Dr. O. P. Rahi 16/11/2023

28

19

# National Institute of Technology, Hamirpur

***Department of Mathematics& Scientific Computing***

*B Tech 5th Semester (End Semester) Examination Nov. 16, 2023*

***Subject: Operation Research*** ***Subject code: MA -311*** ***Time: 3 hrs*** ***Max. Marks: 50***

**Note: Attempt all questions.**

**Question 1(a)** Chemical lab uses raw materials I and II to produce two domestic cleaning solutions A and B. The daily availability of raw materials I and II are 50 and 45 units respectively. One unit of solution A consume 1.5 unit of raw material I and 1.6 unit of raw material II and one unit of solution B uses 1.5 unit of raw material I and 1.4 unit of raw material II. The profit/unit of solutions A and B are Rs8/- and Rs10/- respectively. The daily demand for solution A lies between 30 and 150 units, and that for solution B between 40 and 200 units. Formulate and solve the given LPP problem. **(3)**

**(b)** Use fundamental theorem of duality (Write the dual of the following LPP, solve the dual and recover the solution of primal problem from optimal simplex table) to find solution following LPP.

$Min\ Z = 4X + 2Y$

Subject to constraints:

$3X + Y \geq 27,\ \ X - Y \geq 21\ \ X + Y \geq 30, \qquad X, Y \geq 0.$ **(7)**

**Question 2(a)** Five operators $O_1, O_2, O_3, O_4$ and $O_5$ are available to a manager who has to get five jobs done by assigning one job to each operator. Given below the time in hours by different operator for different jobs. How manager should assign the jobs so that total time to complete all the jobs is minimum. **(4)**

| | $J_1$ | $J_2$ | $J_3$ | $J_4$ | $J_5$ |
|---|---|---|---|---|---|
| **$O_1$** | 3 | 1 | 8 | 8 | 2 |
| **$O_2$** | 4 | 2 | 5 | 1 | 3 |
| **$O_3$** | 6 | 5 | 6 | 4 | 3 |
| **$O_4$** | 1 | 3 | 2 | 2 | 4 |
| **$O_5$** | 5 | 1 | 4 | 5 | 6 |

**(b)** Find the optimal solution and minimum cost to the given transportation problem **(6)**

Destinations

| Factories | | 1 | 2 | 3 | 4 | Capacity |
|---|---|---|---|---|---|---|
| | I | 2 | 3 | 22 | 7 | 6 |
| | II | 1 | 0 | 6 | 1 | 1 |
| | III | 5 | 8 | 15 | 9 | 10 |
| | Required | 7 | 5 | 3 | 2 | |

**Question 3(a)** A project has the following times schedule

| Activity | 1-2 | 1-3 | 2-4 | 3-4 | 3-5 | 4-8 | 5-6 | 5-7 | 6-8 | 7-8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Duration | 8 | 3 | 4 | 6 | 8 | 4 | 2 | 5 | 5 | 9 |

Construct the network and compute

i. $T_E$ and $T_L$ for each event
ii. Total Float for each activity
iii. Critical path and its duration **(5)**

**(b)** The time estimates (in weeks) for the activities of PERT network are given below

| Activity→ Times↓ | 1-2 | 2-3 | 2-4 | 3-4 | 3-5 | 3-7 | 4-5 | 4-6 | 5-6 | 5-7 | 6-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $t_o$ | 1 | 1 | 2 | 0 | 2 | 6 | 4 | 3 | 0.5 | 5 | 3 |
| $t_m$ | 2 | 4 | 4 | 0 | 3 | 8 | 6 | 5 | 1 | 7 | 5 |
| $t_p$ | 9 | 7 | 12 | 0 | 4 | 16 | 8 | 7 | 1.5 | 15 | 13 |

(i) Draw network diagram and determine latest and earliest expected times for each event.

(ii) Find critical path and expected duration of the project and standard deviation for this project duration.

(iii) What is the probability that project will be completed in 25 weeks.
Given $P(Z \leq D_i) = 0.86$ **(5)**

**Question 4(a)(i)** Covert the following game problem into LPP for both the players

Player B

| | | I | II | III |
|---|---|---|---|---|
| Player A | I | 2 | 4 | 3 |
| | II | 2 | -3 | -1 |
| | III | 3 | 2 | 2 |

**(ii)** Solve the following game by principle of dominance

Player B

| | | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Player A | 1 | 2 | 4 | 3 | 8 | 4 |
| | 2 | 5 | 6 | 3 | 7 | 8 |
| | 3 | 4 | 7 | 9 | 8 | 7 |
| | 4 | 4 | 2 | 8 | 4 | 3 |

**(3, 3)**

**(4)**

**(b)** Solve the following game by graphical method:

Player B

| | | I | II | |
|---|---|---|---|---|
| Player A | I | 1 | 4 | 8 |
| | II | 8 | 4 | 2 |

**Question 5**(a) A production manager is faced with the problem of job allocation to his two production teams. The production rate of Team 1 is 5 units per hour, while the production rate of Team 2 is 8 units per hour. The normal working hours for each of the teams is 50 hours per week. The production manager has prioritized the following goals for the coming week:

$P_1$ = Avoid underachievement of the desired production level of 500 units.

$P_2$ = Overtime operation of Team 1 is limited to 4 hours.

$P_3$ = The total overtime for both teams should be minimized.

$P_4$ = Any underutilization of regular working hours

Formulate Goal programming and solve it by graphical method. **(5+5)**