Paper Reference 8FM0–27
Pearson Edexcel Level 3 GCE

Further Mathematics
Advanced Subsidiary
Further Mathematics options
27: Decision Mathematics 1
(Part of options D, F, H and K)

Thursday 17 May 2018 – Afternoon

YOU MUST HAVE:
Mathematical Formulae and Statistical Tables, calculator.

ITEMS INCLUDED WITH QUESTION PAPER
Answer Book
Diagram Book

V60208A

Pearson

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

INSTRUCTIONS

In the boxes on the Answer Book and on the Diagram Book, write your name, centre number and candidate number.

Answer ALL the questions and ensure that your answers to parts of questions are clearly labelled.

Answer the questions in the Answer Book or on the separate diagrams – there may be more space than you need.

Do NOT write on this Question Paper.

You should show sufficient working to make your methods clear. Answers without working may not gain full credit.

Answers should be given to three significant figures unless otherwise stated.

INFORMATION

A booklet 'Mathematical Formulae and Statistical Tables' is provided.

The total mark for this part of the examination is 40
There are 4 questions.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions.

Write your answers in the Answer Book or on the separate diagrams provided.

1. Refer to Diagram 1 and Diagram 2 in the Diagram Book.

Diagram 1 represents a network of roads.

The number on each arc represents the time taken, in minutes, to drive along the corresponding road.

(a) (i) Use Dijkstra's algorithm to find the shortest time needed to travel from A to H

(ii) State the quickest route.

(6 marks)

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1. continued.

For a network with n vertices, Dijkstra's algorithm has order n^2

(b) If it takes $1 \cdot 5$ seconds to run the algorithm when $n = 250$, calculate approximately how long it will take, in seconds, to run the algorithm when $n = 9500$

You should make your method and working clear.

(2 marks)

(c) Explain why your answer to part (b) is only an approximation.

(1 mark)

(Total for Question 1 is 9 marks)

2. A simply connected graph is a connected graph in which any two vertices are directly connected by at most one arc and no vertex is directly connected to itself.

(a) Given that a simply connected graph has exactly four vertices,

(i) write down the minimum number of arcs it can have,

(ii) write down the maximum number of arcs it can have.

(2 marks)

(continued on the next page)

2. continued.

(b) (i) Draw a simply connected graph that has exactly four vertices and exactly five arcs.

(ii) State, with justification, whether your graph is Eulerian, semi–Eulerian or neither.

(3 marks)

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2. continued.

(c) By considering the orders of the vertices, explain why there is only one simply connected graph with exactly four vertices and exactly five arcs.

(5 marks)

(Total for Question 2 is 10 marks)

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3. Refer to Table 1, Diagram 3 and Diagram 4 in the Diagram Book.

Table 1 shows the activities required for the completion of a building project.

For each activity, the table shows the time it takes, in days, and the immediately preceding activities. Each activity requires one worker. The project is to be completed in the shortest possible time.

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3. continued.

Diagram 3 shows a partially completed activity network used to model the project.

The activities are represented by the arcs and the number in brackets on each arc is the time taken, in days, to complete the corresponding activity.

(a) Add the missing activities and necessary dummies to Diagram 4 in the Diagram Book.

(3 marks)

(continued on the next page)

3. continued.

(b) Complete Diagram 4 in the Diagram Book to show the early event times and the late event times.

(3 marks)

(c) State the critical activities.

(1 mark)

(continued on the next page)

3. continued.

At the beginning of the project it is decided that activity **G** is no longer required.

(d) Explain what effect, if any, this will have on

(i) the shortest completion time of the project if activity **G** is no longer required,

(ii) the timing of the remaining activities.

(3 marks)

(Total for Question 3 is 10 marks)

4. Refer to Diagram 5 in the Diagram Book.

The manager of a factory is planning the production schedule for the next three weeks for a range of cabinets.

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4. continued.

The following constraints apply to the production schedule.

- The total number of cabinets produced in week 3 cannot be fewer than the total number produced in weeks 1 and 2
- At most twice as many cabinets must be produced in week 3 as in week 2
- The number of cabinets produced in weeks 2 and 3 must, in total, be at most 125

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4. continued.

The production cost for each cabinet produced in weeks 1, 2 and 3 is £250, £275 and £200 respectively.

The factory manager decides to formulate a linear programming problem to find a production schedule that minimises the total cost of production.

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4. continued.

The objective is to minimise

$$250x + 275y + 200z$$

(a) Explain what the variables x, y and z represent.

(1 mark)

(b) Write down the constraints of the linear programming problem in terms of x, y and z

(2 marks)

(continued on the next page)

4. continued.

Due to demand, exactly 150 cabinets must be produced during these three weeks.

This reduces the constraints to

$x + y \leq 75$

$x + 3y \geq 150$

$x \geq 25$

$y \geq 0$

which are shown in Diagram 5 in the Diagram Book.

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4. continued.

Given that the manager does not want any cabinets left unfinished at the end of a week,

(c) (i) use a graphical approach to solve the linear programming problem and hence determine the production schedule which minimises the cost of production.

You should make your method and working clear.

(ii) Find the minimum total cost of the production schedule.

(8 marks)

(Total for Question 4 is 11 marks)

TOTAL FOR DECISION MATHEMATICS 1

IS 40 MARKS

END OF PAPER