ICS 202 Assignment 3

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Question 1

Question 1 (30 points): For all parts below, show all intermediate steps. Redraw if there is a need to "erase".
   a) (15 points): Draw the tree after inserting integers/keys: 15, 5, 30, 12, 40, 3, 18, 7, 20, 6, 22 into an initially empty
        i.   Binary search tree.
        ii.   AVL tree.
        iii. B-tree of order 3.
   b) (7.5 points) Draw the tree after deleting
        i.   15 from the Binary search tree generated in part a) <u>by copying.</u>
        ii.   3 from the AVL tree generated in part a).
        iii. 3 from the B-tree generated in part a).
   c) (7.5 points) Draw the tree after inserting 50 into
        i.   Binary search tree generated in part a).
        ii.   AVL tree generated in part a).
        iii. B-tree generated in part a).

a)

i.

15 inserted

5 inserted

30 inserted

12 inserted

40 inserted

3 inserted

18 inserted

7 inserted

15

20 inserted

6 inserted

22 inserted

ii.

15 inserted

5 inserted

30 inserted

12 inserted

40 inserted

3 inserted

18 inserted

7 inserted

20 inserted

6 inserted, right rotation

22 inserted, left rotation

iii

| 15 | |

15 inserted

| 5 | 15 |

5 inserted

| 5 | 15 |

↓

| 30 | |

30 inserted, overflow

| 15 | |

| 5 | 12 | | 30 | |

12 inserted, overflow

| 15 | |

| 5 | 12 | | 30 | 40 |

40 inserted

| 5 | 15 |

| 3 | | | 12 | | | 30 | 40 |

3 inserted, overflow

| 15 | |

| 5 | | | 30 | |

| 3 | | | 12 | | | 18 | | | 40 | |

18 inserted, overflow

| 15 | |

| 5 | | | 30 | |

| 3 | | | 7 | 12 | | 18 | | | 40 | |

7 inserted

| 15 | |

| 5 | | | 30 | |

| 3 | | | 7 | 12 | | 18 | 20 | | 40 | |

20 inserted

| 15 | |

| 5 | 7 | | 30 | |

| 3 | | | 6 | | | 12 | | | 18 | 20 | | 40 | |

6 inserted, overflow

| 15 | |

| 5 | 7 | | 20 | 30 |

| 3 | | | 6 | | | 12 | | | 18 | | | 22 | | | 40 | |

22 inserted, overflow

3
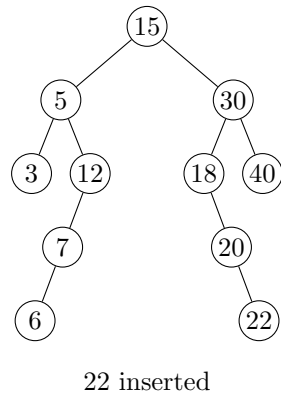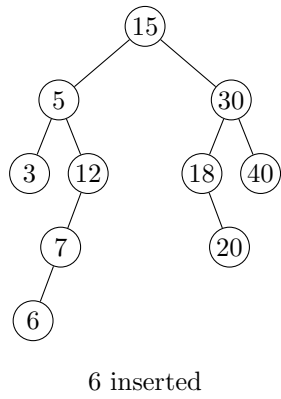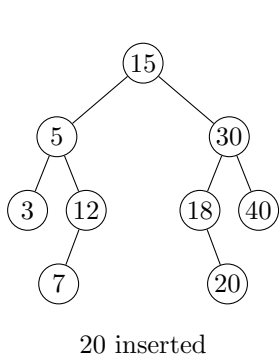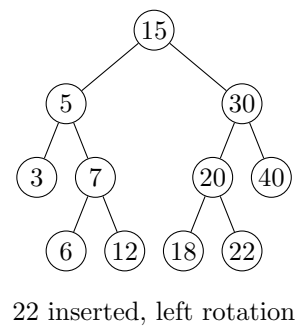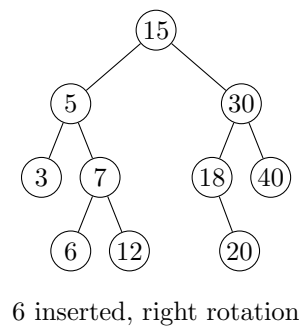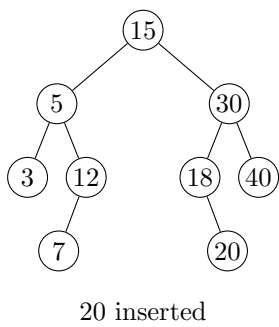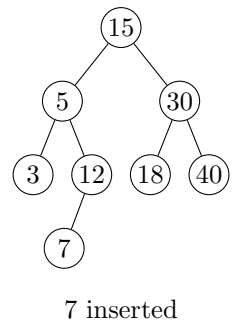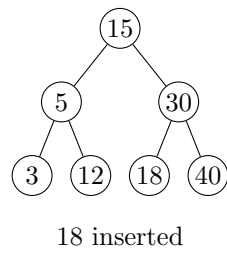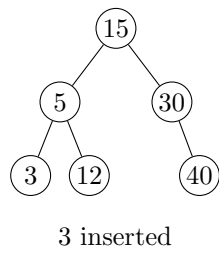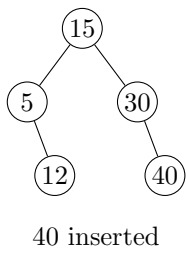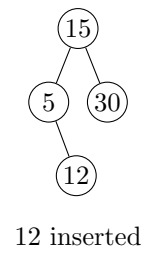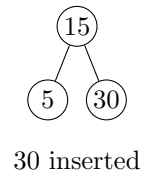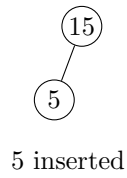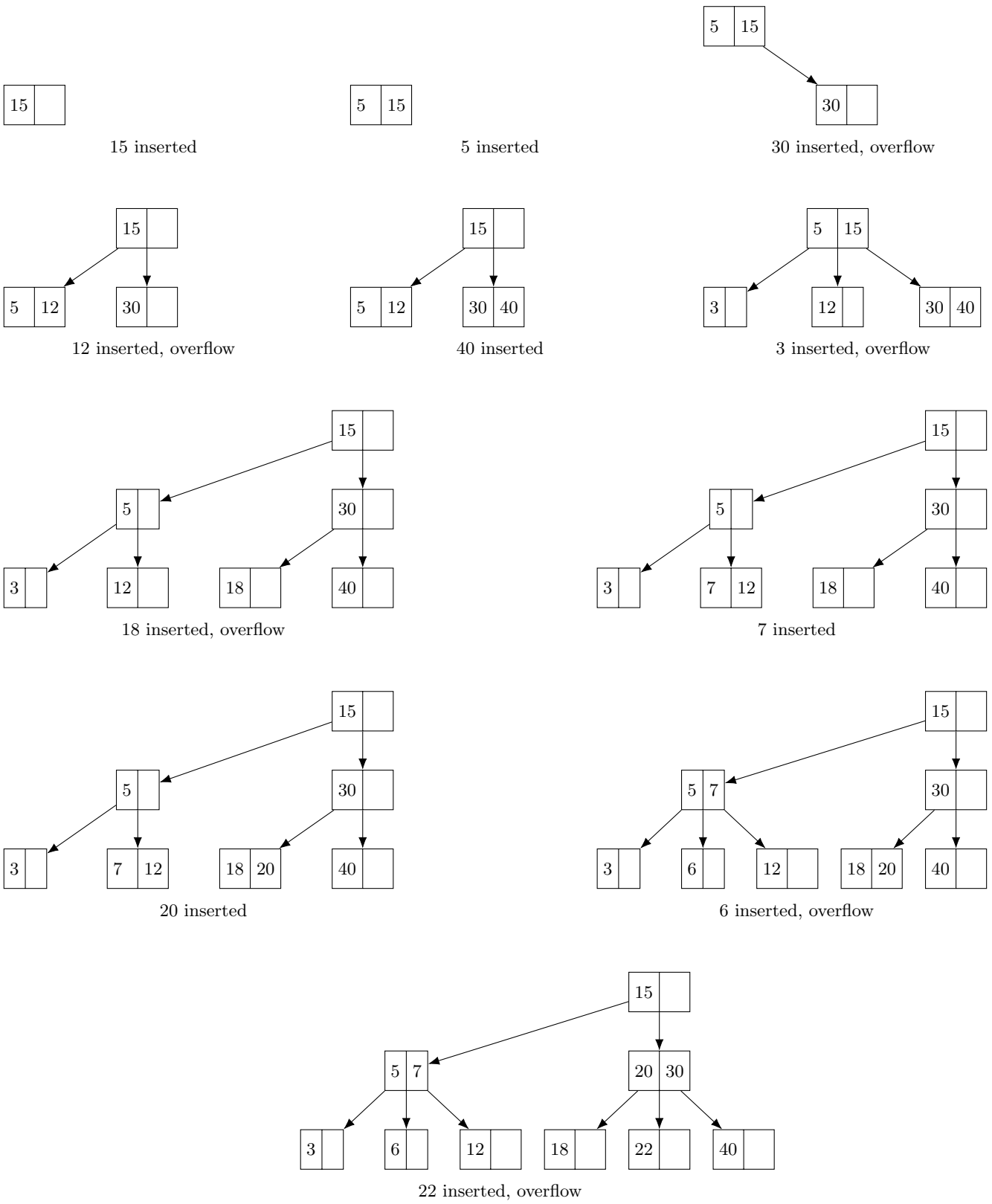
b)

i.

15 deleted, successor convention used

ii.

3 deleted, applied single left rotation

iii.

3 deleted, underflow

c)

i.
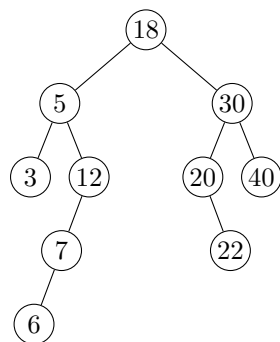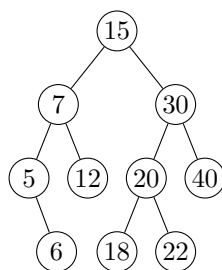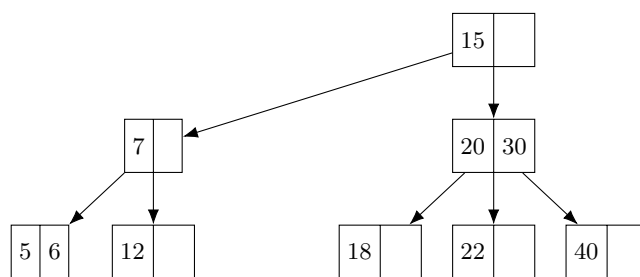
15
5   30
3 12   18   40
7   20   50
6   22

50 added

ii.

15
5   30
3 7   20   40
6 12 18 22   50

50 added

iii.

| 15 | |

| 7 | | | 20 | 30 |

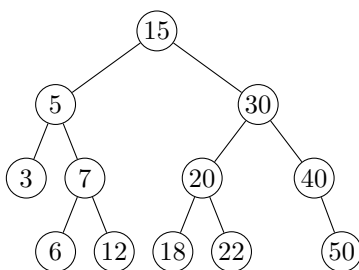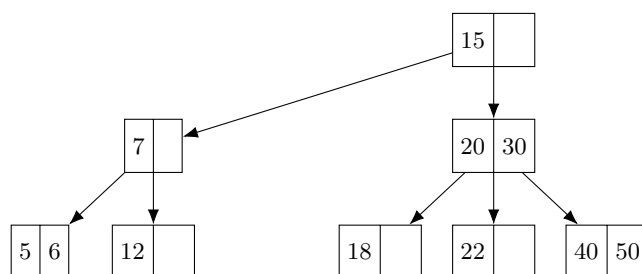| 5 | 6 | | 12 | | | 18 | | | 22 | | | 40 | 50 |
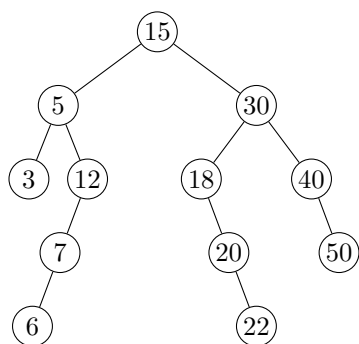
50 added

Question 2

Question 2 (20 points): Use the hash function $h(x) = x \bmod 11$ to load the following values 25, 14, 36, 47 using each of following to resolve collisions into the hash table. Make sure you show all your work:

index	0	1	2	3	4	5	6	7	8	9	10
	33										21

a) $c(i) = i$

index	0	1	2	3	4	5	6	7	8	9	10
	33										21

b) $c(i) = \pm i$

index	0	1	2	3	4	5	6	7	8	9	10
	33										21

c) $c(i) = i * h_p(x)$ where $h_p(x) = 1 + x \bmod 10$

a)

$$25 \bmod 11 = 3 \textbf{ empty}$$
$$14 \bmod 11 = 3 \text{ collision}$$
$$(14 + 1) \bmod 11 = 4 \textbf{ empty}$$
$$36 \bmod 11 = 3 \text{ collision}$$
$$(36 + 1) \bmod 11 = 4 \text{ collision}$$
$$(36 + 2) \bmod 11 = 5 \textbf{ empty}$$
$$47 \bmod 11 = 3 \text{ collision}$$
$$(47 + 1) \bmod 11 = 4 \text{ collision}$$
$$(47 + 2) \bmod 11 = 5 \text{ collision}$$
$$(47 + 3) \bmod 11 = 6 \textbf{ empty}$$

index	0	1	2	3	4	5	6	7	8	9	10
	33			25	14	36	47				21

b)

$$25 \bmod 11 = 3 \ \textbf{empty}$$
$$14 \bmod 11 = 3 \ \text{collision}$$
$$(14 + 1) \bmod 11 = 4 \ \textbf{empty}$$
$$36 \bmod 11 = 3 \ \text{collision}$$
$$(36 + 1) \bmod 11 = 4 \ \text{collision}$$
$$(36 - 1) \bmod 11 = 2 \ \textbf{empty}$$
$$47 \bmod 11 = 3 \ \text{collision}$$
$$(47 + 1) \bmod 11 = 4 \ \text{collision}$$
$$(47 - 1) \bmod 11 = 2 \ \text{collision}$$
$$(47 + 2) \bmod 11 = 5 \ \textbf{empty}$$

index	0	1	2	3	4	5	6	7	8	9	10
	33		36	25	14	47					21

c)

$$25 \bmod 11 = 3 \ \textbf{empty}$$
$$14 \bmod 11 = 3 \ \text{collision}$$
$$h_p(14) = 1 + 14 \bmod 10 = 5$$
$$(14 + 1 \cdot 5) \bmod 11 = 8 \ \textbf{empty}$$
$$36 \bmod 11 = 3 \ \text{collision}$$
$$h_p(36) = 1 + 36 \bmod 10 = 7$$
$$(36 + 1 \cdot 7) \bmod 11 = 10 \ \text{collision}$$
$$(36 + 2 \cdot 7) \bmod 11 = 6 \ \textbf{empty}$$
$$47 \bmod 11 = 3 \ \text{collision}$$
$$h_p(47) = 1 + 47 \bmod 10 = 8$$
$$(47 + 1 \cdot 8) \bmod 11 = 0 \ \text{collision}$$
$$(47 + 2 \cdot 8) \bmod 11 = 8 \ \text{collision}$$
$$(47 + 3 \cdot 8) \bmod 11 = 5 \ \textbf{empty}$$

index	0	1	2	3	4	5	6	7	8	9	10
	33			25		47	36		14		21

Question 3

Question 3 (20 points): Given the following search pattern: ABXABYABXZ
   a) (5 points) Create the KMP lps array.
   b) (15 points) Using that search pattern and the array you created, perform a search on the following block
      of text by filling the following table: ABXABYABXABYABXZABC

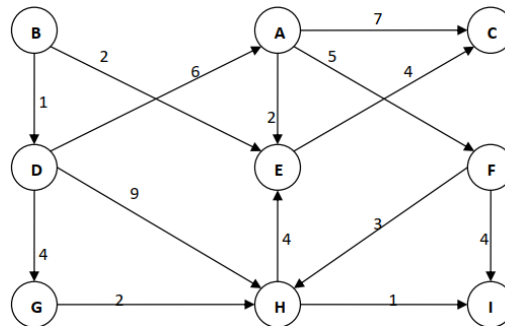| 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	#comparisons
A	B	X	A	B	Y	A	B	X	A	B	Y	A	B	X	Z	A	B	C	

a)

next array $= [-1, 0, 0, 0, 1, 2, 0, 1, 2, 3]$

b)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	#comparisons
A	B	X	A	B	Y	A	B	X	A	B	Y	A	B	X	Z	A	B	C	
A	B	X	A	B	Y	A	B	X	Z										10
					A	B	X	A	B	Y	A	B	X	Z					7, match

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Question 4 (60 points): Given the following graph, answer the following questions. Make sure to process vertices or adjacent vertices in alphabetical order.

a) (9 points) List the vertices in the order they are visited using pre-order depth-first traversal starting from **vertex A**.

b) (9 points) List the vertices in the order they are visited using post-order depth-first traversal starting from **vertex A**.

c) (9 points) List the vertices in the order they are visited using breadth-first traversal starting from **vertex A**.

d) (9 points) List the vertices in the order they are visited using Topological order traversal.

e) (24 points) Trace the execution of Dijkstra's algorithm, filling the table below, as it solves the shortest path problem starting from **vertex B**. Draw the resulting vertex-weighted graph.

Pass	initially	1	2	3	4	5	6	7	8	9	weight	Predecessor
Active Vertex												
A												
B												
C												
D												
E												
F												
G												
H												
I												

a)

pre-order traversal: A, C, E, F, H, I, B, D, G

b)

post-order traversal: C, E, I, H, F, A, G, D, B

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c)

BFS: A, C, E, F, H, I, B, D, G

d)

Topological sort: B, D, A, F, G, H, E, C, I

e)

Pass Active cell	Active cell initially	1 B	2 D	3 E	4 G	5 C	6 A	7 H	8 I	9 F	weight	predecessor
A	∞	∞	7	7	7	7	7	7	7	7	7	D
B	0	0	0	0	0	0	0	0	0	0	0	0
C	∞	∞	∞	6	6	6	6	6	6	6	6	E
D	∞	1	1	1	1	1	1	1	1	1	1	B
E	∞	2	2	2	2	2	2	2	2	2	2	B
F	∞	∞	∞	∞	∞	∞	12	12	12	12	12	A
G	∞	∞	5	5	5	5	5	5	5	5	5	D
H	∞	∞	10	10	7	7	7	7	7	7	7	G
I	∞	∞	∞	∞	∞	∞	∞	8	8	8	8	H