THE HONG KONG POLYTECHNIC UNIVERSITY

DEPARTMENT OF COMPUTING

EXAMINATION

Course : PG Scheme in COMP-61030, MSc Health Informatics-06003,
MSc Data Science & Analytics-63027

Subject : COMP5112 Data Structures and Database Systems

Group : 101, 102, 1012, 1022, 104, 107

Session : 2023 / 2024 Semester I

Date : 20 Dec 2023 Time : 19:00-21:00

Time Allowed: 2 Hours Subject Lecturer: Dr LUK Robert

This question paper has ___5___ pages (cover included).
(Some pages may be intentionally omitted.)

Instructions to Candidates:

Answer ALL questions.

For question 1, an incorrect answer subtracts two marks from the total marks of question 1 and the minimum total mark of question 1 is zero. Question 2 may have more than one correct answer, an incorrect answer carries one negative mark and the minimum mark is zero.

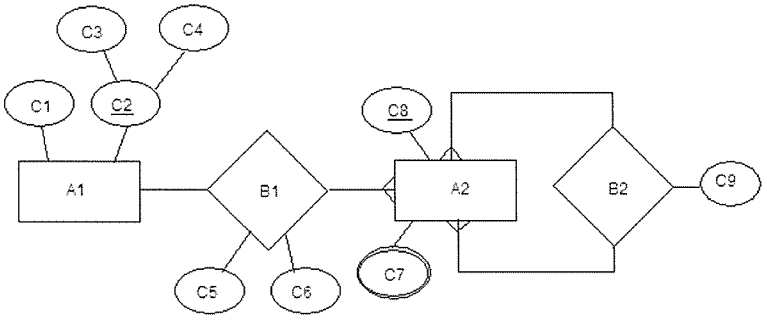
Do not turn this page until you are told to do so!

3 (a) Draw the linked-list stack after inserting the sequence of numbers as follows: 7, 10, 14, 2, 8, 19, 12, 50, 4, 15, where each node of a stack has a next pointer and has an integer to store the data. You should assume that there is a start pointer that points to the top of the stack. [4 marks]

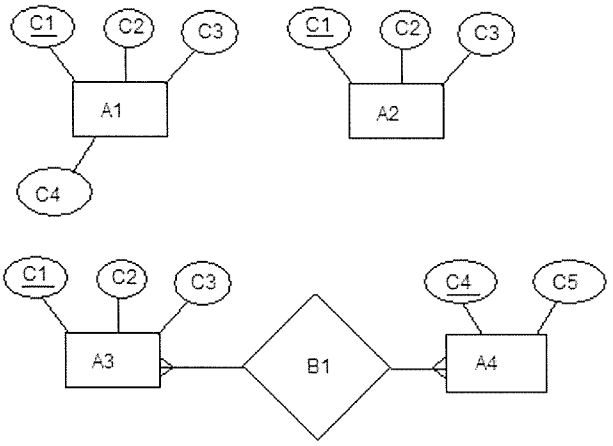
(b) Assuming that there are 70,000 keys and the hash table size is 100,000, what is the average number of elements examined during successful search, rounded to two decimal places for (i) open addressing with linear probing, (ii) open addressing with double hashing and (iii) chained hashing? Show your steps carefully including the general formulae for full marks. [8 marks]

(c) Create a min-heap for the sequence of numbers in Question 3(a). You should show your steps carefully when constructing the heap. [8 marks]

4 (a) Convert the following entity relationship diagram into a relation schema (diagram). [10 marks]



(b) Draw an enhanced entity relationship diagram for the diagram below. Make and declare any appropriate assumptions. [10 marks]



5 (a) Write down four rules (or keywords) that specify when to use indexes in databases. [4 marks]

(b) The union rule states that if A → B and A → C, then A → B, C. Prove the union rule using only Armstrong's axioms. You should mention which Armstrong axiom is used in each step of the proof. [4 marks]

(c) Given the following functional dependencies in a relation; [8 marks]

```
driver-id → name, address;
name, address → driver-id;
license → model, year;
report-number → license, driver-id;
own → driver-id, license;
```

determine a candidate key and show that it satisfies the candidate key properties. You may codify the attributes as (D, N, A, R, O, L, M, Y). Show your steps carefully.

(d) Determine formally whether the relation, R(A,B,C,D,E), which has the following functional dependencies, is in third normal form or not: [4 marks]

```
A → B, D
B, C → E
B → C, D
```

Please state all the reasons whenever possible.

~~~ The End ~~~
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