Exercise 1:

Exercise-1

~~Question~~ Part-A

word -	ibex	hare	ape	bat	koala	mud	dog	carp	stork
h1 :	0	2	6	0	1	6	0	8	8
h2 :	5	6	6	1	2	5	8	7	2

1. Chaining with h1:

0	1	2	3	4	5	6	7	8	9	10
ibex	koala	hare				ape		carp		
↓ bat						↓ mud		↓ stork		
↓ dog										

2. Double hashing

~~[illegible]~~

Probing , $P(key, i) = [h_1(x) + i \times h_2(x)] \% m$

ibex , inserted at 0

hare , inserted at 2

ape , inserted at 6

bat , inserted at 0 but its collision. So,

$P(bat, 1) = [h_1(bat) + 1 \times h_2(bat)] \% 11$

$= (0 + 1) \% 11 = 1$

$\Rightarrow$ bat , inserted at 1

koala, inserted at 1 but its collision

So, $P(\text{koala}, 1) = (1 + 1\times2) \% 11$

$= 3 \% 11 = 3$

$\Rightarrow$ So, koala inserted at 3

mud, also got collision with ape

So, $P(\text{mud}, 1) = (6 + 1\times5) \% 11$

$= 11 \% 11 = 0$

= collision

$P(\text{mud}, 2) = (6 + 2\times5) \% 11$

$= (6 + 10) \% 11 = 16 \% 11$

$= 5$

$\Rightarrow$ mud, inserted at 5

dog, should inserted at 0 but collision.

$P(\text{dog}, 1) = (0 + 1\times8) \% 11$

$= 8 \% 11 = 8$

$\Rightarrow$ dog, inserted at 8

carp, got a collision with dog

$P(\text{carp}, 1) = (8 + 1\times7) \% 11$

$= 15 \% 11 = 4$

$\Rightarrow$ carp, inserted at 4

stork, colliding with dog

$P(\text{stork}, 1) = (8 + 1\times2) \% 11$

$= 10 \% 11 = 10$

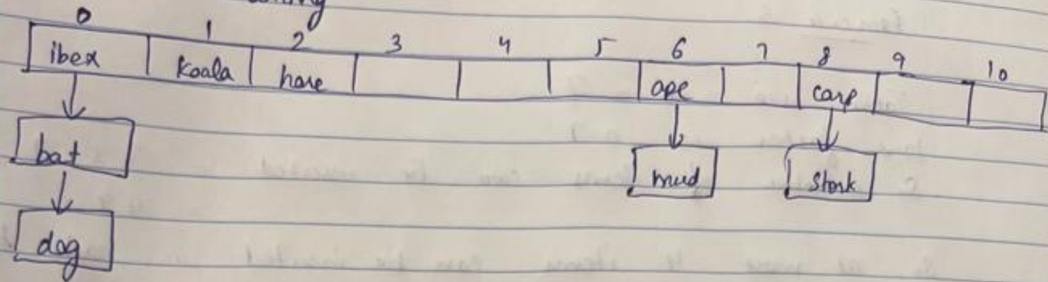
stork, inserted at 10

So, Hash Table is

0	1	2	3	4	5	6	7	8	9	10
ibex	bat	hare	koala	carp	mud	ape		dog		stork

B.

Seperate Chaining



To find a bird, h_1 for bird is 6. So, we find at index 6. So, at index 6, there is ape and mud and not a bird and index 7 is empty. So, bird not found

So, highlighted cells are at index 6, ape and mud and index 7 is empty.

Double hashing

0	1	2	3	4	5	6	7	8	9	10
ibex	bat	hare	koala	carp	mud	ape		dog		stork

hash function, $h_1(\text{bird}) = 6$ and $h_2(\text{bird}) = 5$

$P(\text{bird}, 0) = (6 + 0 \times 5) \% 11 = 6$, not found

$P(\text{bird}, 1) = (6 + 1 \times 5) \% 11 = 11 \% 11 = 0$, not found

$P(\text{bird}, 2) = (6 + 2 \times 5) \% 11 = 16 \% 11 = 5$, not found

$P(\text{bird}, 3) = (6 + 3 \times 5) \% 11 = 21 \% 11 = 10$, not found

$P(\text{bird}, 4) = (6 + 4 \times 5) \% 11 = 26 \% 11 = 4$, not found

$P(\text{bird}, 5) = (6 + 5 \times 5) \% 11 = 31 \% 11 = 9$, ~~emp~~ cell empty, not found

So, when trying to ~~bo~~ find bird, highlighted cells are at index 6 (ape), 0 (ibex), 5 (mud), 10 (stork), 4 (carp) and 9 which is empty.

So, bird not found.

Exercise 2:

1. The worst case for search time having N keys and collision is handled by chaining is O(N) because. So, in the worst case, collision happens which means key value for elements is same. So, it is stored in a link list at that index. So, to search for that item we have to through the link list of items at that index which gives the complexity O(N).
   Ex: For the worst case, all element should be at same index so that it goes through all elements in a link list. If the size of hash table is 11 and items are 12, 23, 34, 45, 56, 67, 78 which gives the index value 1. So, complexity is O(N).

2. No, we cannot use the hash table for time-critical application like air traffic control it take more time and space for searching and inserting a node if the value of N is very high.

Exercise 3:

Exercise 3

Table size, $m = 7$
Load factor is 0.7
So, number of items can be inserted $= 7 \times 0.7$
$= 4.9$

So, at most 4 items can be inserted in hash table of size 7.

Items $= 5, 28, 19, 15, 20, 33$

$h(x) = x \% m$
$h(5) = 5 \% 7 = 5$
$h(28) = 28 \% 7 = 0$
$h(19) = 19 \% 7 = 5$, collision,
So, inserted at index 6.
$h(15) = 15 \% 7 = 1$.

0	1	2	3	4	5	6
					5	

0	1	2	3	4	5	6
28					5	

0	1	2	3	4	5	6
28					5	19

0	1	2	3	4	5	6
28	15				5	19

Now, new size
$\Rightarrow 2 \times m = 2 \times 7 = 14$
Now, nearest prime number less than 14 is 13

So, New size, $m = 13$
So, Load factor is 0.7
$= 0.7 \times 13 = 9.1$
So, total 9 items can be inserted.

$h(k) = k \% m = k \% 13$

$h(5) = 5 \% 13 = 5$

$h(28) = 28 \% 13 = 2$

$h(19) = 19 \% 13 = 6$

$h(15) = 15 \% 13 = 2$, collision.

So, inserted at 3.

$h(20) = 20 \% 13 = 7$

$h(33) = 33 \% 13 = 7$, collision.

So, inserted at 8

0	1	2	3	4	5	6	7	8	9	10	11	12
					5							

0	1	2	3	4	5	6	7	8	9	10	11	12
		28			5							

0	1	2	3	4	5	6	7	8	9	10	11	12
		28			5	19						

0	1	2	3	4	5	6	7	8	9	10	11	12
		28	15		5	19						

0	1	2	3	4	5	6	7	8	9	10	11	12
		28	15		5	19	20	33				

0	1	2	3	4	5	6	7	8	9	10	11	12
		28	15		5	19	20	33				