

# 

### Semester Two Examination, 2018

### Question/Answer booklet

# MATHEMATICS

**APPLICATIONS**

**UNITS 3 AND 4**

## Section One:

## Calculator-free

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Student number: In figures |  |  |  |  |  |  |  |  |  |  |

In words

Your name

## Time allowed for this section

Reading time before commencing work: five minutes

Working time: fifty minutes

## Materials required/recommended for this section

***To be provided by the supervisor***

This Question/Answer booklet

Formula sheet

***To be provided by the candidate***

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener,  
correction fluid/tape, eraser, ruler, highlighters

Special items: nil

## Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

## Structure of this paper

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Working  time (minutes) | Marks available | Percentage of examination |
| Section One:  Calculator-free | 7 | 7 | 50 | 51 | 35 |
| Section Two:  Calculator-assumed | 12 | 12 | 100 | 99 | 65 |
|  | | |  | **Total** | 100 |

## Instructions to candidates

1. The rules for the conduct of examinations are detailed in the school handbook. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet.

3. You must be careful to confine your response to the specific question asked and to follow any instructions that are specified to a particular question.

4. Supplementary pages for the use of planning/continuing your answer to a question  
have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

5. Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.

6. It is recommended that you do not use pencil, except in diagrams.

7. The Formula sheet is not to be handed in with your Question/Answer booklet.

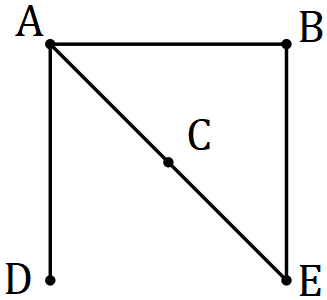
Section One: Calculator-free 35% (51 Marks)

This section has**seven (****7)** questions. Answer **all** questions. Write your answers in the spaces provided.

Working time: 50 minutes.

Question 1 (7 marks)

(a) The following bipartite graph shows the subjects studied by three students. Redraw the graph to clearly show the two distinct sets of vertices and hence state which vertices represent the subjects studied. (3 marks)



(b) The complete bipartite graph denoted by has vertices in one set and vertices in the other set.

(i) Draw and state whether the graph is Eulerian, semi-Eulerian or neither.

(2 marks)

(ii) Draw and state whether the graph is Hamiltonian, semi-Hamiltonian or neither.

(2 marks)

Question 2 (9 marks)

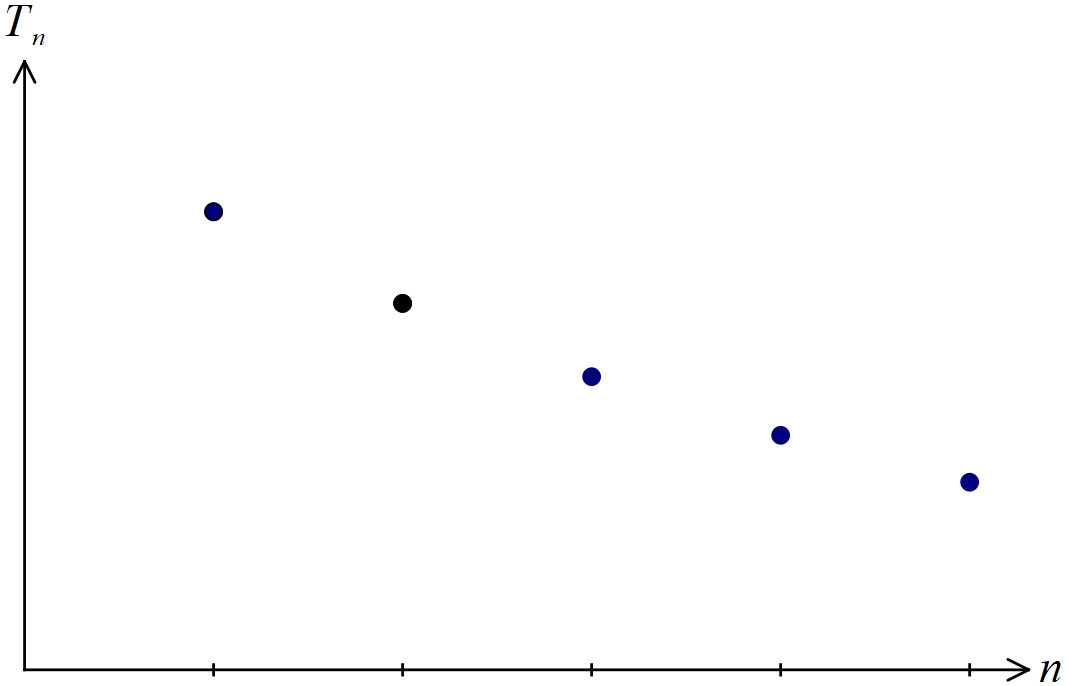
(a) The first two terms of an arithmetic sequence are displayed in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |

(i) Add the next two terms to the table. (2 marks)

(ii) Deduce a rule for the term of this sequence. (1 mark)

(b) The first two terms of a geometric sequence are displayed in graphical form below. Plot the likely position of the next three terms of the sequence on the graph. (2 marks)



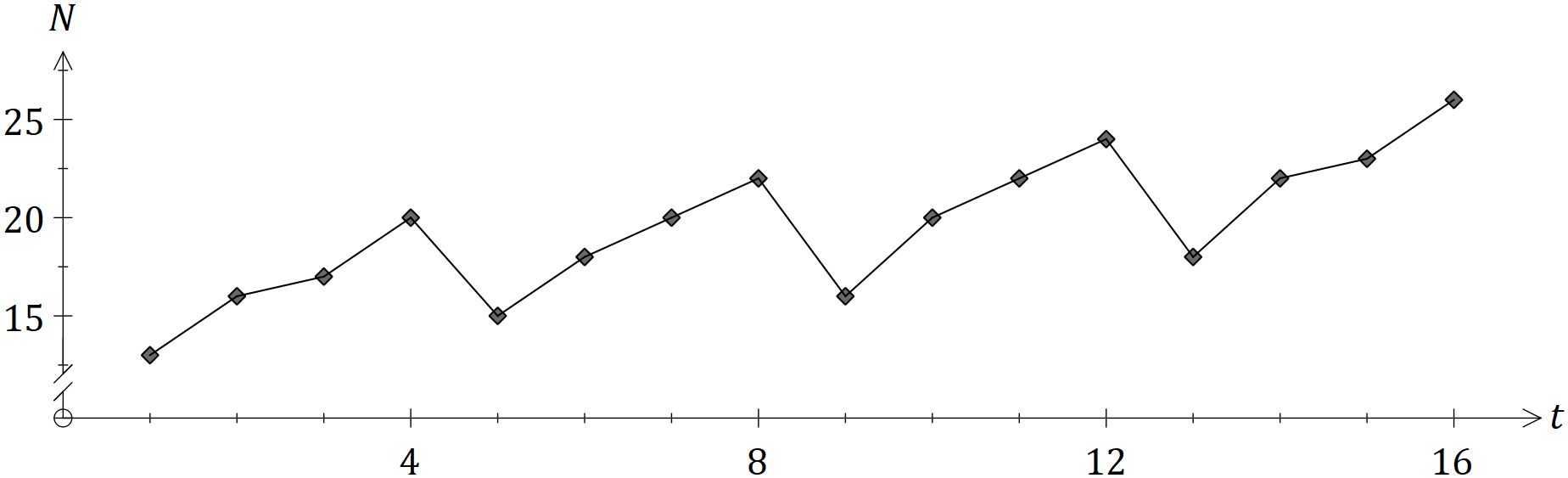
(c) A first-order linear recurrence relation is defined by .

(i) Determine the second and third terms of the sequence. (2 marks)

(ii) In the long-term, the terms of the sequence become very close to . Determine, with justification, the value of . (2 marks)

Question 3 (7 marks)

The graph below shows a time series plot, where is the number of breakdowns of a printing machine that are recorded during month .



(a) Describe the seasonality and trend of the time series. (2 marks)

(b) Some of the data is given in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

(i) Calculate the -point centred moving average for . (2 marks)

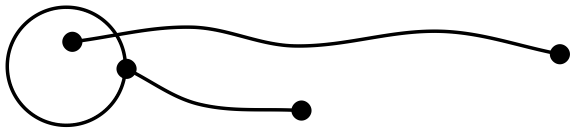
(ii) Explain the purpose of calculating simple moving averages for a time series.

(2 marks)

(iii) Explain the purpose of centring a -point moving average. (1 mark)

Question 4 (8 marks)

(a) Comment, with reasons, on the claim that the graph shown below is simple, planar and satisfies Euler's formula. (3 marks)



(b) A graph has vertices and edges. Determine the sum of the degrees of the vertices.

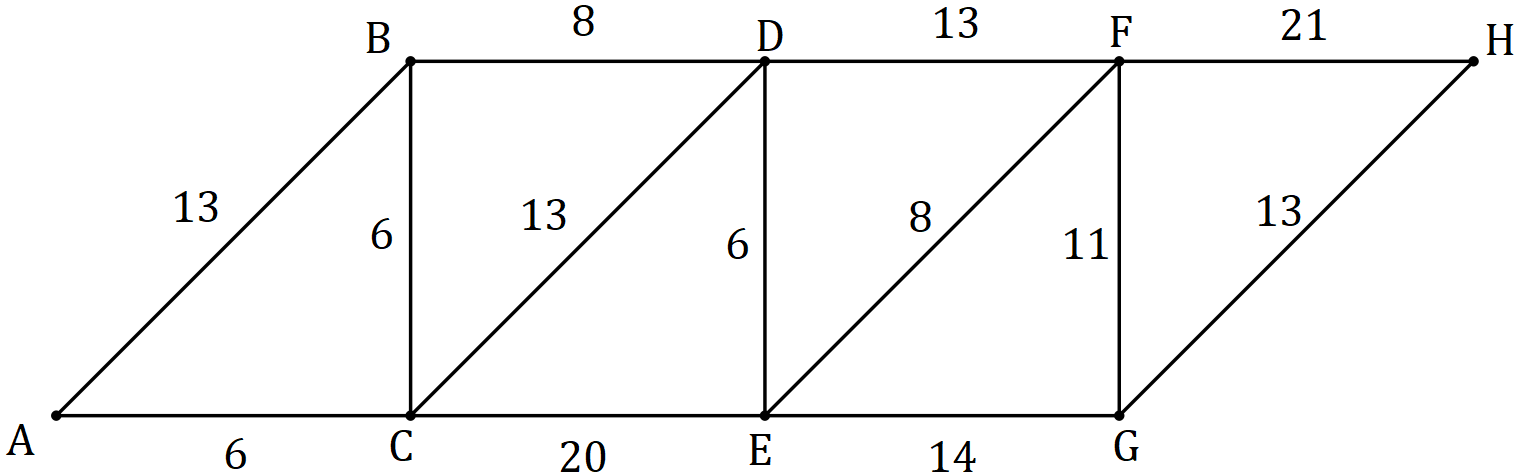
(1 mark)

(c) Draw a semi-Eulerian graph that has vertices and is a tree. (2 marks)

(d) Draw a connected planar graph that has vertices, faces and bridge. (2 marks)

Question 5 (8 marks)

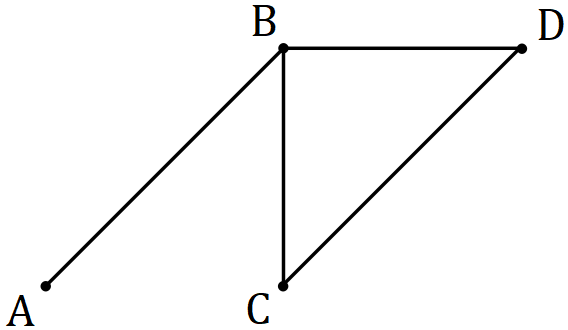
The vertices in the graph below represent city landmarks and the weights on the edges are the times, in minutes, to travel between adjacent landmarks.



(a) Determine the shortest time to travel from to . (3 marks)

(b) The travel times from to and from to both increase by minutes. Explain how these changes affect your answer to (a). (2 marks)

(c) Construct the adjacency matrix for the subgraph shown below, using column and row headings in the order . (2 marks)



(d) If matrix , determine the value of . (1 mark)

Question 6 (6 marks)

Three trucks, selected from a choice of four, are to be used to carry sand from a quarry to three building sites. The table below shows the weight of sand that each truck can carry to each site per day.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Truck 1 | Truck 2 | Truck 3 | Truck 4 |
| Site A |  |  |  |  |
| Site B |  |  |  |  |
| Site C |  |  |  |  |

Use the Hungarian algorithm to show that the maximum amount of sand that can be transported to the three sites is tonnes per day and state the required allocation of trucks to achieve this maximum.

Question 7 (6 marks)

A connected graph has vertices and edges. The vertices represent towns and the edges represent roads between the towns. The lengths of the edges, in kilometres, are:

(a) Determine the minimum possible length of a Hamiltonian cycle for such a graph.

(2 marks)

(b) Draw a possible graph, given that that it is also simple and has a minimum spanning tree of length km. Clearly label the edge lengths and highlight the minimum spanning tree. (4 marks)

Supplementary page

Question number: \_\_\_\_\_\_\_\_\_

Supplementary page

Question number: \_\_\_\_\_\_\_\_\_

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