INSTITUTE OF TECHNOLOGY BLANCHARDSTOWN

Year of Study	Year 2
Semester	Semester 1
Date of Examination	Tuesday 12th January 2010
Time of Examination	3:30 - 5:30 pm

Prog Code	BN002	**Prog Title**	Higher Certificate in Science in Computing in Information Technology	**Module Code**	COMP H2026
Prog Code	BN013	**Prog Title**	Bachelor of Science in Computing in Information Technology	**Module Code**	COMP H2026
Prog Code	BN104	**Prog Title**	Bachelor of Science (Honours) in Computing	**Module Code**	COMP H2026

Module Title	Information Technology Mathematics

Internal Examiner(s): *Laura Keyes*

External Examiner(s): *Mr. John Dunnion*
Dr. Richard Studdert

Instructions to candidates:

1) To ensure that you take the correct examination, please check that the module and programme which you are following is listed in the tables above

2) Question One Section A is COMPULSORY. Candidates should attempt Question One and any two questions in Section B.

3) This paper is worth 100 marks. Question One is worth 40 marks and all other questions are worth 30 marks each.

DO NOT TURN OVER THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION A: COMPULSORY QUESTION

Question 1: This question is compulsory.

Attempt all eight parts. Each part is worth 5 marks each.

(a) Given the matrices

$$A = \begin{bmatrix} 3 & 5 & 2 \\ 1 & 9 & 4 \end{bmatrix}$$

$$B = \begin{bmatrix} 1 \\ 2 \\ 6 \end{bmatrix}$$

answer the following:

i. What is the rank of matrix A, B and B^T

ii. Write down the elements a_{21} and b_{21}

(b) Let $A = \begin{bmatrix} 2 & 3 & -1 \\ 3 & 5 & 2 \\ 1 & -2 & -3 \end{bmatrix}$

i. Find the cofactors C_{11}, C_{12} and C_{13}
ii. Use these cofactors to find the determinant of A.

(c) If two fair dice are rolled calculate the probability that:

i. The sum of the numbers is below 4
ii. The sum of the numbers is equal to or greater than 4

(d) In a local sports club lottery a player picks 4 distinct numbers between 1 and 24 inclusive to win a jackpot of 12,000 Euro. What is the probability that a player wins the jackpot?

(e) When performing data analysis why sometimes is a sample of the data used and not the entire population? Include in your answer a brief description of TWO possible sampling techniques that can be used.

(f) A list of temperatures for 7 days in July is as follows:-

28, 21, 25, 30, 31, 29, 24

Compute the (i) Mean
(ii) Median
(iii) Quartiles

(g) Draw an undirected graph with five vertices $V_1 \ldots V_5$ with edges connecting V_1 to V_2, V_1 to V_4, V_2 to V_3, V_2 to V_4, V_3 to V_4 and V_4 to V_5.

(h) What is a rooted tree structure? In your answer provide an example of a tree representation to explain the following concepts: root node; parent node; child node and leaf node

(40 marks)

SECTION B: Answer any TWO questions

Question 2:

(a) The following table represents a comparison of retail sales in 2008 and 2009 for the months July to November. Construct a Time Series plot of the data given. Interpret the results.

Table 2.1

Month	Sales 2008	Sales 2009
July	2000	1500
Aug	1500	2000
Sept	2450	1800
Oct	2500	1850
Nov	3000	2000

(6 marks)

(b) The following is a distribution of the exam grades of 42 students in a college computing assessment.

Table 2.2

Exam Score	No.of Students
0-9	1
10-19	1
20-29	2
30-39	5
40-49	7
50-59	5
60-69	8
70-79	6
80-89	4
90-99	3

Calculate the following for the grouped data represented in table 2.2

(i) the relative frequencies (2 marks)
(j) the Mean (3 marks)
(k) the standard deviation (5 marks)

(c) Draw a Histogram for the data in part (b) Table 2.2. Comment on the symmetry or skewness of the distribution of the histogram.

(7 marks)

(d) The user-codes on a certain device consists of 2 letters, followed by 2 digits followed by a letter, for example XY12A. (Assume there is no distinction mode between uppercase and lowercase letters).

(i) How many different user-codes can be constructed altogether?
(3 marks)

(ii) In how many of these user codes does the digit 2 occur at least once?
(4 marks)

Question 3

(a) Given the following matrices:

$$A = \begin{bmatrix} 2 & -4 & 1 \\ 0 & 3 & -5 \\ 2 & -2 & 3 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 2 & -3 \\ -6 & 4 & 3 \\ -2 & 0 & 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 3 & -2 & 1 \end{bmatrix}$$

(i) Write down the identity matrix I for the 2x2 and 3x3 matrices

respectively. (2 marks)

(ii) Evaluate: AI; (2 marks)

A+B and (2 marks)

BC_T (4 marks)

(b) Let

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 1 \\ 4 & 9 & 1 \end{bmatrix}$$

Calculate the determinant and inverse of the matrix A (10 marks)

(c) Perform the following transformations:

(i) Translate the x-coordinate of the 2D point (2,6) by a factor of 3 (5 marks)

(ii) Produce a matrix that would scale a 2D object to half its current size. (5 marks)

Question 4

(a) Explain how computers in a LAN (Local Area Network) might be modelled using graph theory. (4 marks)

(b) Consider the graph G depicted in Figure 4.1 below.

(i) Draw the corresponding adjacency matrix. (4 marks)

(ii) Verify that the sum of the degrees equals twice the number of edges. (4 marks)

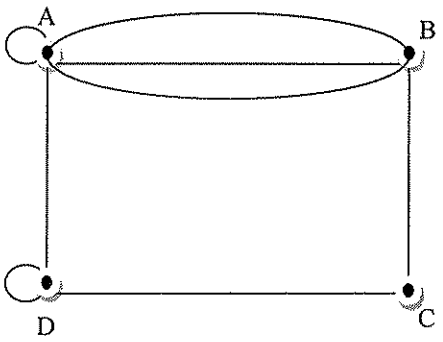

Figure 4.1

(c) What is a Minimal Spanning Tree (MST) of a connected weighted graph. Find a MST for the weighted graph given in Figure 4.2 below.

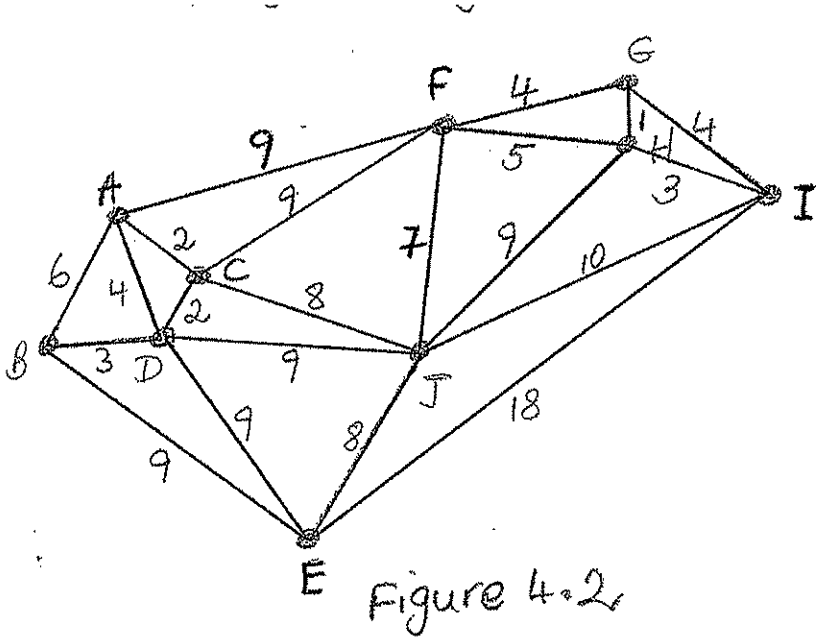

Figure 4.2

(9 marks)

(d) Compute the output of pre-order, in-order and post-order traversal of the following Binary Search Tree in figure 4.3

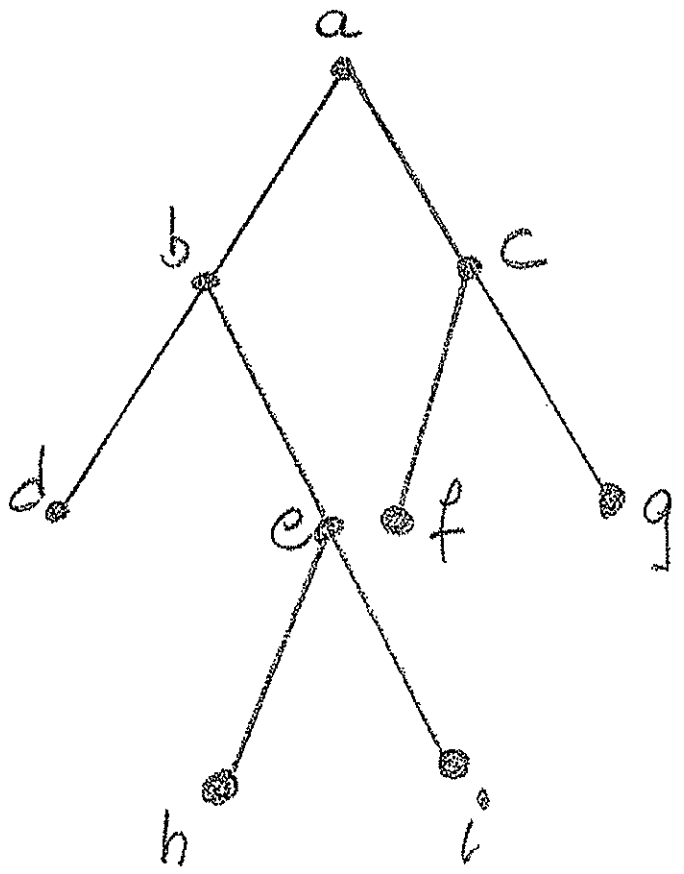

Figure 4.3

(9 marks)

Formulae

Determinants

$$\det A = ad - bc$$

$$\det A = a_{11}c_{11} + a_{12}c_{12} + a_{13}c_{13} + \ldots \text{(using row 1)}$$

Inverses

$$A^{-1} = \frac{1}{\det A}\begin{bmatrix} \mathbf{d} & \mathbf{-b} \\ \mathbf{-c} & \mathbf{a} \end{bmatrix}$$

$$A^{-1} = \frac{1}{\det A}C^T$$

Mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \bar{x} = \frac{\sum_i f_i m_i}{\sum_i f_i}$$

Standard Deviation *s*

$$s^2 = \frac{\sum_{i=1}^{n} x_i^{\,2} - n\left(\bar{x}\right)^2}{n-1} \quad \text{or} \quad s^2 = \frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n-1} \qquad s^2 = \frac{\sum_{i=1}^{M} f_i m_i^{\,2} - n\left(\bar{x}\right)^2}{n-1}$$