Decision Mathematics 1

Edexcel IAL D1 (WDM01/01); the discrete option completing the IAL Mathematics unit table

1. Unit D1 at a glance

Unit D1 at a glance

WDM01/01: 1 hour 30 minutes, 75 marks. No booklet entries beyond the basics — the marks are for executing algorithms precisely and stating results in the required form (list after every pass, pivot at each partition, placements item by item).

2. Sorting and packing

Sorting and packing

Bubble sort: list after every pass, stop after a clean pass. Quick sort: pivot = the middle item (glossary method); partition keeping order. Bin packing: first-fit, first-fit decreasing (sort first), full-bin. First-fit on capacity 10 with items 7, 5, 4, 3, 6, 2 gives bins (7,3), (5,4), (6,2).

3. Minimum spanning trees

Minimum spanning trees

Kruskal: edges in weight order, reject cycles. Prim: grow from a start vertex by the cheapest new edge; the matrix form crosses out rows and rings cheapest column entries. On edges AB 4, AC 2, BC 1, BD 5, CD 8 both give BC + AC + BD = 8.

4. Shortest paths

Dijkstra

Dijkstra: start label 0; repeatedly make the smallest temporary label permanent and update neighbours (new = permanent + weight if smaller). Labels become permanent in increasing order; recover the route by tracing back. On that same network Dijkstra gives A–C–B–D of length 8 from A to D.

5. The Chinese postman problem

Route inspection

Walk every EDGE at least once, closed: total = all edges + the least-weight pairing of the odd nodes (at most four), using shortest paths where no direct edge exists. On edges AB 4, AC 2, BC 3, BD 5, CD 1 (total 15) the odd nodes B and C pair for 3: route length 18.

6. The travelling salesman problem

Travelling salesman

Tour every VERTEX once on a complete graph with the triangle inequality. Upper bounds: nearest neighbour tour, or the doubled MST improved by shortcuts. Lower bounds: the MST, or delete a vertex (MST of the rest + its two cheapest edges). On the 4-city example the optimal tour sits in [14, 17].

7. Critical path analysis

Critical paths

Precedence table to activity-on-arc network; dummies carry dependencies. Forward pass takes maxima (earliest event times), backward pass minima (latest). Float = latest finish − earliest start − duration; critical activities float zero. The example A(3), B(4), C(4), D(1), E(5) has critical path A–C–E = 12 days and D floats 2; Gantt bars run from earliest starts.

8. Linear programming

Linear programming

Variables with units, objective, EVERY constraint including non-negativity. Solve graphically: shade the feasible region, slide the ruler or test the vertices. Maximise $3x + 2y$ on $x + y \leq 10$, $2x + y \leq 14$: vertices give 0, 21, 24, 20 — max 24 at $(4, 6)$; integer answers checked at neighbouring lattice points.

Check yourself

Check yourself

Bubble and quick sorts pass by pass; first-fit, decreasing and full-bin placements; Kruskal and Prim (matrix form too); Dijkstra with permanence order and route recovery; odd-node pairings for the postman; TSP bounds both sides with nearest neighbour; dummies, forward and backward passes, floats, Gantt charts; LP formulation and vertex solutions with integer checks.