OXFORD CAMBRIDGE AND RSA EXAMINATIONS

# AS GCE
# 4771/01
# MATHEMATICS (MEI)
## Decision Mathematics 1
## QUESTION PAPER

**WEDNESDAY 13 JUNE 2018: Morning**

**DURATION: 1 hour 30 minutes**
**plus your additional time allowance**

**MODIFIED ENLARGED 24pt**

**Candidates answer on the Printed Answer Book.**

**OCR SUPPLIED MATERIALS:**
**Printed Answer Book 4771/01**
**MEI Examination Formulae and Tables (MF2) sent with the standard paper.**

**OTHER MATERIALS REQUIRED:**
**Scientific or graphical calculator**

**READ INSTRUCTIONS OVERLEAF**

DC (NF/TP) 167300


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## INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.

WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED IN THE PRINTED ANSWER BOOK. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

Use black ink. HB pencil may be used for graphs and diagrams only.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Answer ALL the questions.

You are permitted to use a scientific or graphical calculator in this paper.

Final answers should be given to a degree of accuracy appropriate to the context.

## INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

The number of marks is given in brackets [ ] at the end of each question or part question on the Question Paper.

You are advised that an answer may receive NO MARKS unless you show sufficient detail of the working to indicate that a correct method is being used.

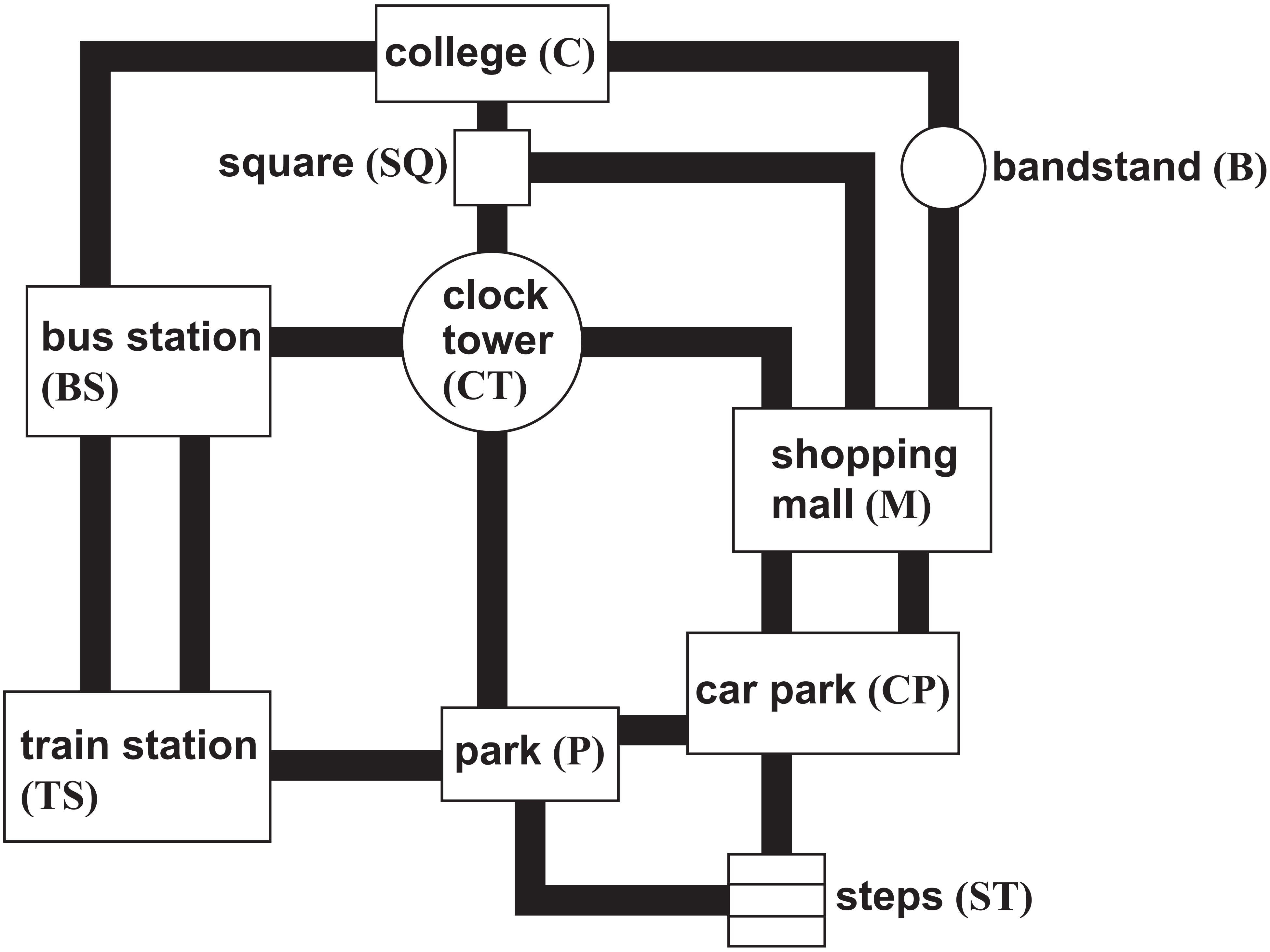
The total number of marks for this paper is 72.

## INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

**Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.**

## SECTION A (24 marks)

1 The diagram represents part of the centre of a town. Roads are shaded black.




(i) Draw a graph to represent this diagram. [2]

A council cleaning team is to clean along each road.

(ii) Explain why it is not possible for the team to clean along each road without passing twice along at least one of the roads. [2]

You are to obtain a route for the team which repeats just one road.

**(iii)** State the road which will be repeated in your route. [1]

**(iv)** Give a starting vertex and a finishing vertex for your route. [1]

**(v)** Give your route. [2]

2 (a) Six parcels, A to F, with weights given in the table are to be packed into crates. Each crate has a capacity of 10 kg.

| Parcel | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Weight (kg) | 1 | 6 | 4 | 2 | 3 | 4 |

(i) Use the first-fit algorithm to pack the parcels, saying how many crates are used. [3]

(ii) Give an optimal solution. [1]

(b) In the first pass of a bubble sort the first item is compared to the second item and they are swapped if they are in the incorrect order, then the second is compared with the third and they are swapped if necessary, and so on until the penultimate is compared to the last and they are swapped if necessary. In the second pass the process is repeated, but without the need to compare the last two items, and similarly for subsequent passes. In the final pass, only the two items in the first two positions are compared and swapped if necessary.

In a sale, a coat costs £78, a pair of gloves cost £26, a hat costs £35 and a scarf costs £12.

(i) Use a bubble sort to rearrange the items from the order given into increasing order of price. Show the list of costs after each pass of the algorithm. [2]

(ii) How many comparisons and how many swaps were made in answering part (i)? [2]

3 (a) Alice is playing Snakes and Ladders with a fair, 6-sided dice numbered 1 to 6. To get started she has to throw a 6. You are to simulate, ten times, how many throws it takes for her to get a 6.

(i) Give a rule for using one-digit random numbers to simulate throwing a six-sided dice. [1]

(ii) Use your rule with the 10 sets of one-digit random numbers given in the Printed Answer Book to complete 10 simulations of Alice repeatedly throwing the dice until she gets a 6. [3]

(iii) Use your simulations to estimate the mean number of throws needed to get a 6. [1]

(b) (i) Give a most efficient rule for using two-digit random numbers to simulate throwing a six-sided dice. [1]

(ii) Explain why it is more efficient to use two-digit random numbers than to use one-digit random numbers to simulate throwing a dice. [1]

(iii) Give a disadvantage of using two-digit random numbers compared to using one-digit random numbers. [1]

## SECTION B (48 marks)

4 A meal is to be prepared and eaten. There will be two courses, meat pie with vegetables, followed by apple crumble with custard. The activities involved and their durations and precedences are shown in the table.

| Activity | Duration (mins) | Immediate predecessors |
|---|---|---|
| A Prepare the vegetables | 10 | – |
| B Defrost the meat pie | 5 | – |
| C Make the apple crumble | 15 | – |
| D Prepare the custard | 5 | – |
| E Heat the oven | 10 | – |
| F Heat the meat pie | 20 | B, E |
| G Cook the vegetables | 15 | A |
| H Cook the apple crumble | 15 | C, E |
| I Heat the custard | 5 | D |
| J Eat the first course | 15 | F, G |
| K Eat the second course | 15 | H, I, J |

(i) Draw an activity-on-arc precedence network for preparing and eating the meal. [5]

(ii) Complete a forward pass and a backward pass to determine the minimum completion time and the critical activities. [6]

The meal is to be prepared and eaten by two people.

Activities A, B, C and D each require one person and cannot be split.

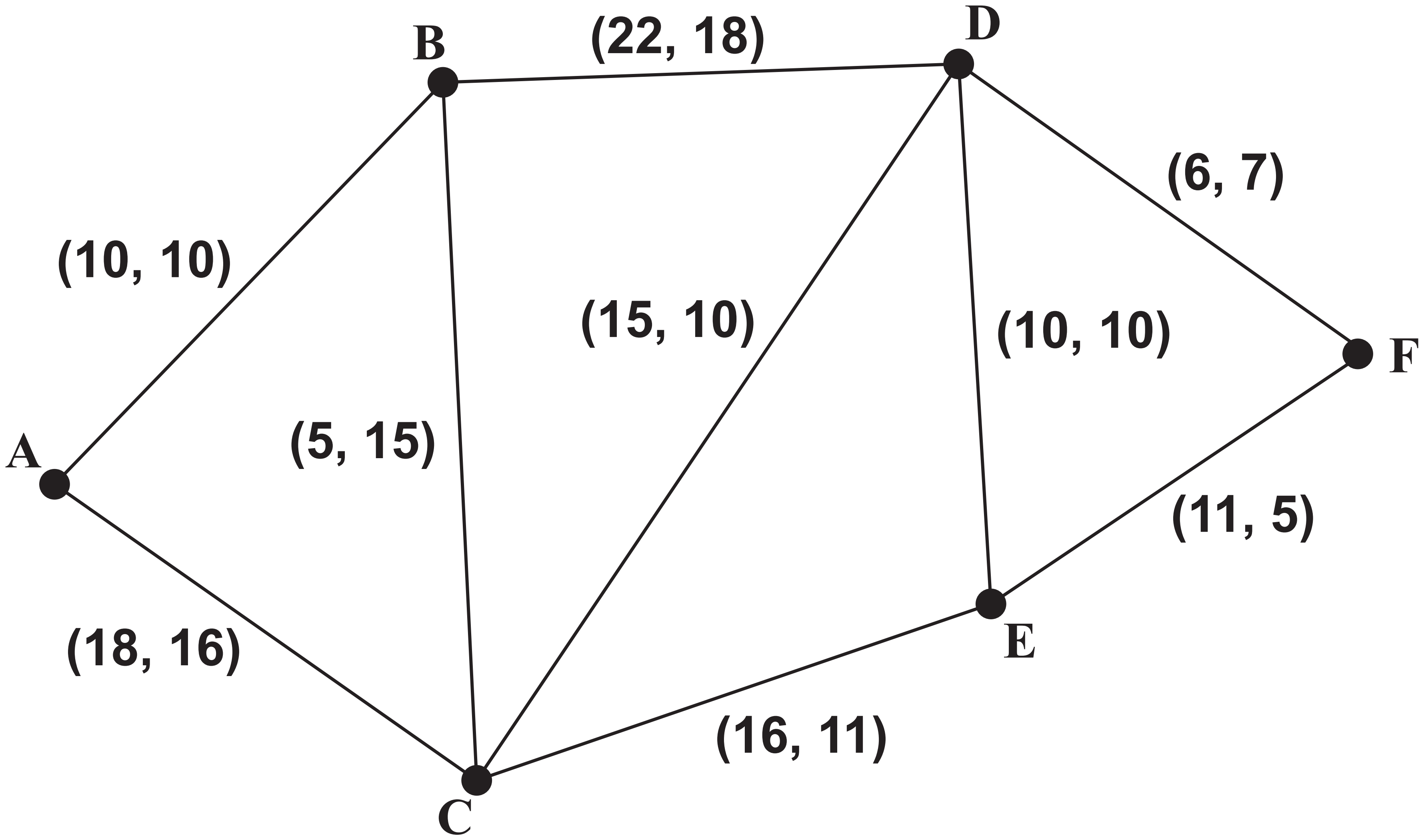
**Activities E, F, G, H and I require no labour.**

**Activities J and K each require 2 people.**

**(iii) Produce a schedule for two people to prepare and eat the meal in the minimum time. [4]**

**(iv) Explain why employing extra help cannot shorten the minimum time found in part (iii). [1]**

5 The network shows 6 locations with connecting arcs. Each arc has a pair of numbers associated with it. The first gives the cost and the second gives the distance involved in proceeding along that arc.




Europa uses Dijkstra's algorithm to find the cheapest route and cheapest cost from A to F.

(i) Show Europa's calculations and give her cheapest route and cheapest cost. [4]

Milo uses Dijkstra's algorithm to find the shortest route and shortest distance from A to F.

(ii) Show Milo's calculations and give his shortest route and shortest distance. [4]

Europa and Milo argue about which of their routes is best. Henry suggests that they compromise by using cost per unit distance as a measure.

(iii) Find the cost per unit distance of Europa's route and the cost per unit distance of Milo's route. [2]

**(iv)** Explain why Henry cannot use Dijkstra's algorithm to find a route with the minimum cost per unit distance. [1]

Bridget suggests that both Europa and Milo find their minimum spanning trees, and that they then use arcs within their trees to connect A to F.

**(v)** Use Prim's algorithm starting at A to find Europa's minimum spanning tree, making clear your use of the algorithm and drawing your tree. [2]

**(vi)** Use Kruskal's algorithm to find Milo's minimum spanning tree, making clear your use of the algorithm and drawing your tree. [2]

**(vii)** Why will Milo not like Bridget's suggestion? [1]

6 A council owns 50 acres of land on the boundary between an urban area and a rural area. The council is considering strategic plans for the land.

The council could sell land with planning permission for housing at £200 000 per acre. The council has already limited the amount of such development on this land to no more than 10 acres.

Land can also be developed for recreational use. The capital cost of this (landscaping, etc) will be £5000 per acre.

The council will invest the difference between what it gains from selling land for housing and what it spends on developing land for recreational use. Any money that the council invests will earn interest at 1.5% per year. The investment income must be sufficient to cover the cost of maintenance of the recreational land, which will be £500 per acre per year.

(i) Define appropriate variables. Using those variables, formulate and simplify three inequalities to model the constraints described above. [6]

(ii) Draw a graph representing the feasible region for the council's decision problem. [5]

(iii) Give the four solutions corresponding to the four vertices of your feasible region. For each of them state the circumstances in which the council might choose that solution. [3]

The council decides to sell 10 acres for housing development, but, before it can do so, a benefactor gives the council another 15 acres on an adjoining plot.

(iv) How much of the remaining 55 acres can be developed for recreational use? [2]

END OF QUESTION PAPER

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