CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2008/2009
Examination Period:	Spring
Examination Paper Number:	CM0167
Examination Paper Title:	Mathematics for Computer Science
Duration:	2 hours

Do not turn this page over until instructed to do so by the Senior Invigilator.

Structure of Examination Paper:

There are 5 pages.
There are 9 questions in total.
There are no appendices.
The mark obtainable for a question or part of a question is shown in brackets alongside the question.

Students to be provided with:

The following items of stationery are to be provided:
ONE answer book.

Instructions to Students:

Answer all questions.
The use calculators **without** programmable memory is permitted.
The use of translation dictionaries between English or Welsh and a foreign language bearing an appropriate departmental stamp is permitted in this examination.

Q1. Given the following vertex set, $V = \{A, B, C, D, E, F\}$, and edge set, $E = \{AB, AF, BC, BD, CE, CF, DE\}$ for a simple graph, $G = (V, E)$:

(a) *Draw* the graph, G. [3]

(b) What is the *order* and *size* of the graph, G [2]

(c) What is the *adjacency matrix* for the graph, G. [3]

Q2. Using the *HuffmanCoding Algorithm* code the following sequence of characters:

`ABBBBCCAADDA`

[8]

Q3. Consider the following table of distances between the cities A, B, C, D and E:

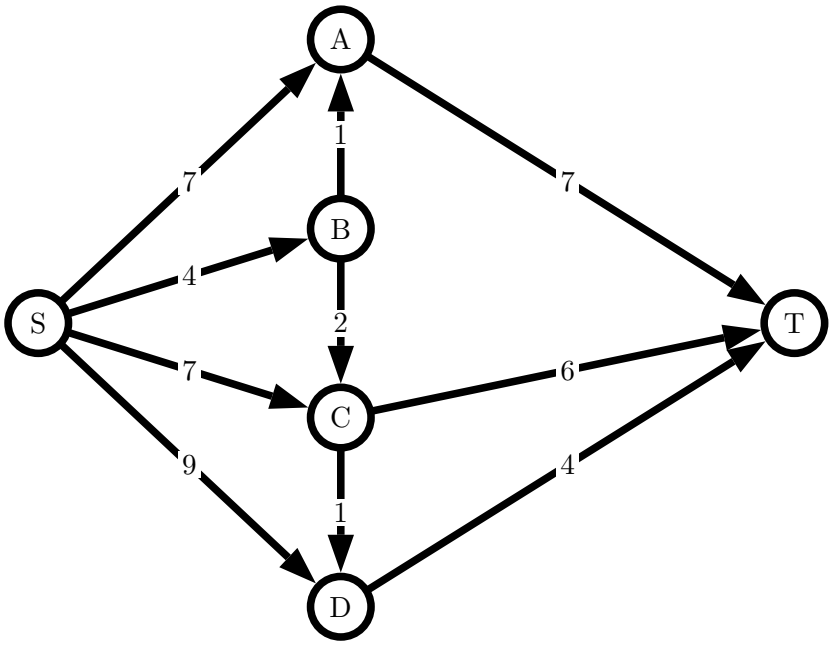
	A	B	C	D	E
A	–	24	16	29	23
B	24	–	37	41	58
C	16	37	–	14	23
D	29	41	14	–	31
E	23	58	23	31	–

(a) Draw a graph to represent the information in the table above. [4]

(b) Find an *upper bound* for the solution to the travelling salesman problem for the six cities above using the heuristic *nearest neighbour* algorithm. [7]

(c) Find a *lower bound* for the solution to the travelling salesman problem by *removing* city A. [7]

Q4. Find the shortest path from S to T in the digraph below using Dijkstra's algorithm. *Your solution should show complete workings using tables*.



[10]

Q5. (a) A card is drawn at random from a regular pack of 52 playing cards: What is the probability that it is not a picture card of any suit? [2]

(b) Two cards are drawn at random from a regular pack of 52 playing cards:

(i) What is the probability that they are a pair of aces? [2]

(ii) What is the probability that they are any pair? [2]

(iii) What is the probability that they are the same suit? [2]

(iv) What is the probability that they are both club suit cards? [2]

(c) A coin and dice are thrown together. What is the probability of a head *or* a number greater than 3 being obtained? [3]

Q6. Consider a sample of size 12 about the monthly change in house prices.

$$0\%,\ 4\%,\ 3\%,\ 3\%,\ 4\%,\ 1\%,\ 0\%,\ 2\%,\ 0\%,\ 1\%,\ 1\%,\ 0\%$$

Calculate the *absolute* and *relative frequency* of each monthly change and draw a vertical bar graph for the sample. [8]

Q7. Consider the following sample.

$$0,\ 2,\ 6,\ 1,\ 8,\ 4,\ 3,\ 6,\ 5,\ 4,\ 1,\ 2,\ 4,\ 5,\ 2$$

(a) Calculate the *arithmetic mean* $\bar{x}$ and the *sample variance* s^2. [5]

(b) Calculate the *inter-quartile range* IQR and the *median* x_{med} of the sample. [4]

(c) Draw a *box-plot* for the sample. Are there any *outliers*? [6]

Q8. Given the following vectors:

$$\mathbf{v} = (-1, 4), \mathbf{w} = (2, 3)$$

(a) What are the *norms* of $\mathbf{v}$ and $\mathbf{w}$? [2]

(b) What is the *scalar product* $\mathbf{v}.\mathbf{w}$? [2]

(c) What is the angle θ between $\mathbf{v}$ and $\mathbf{w}$? [3]

(d) What is the *vector cross product* $\mathbf{v} \times \mathbf{w}$? [4]

(e) What is the area of the parallelogram spanned by $\mathbf{v}$ and $\mathbf{w}$? [2]

Q9. Calculate the determinant of the matrix

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 1 & 1 & -3 \\ 2 & 0 & 1 \end{pmatrix}$$

[7]

END OF EXAMINATION