(C) 109
(D) 119
(E) 991
(F) None of these

10 Hashing

1. Which of the following statement(s) is TRUE?
(I) A hash function takes a message of arbitrary length and generates a fixed length code.
(II) A hash function takes a message of fixed length and generates a code of variable length.
(III) A hash function may give the same hash value for distinct messages.
(IV) Searching a key in a hash table takes linear amount of time at worst case.
(A) (I) and (IV) only
(B) (II) and (III) only
(C) (I) and (III) only
(D) (II) and (IV) only
(E) (IV) only

2. A hash table of length 10 uses open addressing with hash function h(k)=k mod 10, and linear probing.

0	29
1	11
2	82
3	43
4	34
5	
6	96
7	117
8	
9	289

After inserting 8 values into an empty hash table, the table is as shown below. Which one of the following choices gives a possible order in which the key values could have been inserted in the table?

(A) 29, 11, 82, 43, 34, 117, 289, 96
(B) 11, 82, 43, 34, 29, 117, 289, 96

(C) 43, 34, 82, 11, 289, 96, 117, 29
(D) 34, 82, 43, 11, 96, 29, 289, 117

3. An advantage of chained hash table (external hashing) over the open addressing scheme is
(A) Worst case complexity of search operations is less
(B) Space used is less
(C) Deletion is easier
(D) None of the above

4. Given the following input:
(4322, 1334, 1471, 9679, 1989, 6171, 6173, 4199). The hash function is $xmod10$. Which of the following statements are true?
(i) 9679, 1989, 4199 hash to the same value
(ii) 1471, 6171 hash to the same value
(iii) All elements hash to the same value.
(iv) Each element hashes to a different value :
(A) (i) only
(B) (ii) only
(C) (i) and (ii) only
(D) (iii) or (iv)

5. Consider a 13 element hash table for which f(key)=key mod 13 is used with integer keys. Assuming linear probing is used for collision resolution, at which location would the key 103 be inserted, if the keys 661, 182, 24 and 103 are inserted in that order?
(A) 0
(B) 1
(C) 11
(D) 12

6. Consider a hash function that distributes keys uniformly. The hash table size is 20. After hashing of how many keys will the probability that any new key hashed collides with an existing one exceed 0.5.
(A) 5
(B) 6
(C) 7
(D) 10

7. Consider a hash table with 9 slots. The hash function is h(k) = k mod 9. The collisions are resolved by chaining. The following 9 keys are inserted in the order: 5, 28, 19, 15, 20, 33, 12, 17, 10. The maximum, minimum, and average chain lengths in the hash table, respectively, are

(A) 3, 0, and 1
(B) 3, 3, and 3
(C) 4, 0, and 1
(D) 3, 0, and 2

8. What will be the cipher text produced by the following cipher function for the plain text ISRO with key k =7. [Consider 'A' = 0, 'B' = 1, ...'Z' = 25]. $C_k(M) = (kM + 13)mod26$
(A) RJCH
(B) QIBG
(C) GQPM
(D) XPIN

9. Consider a hash table of size seven, with starting index zero, and a hash function (3x+4)mod7. Assuming the hash table is initially empty, which of the following is the content of the table when the sequence 1, 3, 8, 10 is inserted into the table using closed hashing? Note that - denotes an empty location in the table.
(A) 8, - , - , - , - , - , 10
(B) 1, 8, 10, - , - , - , 3
(C) 1, - , - , - , - , - , 3
(D) 1, 10, 8, - , - , - , 3

10. Given a hash table T with 40 slots that stores 2019 elements, the load factor α for T is?
(A) 80.475
(B) 10.0125
(C) 80
(D) 50.475
(E) 55.125

11. Consider a hash function that distributes keys uniformly. The hash table size is 20. After hashing of how many keys will the probability that any new key hashed collides with an existing one exceed 0.5?
(A) 5
(B) 6
(C) 7
(D) 10

12. Consider a hash table with n slots where collisions are resolved using chaining. Half of the table is filled with m keys uniformly.
Answer following two questions:
(a) What is the load factor for this table?

(b) What is the probability that exactly k keys hash into some particular slot?

13. Which one of the following hash functions on integers will distribute keys most uniformly over 10 buckets numbered 0 to 9 for i ranging from 0 to 2020?
(A) h(i) $=i^2$ mod 10
(B) h(i) $=i^3$ mod 10
(C) h(i) = (11 * i^2) mod 10
(D) h(i) = (12 * i) mod 10

14. After inserting 7 values into an empty hash table, the table is shown as below

0	
1	
2	82
3	43
4	34
5	112
6	96
7	113
8	
9	289

How many different insertion sequences of the key values using the same hash function and linear probing will result in the hash table shown above?
(A) 10
(B) 30
(C) 64
(D) 144
(E) 196

15. Consider a hash table with 64 slots. Collisions are resolved using chaining. Assuming simple uniform hashing, what is the probability that the last 4 slots are filled exactly 50% after the first 3 insertions?
(A) $\frac{1}{64}$

(B) $\frac{1}{112}$

(C) $\frac{1}{122}$

(D) $\frac{7}{32}$

16. Consider a hash table with n buckets, where external chaining is used to resolve collisions. The hash function is such that the probability that a key value is hashed to a particular bucket is $\frac{1}{n}$. The hash table is initially empty and K distinct values are inserted in the table.
Answer following questions:
(a) What is the probability that bucket number 1 is empty after the K^{th} insertion?
(b) What is the probability that no collision has occurred in any of the K insertions?
(c) What is the probability that the first collision occurs at the K^{th} insertion?