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# P.E.S. College of Engineering, Mandya - 571 401

*(An Autonomous Institution affiliated to VTU, Belagavi)*

## Seventh Semester, B.E. - Industrial and Production Engineering

## Semester End Examination; February - 2022

## Operations Research

*Time: 3 hrs* *Max. Marks: 100*

***Course Outcomes***

*The Students will be able to:*

*CO1: Identify and Develop operational research models that consider the key elements of the real world problem from the verbal description of the real system.*

*CO2: Solve the linear programming models for their optimal solution and interpret the model's solution.*

*CO3: Analyze and Solve managerial problems in industry so that they are able to use resources more effectively using assignment and transportation model.*

*CO4: Select mathematical and computational modeling of real decision making problems, including the use of modeling tools and computational tools, as well as analytic skills to Evaluate the problems under uncertainty.*

*CO5: Design new simple models: CPM, PERT, to improve decision-making and develop critical thinking and objective analysis of decision problems.*

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for Maximum of **18 marks** from each unit.*

| Q. No. | Questions | Marks | BLs | COs | POs |
|---|---|---|---|---|---|
| | **I : PART - A** | **10** | | | |
| I a. | What are the main features of Standard form of LPP? | 2 | L1 | CO1 | PO1 |
| b. | What is the difference between primal and dual problems in LPP? | 2 | L1 | CO2 | PO1 |
| c. | What is degeneracy in transportation problem? | 2 | L1 | CO3 | PO1 |
| d. | What is the difference between individual and group replacement policy? | 2 | L1 | CO4 | PO1 |
| e. | What does the does the Kendal and Lee notation represent in queuing theory? | 2 | L1 | CO5 | PO1 |
| | **II : PART - B** | **90** | | | |
| | **UNIT - I** | **18** | | | |
| 1 a. | A Farmer has 100 acres land. He can sell all tomatoes, lettuce, or radishes he can raise. The price he can obtain is Rs.1 per kg for tomatoes Rs. 0.75 ahead for lettuce and Rs. 2 per kg for radishes. The average yield per acre is 2000 kgs of tomatoes, 3000 heads of lettuce and 1000 kgs for radish. Fertilizer is available at Rs. 0.5 per kg and the amount required per acre is 100 kgs each for tomatoes and lettuce and 50 kgs for radish. Labour required for sowing, cultivating and harvesting per acre is 5 man days for tomatoes and radish and 6 man days for lettuce. A total of 400 man days of labour are available at Rs. 20 per man day. Formulate this problem as a LPP to maximize the farmer's total profit. | 9 | L3 | CO1 | PO2 |

Contd... 2

b. Old machines can be brought at Rs. 2 lakhs each and new machines at Rs. 5 lakhs each. The old machines produce 3 components/week while the new machines produce 5 components/week, each component being worth Rs. 30,000. A machine (New or old) costs Rs. 1 lakh/week to maintain. The company has only Rs. 80 lakhs to spend on machines. How many of each kind should the company buy to get a profit of more than Rs. 6 lakhs/week? Assume that the company cannot house more than 20 machines. Formulate this as a linear programming problem and solve it by graphical method. — 9 — L3 — CO1 — PO2

c. The XYZ company has been a producer of electronic circuits for Television sets and certain printed circuit boards for radios. The company has decided to expand into full scale production and marketing of AM and AM-FM radios. It has built a new plant than can operate 48 hours per week. Production of an AM radio in the new plant will require 2 hours and production of AM-FM radio will require 3 hours. Each AM radio will contribute Rs. 40 to profit, while an AM-FM radio will contribute Rs. 80 to profits. The marketing department after extensive research has determined that a maximum of 15 AM radios and 10 AM-FM radios can be sold each week. Formulate a LP model to determine the optimal production mix of AM and AM-FM radios that will maximize profits and solve the problem using Graphical method. — 9 — L3 — CO1 — PO2

## UNIT - II — 18

2 a. Solve by using simplex method; — 9 — L3 — CO2 — PO2

$$\text{Min } Z = 2x_1 + 3x_2$$
$$\text{stc} \quad 2x_1 + x_2 \le 12$$
$$x_1 + 3x_2 \le 15$$
$$x_1, x_2 \ge 0$$

b. Solve by using Big-M method — 9 — L3 — CO2 — PO2

$$\text{Min } Z = 2x_1 + x_2$$
$$\text{stc} \quad 3x_1 + x_2 = 3$$
$$4x_1 + 3x_2 \ge 6$$
$$x_1, x_2 \le 4$$

c. Give the dual of the following LPP — 9 — L3 — CO2 — PO2

$$\text{Min } Z = 2x_1 + 3x_2 + 4x_3$$
$$\text{stc} \quad 2x_1 + 3x_2 + 5x_3 \ge 2$$
$$3x_1 + x_2 + 7x_3 = 3$$
$$x_1 + 4x_2 + 6x_3 \le 5$$
$$x_1, x_2 \ge 0 \text{ and } x_3 \text{ is unrestricted.}$$

Contd... 3

**UNIT - III** **18**

3 a. Solve the following transportation problem by using Northwest corner method and optimize using UV (MODI) Method.

| | D1 | D2 | D3 | D4 | Supply |
|---|---|---|---|---|---|
| S1 | 3 | 1 | 7 | 4 | 250 |
| S2 | 2 | 6 | 5 | 9 | 350 |
| S3 | 8 | 3 | 3 | 2 | 400 |
| Demand | 200 | 300 | 350 | 150 | |

9 L3 CO3 PO2

b. A small machine shop has five jobs to be assigned to five operators. The following matrix indicates the processing time of each of the five jobs by each of the five operators. Obtain the optimum assignment of jobs to operators in order to minimize the total processing time.

| | O1 | O2 | O3 | O4 | O5 |
|---|---|---|---|---|---|
| J1 | 9 | 11 | 14 | 11 | 7 |
| J2 | 6 | 15 | 13 | 13 | 10 |
| J3 | 12 | 13 | 6 | 8 | 8 |
| J4 | 11 | 9 | 10 | 12 | 9 |
| J5 | 7 | 12 | 14 | 10 | 14 |

9 L3 CO3 PO2

c. A Travelling Salesman has planned to visit 4 cities .He would like to start from a particular city, visit each city only once and return to the starting city. The travelling cost in rupees is given in the table below. Find the least cost route.

| | | To city | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| From City | A | 0 | 25 | 75 | 45 |
| | B | 35 | 0 | 150 | 25 |
| | C | 35 | 40 | 0 | 15 |
| | D | 65 | 75 | 130 | 0 |

9 L3 CO3 PO9

**UNIT - IV** **18**

4 a. The cost of a machine is Rs.10.500 and its scrap value is Rs. 500.The maintenance costs found from experience are as follows:

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Maintenance Cost(Rs.) | 300 | 500 | 700 | 1000 | 1400 | 1900 | 2400 | 3000 |

9 L3 CO4 PO2

When should the machine be replaced?

b. A project consists of the activities as given in the table below.
i) Draw the project network and find the critical path and
ii) Find the expected completion time of the project.

| Activity | Immediate predecessor | Time in weeks* | | |
|---|---|---|---|---|
| | | $t_o$ | $t_p$ | $t_l$ |
| A | - | 1 | 7 | 2 |
| B | A | 2 | 7 | 4 |
| C | - | 2 | 8 | 2 |
| D | B, C | 1 | 1 | 1 |
| E | C | 3 | 14 | 5 |
| F | A, B, C | 2 | 8 | 5 |
| G | D | 3 | 15 | 6 |
| H | F,G | 3 | 12 | 7 |

9 L3 CO4 PO2

Contd... 4

c. Consider the data of a project as shown in the following table.

| Activity | Normal Time (weeks | Normal Cost (Rs.) | Crash Time (Weeks) | Crash Cost(Rs.) |
|---|---|---|---|---|
| 1-2 | 7 | 700 | 4 | 850 |
| 1-3 | 5 | 500 | 3 | 700 |
| 1-4 | 8 | 600 | 5 | 1200 |
| 2-5 | 9 | 800 | 7 | 1250 |
| 3-5 | 5 | 700 | 3 | 1000 |
| 3-6 | 6 | 1100 | 5 | 1300 |
| 4-6 | 7 | 1200 | 5 | 1450 |
| 5-7 | 2 | 400 | 1 | 500 |
| 6-7 | 3 | 500 | 2 | 850 |

If the indirect cost per week is Rs 200, find the optimal crashed project completion time.

9 L3 CO4 PO2

**UNIT - V** **18**

5 a. In a municipality hospital patient's arrival are considered to be Poisson with an arrival interval time of 10 mins. The doctors (examination and dispensing) time may be assumed to be Exponential Distribution with an average of 6 mins. Find;

i) What is the chance that a new patient directly sees the doctor?

ii) For what proportion of the time the doctor is busy?

iii) What is the average number of patients in the system?

iv) What is the average waiting time in the system?

9 L3 CO5 PO2

b. Solve the following game graphically.

| A | B | | | | | |
|---|---|---|---|---|---|---|
| | | B1 | B2 | B3 | B4 | B5 |
| | A1 | –4 | 2 | 5 | –6 | 6 |
| | A2 | 3 | –9 | 7 | 4 | 8 |

9 L2 CO5 PO1

c. Two players A and B playing matching coins game in which each player has 4 coins; a 1 Rs., a 2 Rs., a 5 Rs. and a 10 Rs. Each player selects a coin without the knowledge of others choice. If the sum of the coins amount is an odd, player-A wins player-B's coin. If the sum of the coins amount is even, B wins A's coin. Formulate this problem as game theory problem and find the optimal strategies for each player and value of the game.

9 L3 CO5 PO2

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