Appendix B – Coursework brief template

MSc Computer Science

Module: CSM050 Fundamentals of Computing
Coursework: January to March 2025 study session

Submission Deadline: Monday 31 March 2025 13.00 BST

Please Note: You are permitted to upload your Coursework in the final submission area as many times as you like before the deadline. You will receive a similarity/originality score which represents what the Turnitin system identifies as work similar to another source. The originality score can take over 24 hours to generate, especially at busy times e.g., submission deadline.

- If you upload the wrong version of your Coursework, you can upload the correct version of your Coursework via the same submission area. You simply need to click on the 'submit paper' button again and submit your new version before the deadline.

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- Please note, when the due date is reached, the version you have submitted last, will be considered as your final submission and it will be the version that is marked.

- **Once the due date has passed, it will not be possible for you to upload a different version of your assessment. Therefore, you must ensure you have submitted the correct version of your assessment which you wish to be marked, by the due date.**

Coursework is weighted at 100% of final mark for the module.

Answer all **ten** questions. Each question is worth 30 marks for a total of 300 marks.

Question 1

[30 marks total]

Write about how the hardware and software of computers has advanced since the time of Charles Babbage. Give specific details about the places, people and times when advances in computing hardware and software were made. (400 words approx.)

[10 marks]

a) Convert to 1011001_2 to decimal. Show your workings.

[5 marks]

b) Convert 1011.0101_2 to decimal. Show your workings.

[5 marks]

c) Convert 246_{10} to binary. Show your workings.

[5 marks]

d) Convert the hexadecimal number $41B2_{16}$ to decimal. Show your workings.

[5 marks]

Question 2

[30 marks total]

a) Calculate the binary sum 110011 + 11111. Show your workings.

[5 marks]

b) Write the number 0.00435 in normalized scientific notation.

[5 marks]

c) What is -44_{10} as a two's complement 32-bit binary number? Explain your answer.

[10 marks]

d) Calculate the difference 1100011 – 110111 by adding the two's complement of the number to be subtracted. Show your workings.

[10 marks]

Question 3

[30 marks total]

a.) Which of these sentences are propositions? What (if any) are the truth values of those that are propositions?

    i)   London is the capital of France.

    ii)   Open the window please.

    iii) $X + 5 = 10$.

[9 marks]

b.) Let p be "The table is green" and q be "the ball is yellow".

Write each of the following statements in symbolic form using p and q:

    i)   If the table is green, then the ball is yellow.

    ii)   The table is not green or the ball is yellow.

    iii)   It is not true that the table is green and the ball is yellow.

[9 marks]

c.) Consider the statements below:

    S1: Charlie is not a cook;
    S2: Alice is an architect or Bob is a builder.
    S3: If Bob is a builder, then Charlie is a cook.

    Which of the following arguments are logically correct (show your workings as part of the answer):

    i)   Suppose S1, S2 and S3 are all true. Then Alice is an architect.
    ii)   Suppose S1, S2 and S3 are all true. Then Bob is a builder.
    iii)   Suppose S1, S2 and S3 are all true. Then Charlie is a builder.
    iv)   Suppose S1, S2 and S3 are all true. Then Charlie is not a builder.

[12 marks]

Question 4

[30 marks total]

a) Describe each of the following sets in terms of a property of its elements (that is, using the 'description by common property' notation).

   i)   the set of dates in the month of March
   ii)   {17,19,21,23,25}
   iii)   the set of non-negative rational numbers

[6 marks]

b) Consider the following sets:

Universal set U = {1, 2, 4, 5, 6, 7, 12, blue, red, green, pink, water}

    A = { blue, red, green, pink}
    B = {12, 5, 6, 7}
    C = {green, 4, 12, 7, water}
    D = {1, 2, 5}

Find the following:

   i) $(A \cup D) \cap C$
   ii) $(B \cap D) \cap A$
   iii) $D - B$
   iv) $A' \cap (B \cup D)'$
       (i.e., the intersection of the complement of A and the complement of B union D)
   v)   A X D
       (The Cartesian product of A and D)

[15 marks]

c) Consider the sets P = {21, 12, 5, 22} and Q = {4, 3}. Suppose that the relation R expresses "is divisible by (with no remainder)". Define R from P to Q as a set of ordered pairs.

[9 marks]

Question 5

a) Let A = {c, a} and B = {a, b, c}.

What is:

i)   A x A
ii)   B x A
iii)   A x B

(Where x denotes the Cartesian product)

[9 marks]

b) For each of the following relations on the set {1, 2, 3, 4}, decide whether it is reflexive, and/or irreflexive, and/or symmetric, and/or antisymmetric, and/or transitive:

  i)   {(2, 2), (2, 3), (2, 4), (3, 2), (3, 3), (3, 4)}
  ii)   {(1, 1), (1, 2), (2, 1), (2, 2), (3, 3), (4, 4)}
  iii) {(1, 4), (4, 2)}

[9 marks]

c) Consider the following sets:

    U = {1,2,3,4,5,6,7,8,9}
    A = {1,2,3,4,5}
    B = {4,5,6,7}
    C = {5,6,7,8,9}
    D = {1,3,5,7,9}
    E = {2,4,6,8}
    F = {1 ,5 ,9}

What is:

  i)   A ∩ (B ∪ E)
  ii)   (B ∩ F) ∪ (C ∩ E)
  iii) B' (that is: "the complement of B")
  iv)   (A ∩ D) − B
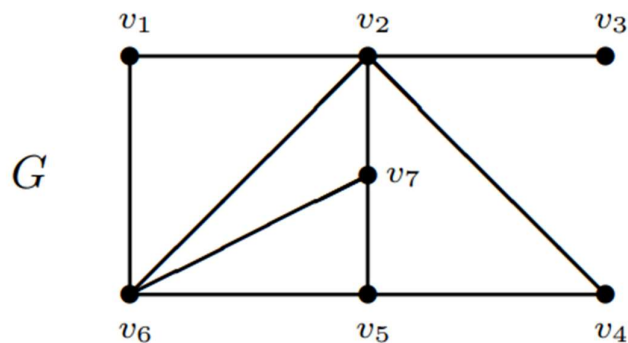
[12 marks]

Question 6

[30 marks total]

a) Consider the graph H, below:
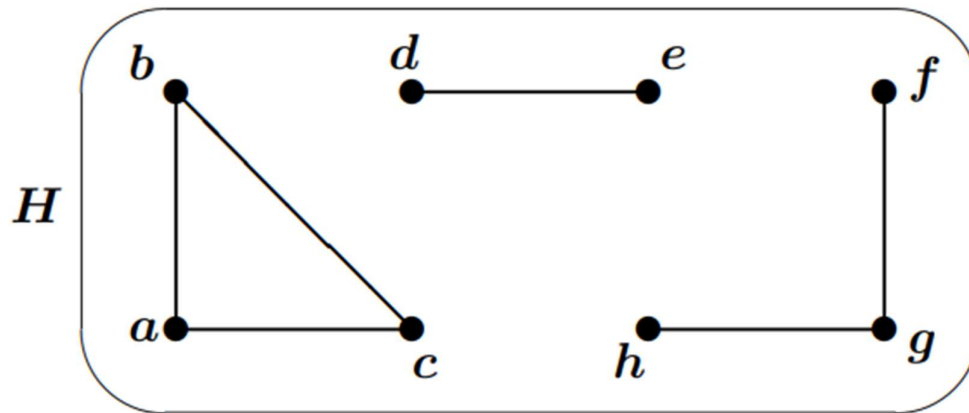
i)   What is the degree of the node a?
ii)   How many vertices are in the graph H?
iii)   How many connected components are in H?
iv)   Identify a simple cycle of length 3 in H.
v)   Is the cycle you have identified Hamiltonian? Why or why not?

[10 marks]

b) Consider the graph G, below:

i)   Which vertex is pendant?
ii)   Is the sequence (v1, v6, v2, v5, v4) a path? Explain your answer.
iii)   Is the sequence (v6, v7, v5, v6, v2, v1, v6) a simple cycle? Explain your answer
iv)   Is G a connected graph?

v)   Which vertices are adjacent to v6?

[10 marks]

c) Represent G and H as adjacency matrices.

[10 marks]

Question 7

[30 marks total]

a) Consider the following finite automaton A: it has five states: s, p, q, r, t; its initial state is s; the accepting states are s, p, r, t; and the transition function is given by the table below:

[15 marks]

	0	1
s	p	r
p	q	r
q	q	r
r	t	r
t	q	r

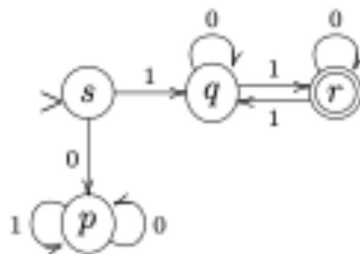i)   Draw a graphical representation of A.

[5 marks]

ii)   Does A accept the words 110100 and 011010? Show the computations of A on these input words.

[5 marks]

iii) Describe in ordinary words the language accepted by the automaton A.

[5 marks]

b) Consider the following deterministic finite automaton:

[15 marks]

i) Give a formal description of the automaton, using a transition table.

[5 marks]

ii) Find the computations of the automaton on the input words 01, 101, 100 and determine if these words are accepted.

[5 marks]

iii) Describe in ordinary words the language accepted by the automaton.

[5 marks]

Question 8

[30 marks total]
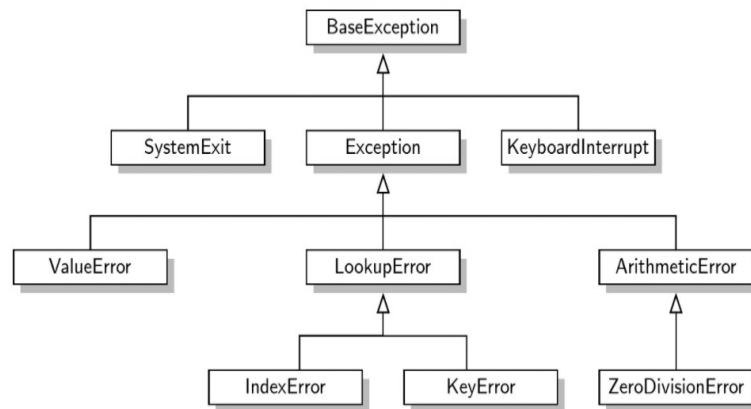
a) Answer the following questions with respect to the tree above:

    i) What are the leaf nodes of the tree?

           [4 marks]

    ii) What is the height of the tree?

           [4 marks]

    iii) What are the siblings of the *ArithmeticError* node?

           [4 marks]

b)

    i) Represent the following arithmetic expression as a binary tree:

        $(((9\text{-}2) \times 5)/(11\text{-}8) +8) - ((3 \times (88\text{-}12) - 8))$

           [6 marks]

    ii) How many levels does the resulting tree have?

           [3 marks]

    iii) What is the maximum number of nodes that can be at level 5 of a binary tree?

           [3 marks]

    iv) Which additional accessor methods should a binary tree Abstract Data Type implement in addition to those of an ordinary tree?

           [6 marks]

Question 9

[30 marks total]

a)

    i) Is it easier to insert and delete elements into a linear data structure if the data structure is based on an array or a linked list? Explain why.

                                   [8 marks]

    ii) Explain the differences between the str, list, and tuple data structures in python, with reference to their memory allocation and how they store elements.

                                   [8 marks]

b)

    i) If S is a stack, what is the output of the following pseudocode program? Draw the state of the stack at each operation.

```
S.push(5)
S.push(3)
S.push(22)
print(S.top())
print(S.pop())
S.push(7)
print(S.pop())
print(S.pop())
```

                                   [7 marks]

    ii) If Q is a queue, what is the output of the following pseudocode program? Draw the state of the queue at each operation.

```
Q.enqueue(15)
Q.enqueue(31)
Q.enqueue(4)
print(Q.dequeue())
Q.enqueue(11)
print(Q.dequeue())
print(Q.dequeue())
print(Q.dequeue())
print(Q.dequeue())
```

                                   [7 marks]

Question 10

[30 marks total]

a)

i) Draw the binary search tree obtained by inserting items with the following keys into an initially empty unbalanced binary search tree:

31, 38, 23, 57, 51, 24, 10, 12

[8 marks]

ii) Write the order that the nodes would be visited in a pre-order traversal of the tree.

[4 marks]

iii) Write the order that the nodes would be visited in a post-order traversal of the tree.

[4 marks]

iv) Write the order that the nodes would be visited in an in-order traversal of the tree.

[4 marks]

b) Show how binary trees might be used in a real-world context. In your answer, give an example showing how building and operating using a binary tree helps solve a problem.

[10 marks]

Assessment Criteria

Please refer to Appendix C of the Programme Regulations for detailed Assessment Criteria.

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