Assignment Problem

TD6

1 Minimization Problems

1.1 Problem 1: Production Line Assignment

A manufacturing company needs to assign 4 workers to 4 production lines. The time (in hours) each worker takes on each line is given below. **Minimize the total time.**

Worker	Line 1	Line 2	Line 3	Line 4
A	12	8	16	10
B	15	10	14	11
C	9	13	12	8
D	14	11	9	12

Find the optimal assignment and minimum total time.

1.2 Problem 2: Delivery Route Assignment

A courier company has 4 drivers and 4 delivery zones. The delivery time (in minutes) for each driver-zone combination is shown below. **Minimize total delivery time.**

Driver	Zone A	Zone B	Zone C	Zone D
1	25	30	20	28
2	22	24	28	25
3	28	26	22	30
4	24	22	26	23

Determine the optimal assignment and minimum total delivery time.

1.3 Problem 3: Machine-Job Assignment

Four machines need to be assigned to four jobs. The processing cost (in $) for each machine-job combination is given below. **Minimize the total cost.**

Machine	Job 1	Job 2	Job 3	Job 4
M1	40	35	50	45
M2	38	42	40	48
M3	50	45	38	42
M4	45	40	46	40

Find the optimal assignment and minimum total cost.

1.4 Problem 4: Maintenance Crew Assignment

A facility manager needs to assign 4 maintenance crews to 4 buildings. The estimated completion time (in days) for each crew-building combination is:

Crew	Building 1	Building 2	Building 3	Building 4
Alpha	6	8	5	7
Beta	7	6	9	8
Gamma	8	7	6	5
Delta	5	9	7	6

Minimize the total completion time. Find the optimal assignment.

2 Maximization Problems

2.1 Problem 5: Sales Territory Assignment

A company wants to assign 4 salespeople to 4 territories. The expected monthly revenue (in $1000s) is shown below. **Maximize the total revenue.**

Salesperson	Territory 1	Territory 2	Territory 3	Territory 4
Alice	45	52	48	50
Bob	50	48	55	46
Carol	48	55	50	52
Dave	52	50	46	55

Find the optimal assignment and maximum total revenue.

2.2 Problem 6: Project Profit Assignment

Four teams need to be assigned to four projects. The expected profit (in $10,000s) for each team-project combination is:

Team	Project A	Project B	Project C	Project D
Team 1	30	35	28	32
Team 2	32	30	35	30
Team 3	28	32	30	35
Team 4	35	28	32	28

Maximize total profit. Determine the optimal assignment.

3 Unbalanced Problems

3.1 Problem 7: Unbalanced Worker-Job (More Workers)

A company has **5 workers** but only **4 jobs**. The cost (in $) of assigning each worker to each job is shown below. **Minimize the total cost.**

Worker	Job 1	Job 2	Job 3	Job 4
W1	18	22	16	20
W2	20	18	24	19
W3	22	20	18	22
W4	19	24	20	18
W5	24	19	22	21

Hint: Add a dummy job with zero costs. Find which worker remains unassigned.

3.2 Problem 8: Unbalanced Machine-Task (More Tasks)

There are **4 machines** but **5 tasks** to complete. The processing time (in hours) is given below. **Minimize total time.**

Machine	Task 1	Task 2	Task 3	Task 4	Task 5
M1	14	16	12	18	15
M2	16	14	18	15	17
M3	18	15	16	14	16
M4	15	18	14	16	14

Hint: Add a dummy machine with zero costs. Identify which task is not assigned.

4 Problems with Restrictions

4.1 Problem 9: Prohibited Assignments

Assign 4 technicians to 4 repair jobs. Some assignments are **not allowed** due to skill limitations. The time (in hours) is shown below, with "—" indicating prohibited assignments. **Minimize total time.**

Technician	Job 1	Job 2	Job 3	Job 4
T1	15	18	—	20
T2	20	15	22	18
T3	—	22	18	16
T4	18	20	16	—

Hint: Use a large cost $M = 999$ for prohibited cells.

4.2 Problem 10: Multiple Prohibited Assignments

Four employees are to be assigned to four departments. Due to conflicts of interest, certain assignments are **prohibited** (marked with X). The effectiveness score (higher is better) is shown. **Maximize total effectiveness.**

Employee	Dept. A	Dept. B	Dept. C	Dept. D
E1	85	X	78	82
E2	80	88	85	X
E3	X	82	80	86
E4	88	84	X	80

Hint: Convert to minimization first, then use $M = 999$ for prohibited cells.

5 Mixed Complexity Problems

5.1 Problem 11: Equipment Allocation

A construction company needs to assign 4 equipment units to 4 project sites. The transportation and setup cost (in $100s) is:

Equipment	Site 1	Site 2	Site 3	Site 4
Excavator	8	12	10	14
Crane	10	8	14	12
Bulldozer	12	14	8	10
Loader	14	10	12	8

Minimize total transportation and setup cost. Find optimal assignment.

5.2 Problem 12: Nurse Shift Assignment

Four nurses need to be assigned to four hospital shifts. The preference rating (1-10 scale, higher is better) is shown. **Maximize total preference rating.**

Nurse	Morning	Afternoon	Evening	Night
Nurse A	9	7	6	5
Nurse B	6	9	8	7
Nurse C	7	6	9	8
Nurse D	5	8	7	9

Determine the optimal assignment that maximizes total preference.

5.3 Problem 13: Taxi Dispatch

Four taxis are at different locations and need to pick up four passengers. The distance (in km) from each taxi to each passenger is:

Taxi	Passenger 1	Passenger 2	Passenger 3	Passenger 4
Taxi 1	2.5	4.2	3.8	5.1
Taxi 2	4.0	2.8	5.2	3.5
Taxi 3	3.6	5.0	2.6	4.3
Taxi 4	5.2	3.4	4.5	2.9

Minimize total distance traveled. Find the optimal taxi-passenger assignment.

5.4 Problem 14: Course-Instructor Assignment

Four instructors need to be assigned to four courses. The teaching load score (in hours per week) is shown. **Minimize total teaching load.**

Instructor	OR	Statistics	Calculus	Algebra
Prof. Kim	10	12	14	11
Prof. Lee	12	10	11	13
Prof. Park	14	11	10	12
Prof. Chen	11	13	12	10

Find the optimal course assignment that minimizes total teaching load.

5.5 Problem 15: Research Team Assignment

Four research teams are to be assigned to four innovation projects. The expected breakthrough score (0-100, higher is better) based on team expertise is:

Team	AI Project	Biotech	Robotics	Nanotech
Team Alpha	85	72	78	80
Team Beta	75	85	82	70
Team Gamma	80	78	85	75
Team Delta	70	80	75	85

Maximize total breakthrough score. Determine the optimal team-project assignment.