Networks, scheduling and assignment - Test 6

Name: _____ Date: _____

10 questions | 60 marks | 75 minutes

A more demanding applications paper combining network sensitivity, resource assumptions and assignment-model choices.

A scientific calculator may be used.

1. Use the school-garden installation project. [6 marks]

Installing a school garden; durations are in days.

Activity	Duration	Immediate predecessors
A	3	None
B	5	None
C	4	A
D	2	A
E	3	B and C
F	6	D
G	2	E and F

(a) Complete the earliest activity schedule. [4 marks]

(b) Find the critical path and minimum completion. [2 marks]

2. Use the garden project with completion at day 13. [7 marks]

Installing a school garden; durations are in days.

Activity	Duration	Immediate predecessors
A	3	None
B	5	None
C	4	A
D	2	A
E	3	B and C
F	6	D
G	2	E and F

(a) Calculate the latest start and float for B, C, E. [4 marks]

(b) C and E are each extended by 1 day. Find the new completion and explain why adding their original floats is misleading. [3 marks]

3. In the garden project, replace B's duration by $x \geq 0$ days. [5 marks]

Installing a school garden; durations are in days.

Activity	Duration	Immediate predecessors
A	3	None
B	5	None
C	4	A
D	2	A
E	3	B and C
F	6	D
G	2	E and F

(a) Show that the project completion is $T = \max(13, x + 5)$. [3 marks]

(b) Find the largest x that preserves the original finish; then find T when $x = 9$. [2 marks]

4. Possible garden time reductions are assessed using the original table. [6 marks]

Installing a school garden; durations are in days.

Activity	Duration	Immediate predecessors
A	3	None
B	5	None
C	4	A
D	2	A
E	3	B and C
F	6	D
G	2	E and F

(a) Reduce F from 6 to 4 days. Find the new completion and critical route. [3 marks]

(b) Make that reduction and also reduce C from 4 to 3 days. Find the finish and all critical routes. [3 marks]

5. For this garden project, A and B need the same single excavator. Other activities have independent resources. [6 marks]

Installing a school garden; durations are in days.

Activity	Duration	Immediate predecessors
A	3	None
B	5	None
C	4	A
D	2	A
E	3	B and C
F	6	D
G	2	E and F

(a) Schedule A before B and find the earliest completion. [3 marks]

(b) Schedule B before A and compare. [3 marks]

6. The four-worker assignment costs are shown. A training payment of $1 is added only to the selected job of worker B, regardless of which job B receives. [5 marks]

Assignment costs ($). Each worker does one job.

Worker	1	2	3	4
A	8	3	7	6
B	5	9	4	8
C	6	7	2	5
D	7	4	8	3

(a) Find the new optimum assignment and total. [3 marks]

(b) A colleague instead adds $1 to all four selected entries. Explain the numerical difference. [2 marks]

7. Two workers must each take one different job. The time table is A:$[1, 6]$ and B:$[6, 10]$, in hours. Work starts simultaneously. [5 marks]

(a) Find the assignment minimising total worker-hours. [2 marks]

(b) Find the assignment minimising the time when both jobs are finished. [2 marks]

(c) Explain which assignment the ordinary sum-cost Hungarian model chooses. [1 mark]

8. The team profits are in $1,000 units. TeamB cannot take contract 1. [6 marks]

Contract profit in $1,000 units.

Team	1	2	3	4
A	14	18	12	11
B	16	13	15	12
C	10	16	14	17
D	15	11	18	14

(a) Give the best remaining allocation and total profit. [4 marks]

(b) An outside specialist could take contract 1 for a net profit of $15,500, with the other three teams free to cover three remaining contracts. Explain why this is not automatically comparable with the four-team table. [2 marks]

9. For the two-worker/three-job cost table below, omission penalties are permitted. [8 marks]

Costs ($), including a permitted unfilled-job penalty row.

Resource	1	2	3
A	6	4	8
B	5	7	3
Unfilled	10	2	7

(a) Find the minimum total including penalties. [3 marks]

(b) The client now makes job 2 compulsory but permits either job 1 or job 3 to remain unfilled at its original penalty. Find the new optimum. [4 marks]

(c) State what changed in the recommendation. [1 mark]

10. A final report states: 'Our project will certainly finish in 13 days, and the assignment algorithm guarantees the cheapest real-world outcome.' [6 marks]

(a) Rewrite the project conclusion accurately. [2 marks]

(b) Rewrite the assignment conclusion accurately. [2 marks]

(c) Give one targeted check for each model. [2 marks]