Correlation)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | 3 | 2 | 1 | 2 | 2 |
| CO2 | 2 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 2 | 3 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO5 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |

|  |  |  |
| --- | --- | --- |
|  | **P.R.GOVERNMENT COLLEGE(A), KAKINADA** | **Program & Semester** **III B.Sc. (V Sem)****Paper-VI** |
| **Course****Code** | **TITLE OF THE COURSE**OPERATION RESEARCH-II |
| **Practical** | **Hours Allocated: 30 hrs** | **L** | **T** | **P** | **C** |
| **Pre-requisites:** |  **Basic knowledge in Statistical functions** | **-** | **-** | **2** | **1** |

## Practical/Lab to be performed on a computer using OR/Statistical packages

* 1. **IBFS of transportation problem by using North- West corner rule, Matrix minimum method and VAM**
	2. **Optimum solution to balanced and unbalanced transportation problems by MODI method (both maximization and minimization cases)**
	3. **Solution of Assignment problem using Hungarian method (both maximization and minimization cases),**
	4. **Solution of sequencing problem—processing of n jobs through two machines**
	5. **Solution of sequencing problem - processing of n jobs through three machines**
	6. **To perform Project scheduling of a given project (Deterministic case-CPM).**
	7. **To perform Project scheduling of a given project (Probabilistic case-PERT).**
	8. **Graphical method of solving for m x 2 and 2 x n games.**
	9. **Solution of m x n games by dominance rule.**
	10. **Linear programming method for solving m x n games.**

# Reference books:

**1) Operations Research by Kanthi Swaroop k.GUPTA AND**

 **ManMohan –Sultan Chand**

**2 )Operation Research- S.D Sharma**

# Virtual Lab Links:

1. <https://youtu.be/k3lUo0XYG3E>

2. <https://youtu.be/qSUjVDbKLWQ>

3. <https://youtu.be/8DaOIjuF4BY>

**Model blue print for the Question Paper setter**

**Course VI -** **OPERATIONS RESEARCH – II**

**Max. Marks: 60 Time : 2 ½ Hrs.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Module** | **Short Answer Questions** | **Essay Questions** | **Marks allotted to the Unit/Chapter** |
| **I** | **2** | **2** | **30** |
| **II** | **1** | **2** | **15** |
|  **III** | **1** | **1** | **15** |
| **IV** | **1** | **1** | **15** |
| **V** | **1** | **2** | **25** |
| **Total including choice**  | **6** | **8** | **110** |

QUESTION BANK

**SHORT QUESTIONS**

1. Write a short notes on un- balanced Transportation problems.
2. Explain the degeneracy in Transportation problems. How can you resolve it.
3. Explain NWCR method.
4. General Mathematical form of Transportation problems.
5. Write a procedure on optimal solution.
6. Assignment problem as a particular case of LPP.
7. Explain travelling sales man problem.
8. Explain the types of Assignment Problems.
9. Explain the Assumptions on sequencing problems.
10. Write a procedure for n- jobs through k- machines.
11. Explain the rules of constructing a networking diagram.
12. Explain PERT and CPM.
13. Explain the components of a networking.
14. Two persons zero sum game.
15. Explain the concept of Max-min and Min-max criterion principal.

**ESSAY QUESTIONS**

1. Explain procedure on LCEM and obtain IBFS for T.P by using LCEM.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | W1 | W2 | W3 | W4 | SUPPLY |
| F1 | 5 | 3 | 6 | 7 | 19 |
| F2 | 4 | 7 | 9 | 1 | 37 |
| F3 | 3 | 4 | 7 | 5 | 34 |
| DEMAND | 16 | 18 | 31 | 25 |  |

1. Obtain IBFS for T.P by using VAM.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | D1 | D2 | D3 | D4 | Availability |
| O1 | 11 | 20 | 7 | 8 | 50 |
| O2 | 21 | 16 | 10 | 12 | 40 |
| O3 | 8 | 12 | 18 | 9 | 70 |
| Requirements | 30 | 25 | 35 | 40 |  |

1. Explain the procedure for modi method.
2. Write the procedure for Hungarian method.
3. Solve the following A.P

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I | II | III | IV |
| A | 30 | 25 | 26 | 28 |
| B | 26 | 32 | 24 | 20 |
| C | 20 | 22 | 18 | 27 |
| D | 23 | 20 | 21 | 19 |

1. Explain the sequencing algorithm for n jobs on two machines.
2. Determine the optimal sequence of jobs that minimizes the total elapsed time based on the following information processing time on machines given in hours and passing is not followed.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| JOB | A | B | C | D | E | F | G |
| M1 | 3 | 8 | 7 | 4 | 9 | 8 | 7 |
| M2 | 4 | 3 | 2 | 5 | 1 | 4 | 3 |
| M3 | 6 | 7 | 5 | 11 | 5 | 6 | 12 |

1. Explain forward & backward time computations.
2. Explain the critical path method?
3. Explain the PERT algorithm.
4. Find the optimum time of completion of projects, when the time of completion of each task is as follows

 A<D,E B,D<F; C<G; B,G<H; F,G<I.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TASK | A | B | C | D | E | F | G | H | I |
| TIME | 23 | 8 | 20 | 16 | 24 | 18 | 19 | 4 | 10 |

1. Write a procedure on graphical method 2xn, mx2 games.
2. Write a procedure on Domains properly and solve the following problem using dominance property.

|  |  |  |  |
| --- | --- | --- | --- |
|  | A | B | C |
| A | 10 | 5 | 7 |
| B | 6 | 7 | 5 |
| C | 7 | 6 | 7 |

**P.R. Government College (Autonomous), Kakinada**

**II year B.Sc., Degree Examinations IV Semester (w.e.f 2022-23)**

**for 2021-22 Batch**

**Statistics Course 7A:OPERATIONS RESEARCH-II**

**(Model paper)**

**Time: 2 1/2 Hrs. Max. Marks: 50**

**Section – A 4x5 = 20 M**

**Answer any four of the following questions. Each question carries five marks.**

1. Explain the degeneracy in Transportation problems. How can you resolve it.
2. Explain NWCR method.
3. General Mathematical form of Transportation problems.
4. Explain travelling sales man problem.
5. Explain PERT and CPM.
6. Two persons zero sum game.

**Section – B**

Answer any two of the following questions 2X10 = 20 M

1. Obtain IBFS for T.P by using VAM.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | D1 | D2 | D3 | D4 | Availability |
| O1 | 11 | 20 | 7 | 8 | 50 |
| O2 | 21 | 16 | 10 | 12 | 40 |
| O3 | 8 | 12 | 18 | 9 | 70 |
| Requirements | 30 | 25 | 35 | 40 |  |

1. Explain the procedure for modi method.
2. Write the procedure for Hungarian method.
3. Solve the following A.P

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I | II | III | IV |
| A | 30 | 25 | 26 | 28 |
| B | 26 | 32 | 24 | 20 |
| C | 20 | 22 | 18 | 27 |
| D | 23 | 20 | 21 | 19 |

. **Section – C**

Answer any two of the following questions 2X10 = 20 M

1. Explain the sequencing algorithm for n jobs on two machines
2. Find the optimum time of completion of projects, when the time of completion of each task is as follows

 A<D,E B,D<F; C<G; B,G<H; F,G<I.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TASK | A | B | C | D | E | F | G | H | I |
| TIME | 23 | 8 | 20 | 16 | 24 | 18 | 19 | 4 | 10 |

1. Write a procedure on graphical method 2xn, mx2 games
2. Explain the concept of Max-min and Min-max criterion principal