Paper Reference(s)

6689/01

Edexcel GCE

Decision Mathematics D1

Advanced/Advanced Subsidiary

Wednesday 18 January 2006 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Nil	D1 Answer book

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates must NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.

Instructions to Candidates

Write your answers for this paper in the D1 answer book provided.
In the boxes on the answer book, write your centre number, candidate number, your surname, initials and signature.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**
There are 6 questions in this question paper. The total mark for this question paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

Write your answers in the D1 answer booklet for this paper.

1.

Figure 1

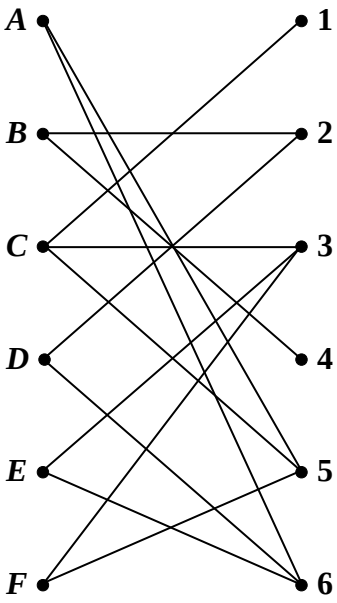
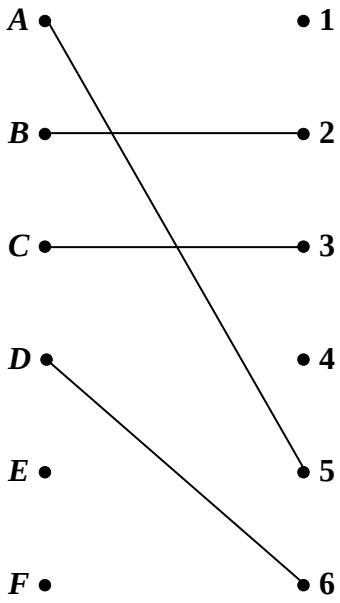


Figure 2



A taxi firm has six taxis *A*, *B*, *C*, *D*, *E* and *F*, available for six journeys, 1, 2, 3, 4, 5 and 6, which are booked for 9 a.m. tomorrow.

The bipartite graph shown in Figure 1 shows the possible matchings.

Initially *A*, *B*, *C* and *D* are matched to 5, 2, 3 and 6 respectively, as indicated in Figure 2.

(*a*) Explain why it is necessary to perform the maximum matching algorithm twice in order to try to obtain a complete matching.

(1)

(*b*) Use the maximum matching algorithm twice to obtain a complete matching. List clearly the alternating paths you use.

(6)

2.

	A	*B*	*C*	*D*	*E*	*F*	*G*
A	–	48	117	92	–	–	–
B	48	–	–	–	–	63	55
C	117	–	–	28	–	–	85
D	92	–	28	–	58	132	–
E	–	–	–	58	–	124	–
F	–	63	–	132	124	–	–
G	–	55	85	–	–	–	–

The table shows the lengths, in metres, of the paths between seven vertices *A*, *B*, *C*, *D*, *E*, *F* and *G* in a network N.

(*a*) Use Prim's algorithm, starting at *A*, to solve the minimum connector problem for this table of distances. You must clearly state the order in which you selected the edges of your tree, and the weight of your final tree. Draw your tree using the vertices given in Diagram 1 in the answer book.

(5)

(*b*) Draw N using the vertices given in Diagram 2 in the answer book.

(3)

(*c*) Solve the Route Inspection problem for N. You must make your method of working clear. State a shortest route and find its length. (The weight of N is 802.)

(7)

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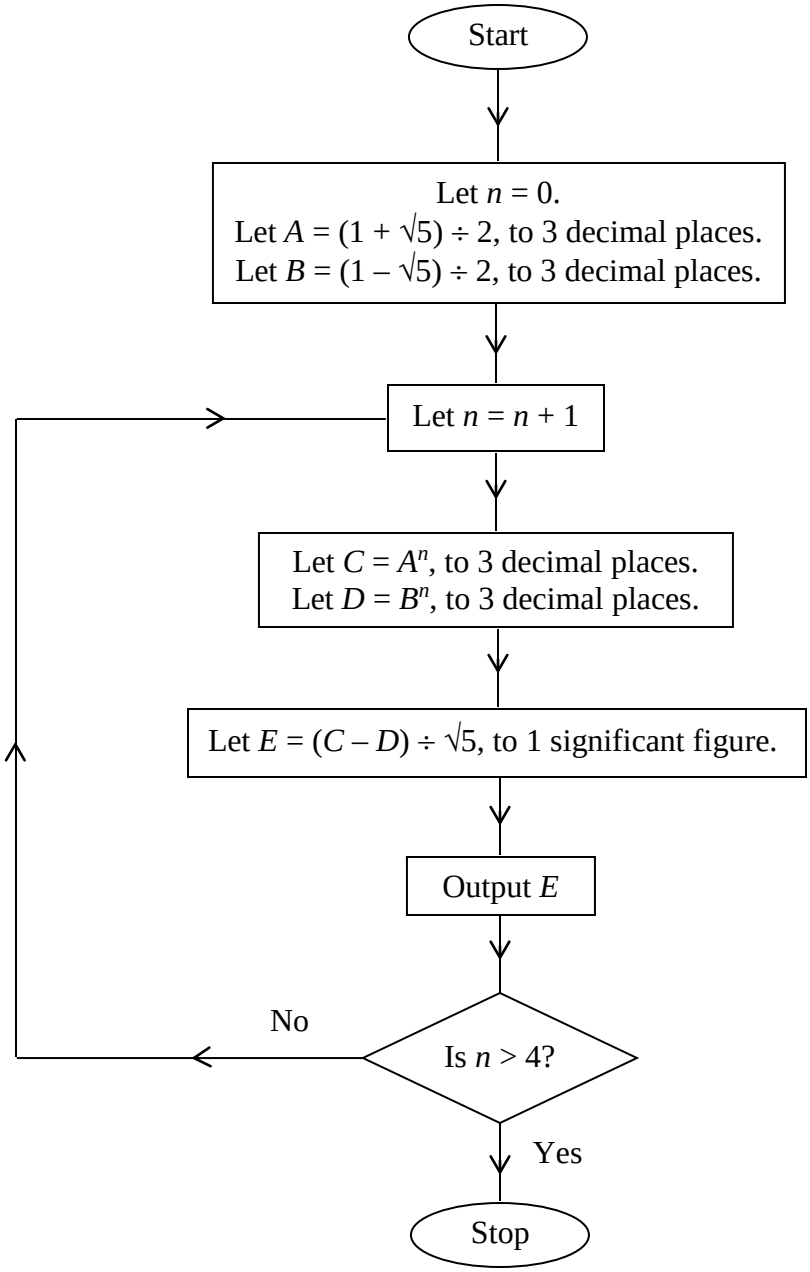
3. **Figure 3**



An algorithm is described by the flow chart shown in Figure 3.

(*a*) Complete the table in the answer book recording the results of each step as the algorithm is applied.

(Notice that values of A, B, C and D are to be given to 3 decimal places, and the values of E to 1 significant figure.)

(8)

(*b*) Write down the output from the algorithm.

(1)

4. (*a*) Define the terms

(i) cut,

(ii) minimum cut,

as applied to a directed network flow.

(2)

Figure 4

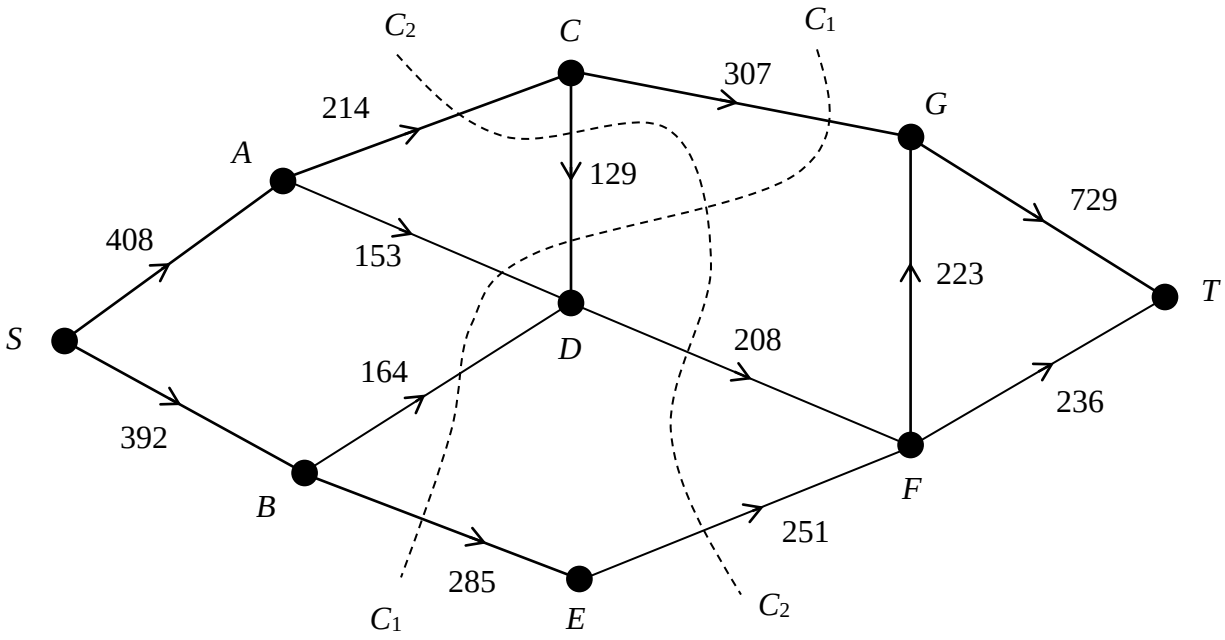


Figure 4 shows a capacitated directed network and two cuts C_1 and C_2. The number on each arc is its capacity.

(*b*) State the values of the cuts C_1 and C_2.

(3)

Given that one of these two cuts is a minimum cut,

(*c*) find a maximum flow pattern by inspection, and show it on the diagram in the answer book.

(3)

(*d*) Find a second minimum cut for this network.

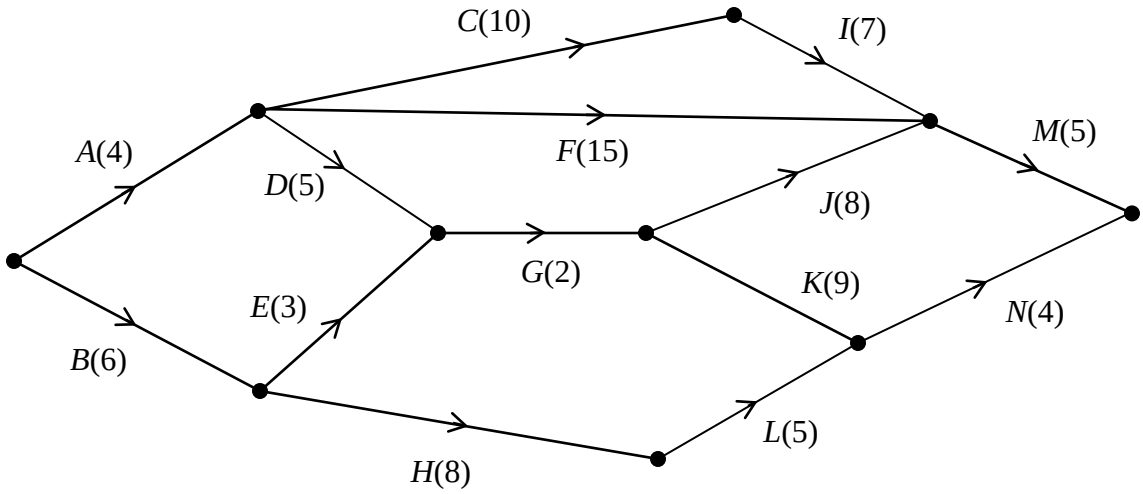
(1)

In order to increase the flow through the network it is decided to add an arc of capacity 100 joining *D* **either** to *E* **or** to *G*.

(*e*) State, with a reason, which of these arcs should be added, and the value of the increased flow.

(2)

5. **Figure 5**



The network in Figure 5 shows the activities involved in a process. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, taken to complete the activity.

(*a*) Calculate the early time and late time for each event, showing them on the diagram in the answer book.

(4)

(*b*) Determine the critical activities and the length of the critical path.

(2)

(*c*) On the grid in the answer book, draw a cascade (Gantt) chart for the process.

(4)

Each activity requires only one worker, and workers may not share an activity.

(*d*) Use your cascade chart to determine the minimum numbers of workers required to complete the process in the minimum time. Explain your reasoning clearly.

(2)

(*e*) Schedule the activities, using the number of workers you found in part (*d*), so that the process is completed in the shortest time.

(3)

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6. A company produces two types of party bag, Infant and Junior. Both types of bag contain a balloon, a toy and a whistle. In addition the Infant bag contains 3 sweets and 3 stickers and the Junior bag contains 10 sweets and 2 stickers.

The sweets and stickers are produced in the company's factory. The factory can produce up to 3000 sweets per hour and 1200 stickers per hour. The company buys a large supply of balloons, toys and whistles.

Market research indicates that at least twice as many Infant bags as Junior bags should be produced.

Both types of party bag are sold at a profit of 15p per bag. All the bags are sold. The company wishes to maximise its profit.

Let x be the number of Infant bags produced and y be the number of Junior bags produced per hour.

(*a*) Formulate the above situation as a linear programming problem.

(5)

(*b*) Represent your inequalities graphically, indicating clearly the feasible region.

(6)

(*c*) Find the number of Infant bags and Junior bags that should be produced each hour and the maximum hourly profit. Make your method clear.

(3)

In order to increase the profit further, the company decides to buy additional equipment. It can buy equipment to increase the production of **either** sweets **or** stickers, but **not both**.

(*d*) Using your graph, explain which equipment should be bought, giving your reasoning.

(2)

The manager of the company does not understand why the balloons, toys and whistles have not been considered in the above calculations.

(*e*) Explain briefly why they do not need to be considered.

(2)

TOTAL FOR PAPER: 75 MARKS

END