

(1)

Name: Muhammad Asim Anis

ID: FA14-BSSE-0032

Assignment #4

Topic: Asymptotic Notations: example # 1

i) Big O (Best)

$$O \leq f_n < c(g(n))$$

$$f_n = 3n + 2$$

$$g_n = n$$

$$O \leq 3n + 2 \leq c(n) \quad c=1$$

$$O \leq 3(1) + 2 \leq 1(1) \quad n=1$$

$$O \leq 5 \leq 1$$

$$O \leq 3(2) + 2 \leq 2(2) \quad c=2$$

$$O \leq 8 \leq 4 \quad n=2$$

$$O \leq 3(3) + 2 \leq 3(3) \quad c=3$$

$$O \leq 11 \leq 9 \quad n=3$$

$$O \leq 3(4) + 2 \leq 4(4)$$

$$\boxed{c=4}$$

$$O \leq 14 \leq 16 \quad n=4$$

equation satisfy of the best
Case.

(2)

ii) Big Ω (worst)

$$0 \leq f_n \geq c(g(n))$$

$$f_n = 3n + 2$$

$$g_n = n$$

$$f_n \geq c(g(n))$$

$$3n + 2 \geq c(n)$$

$$\begin{matrix} c=1 \\ n=1 \end{matrix}$$

$$3(1) + 2 \geq c(1)(1)$$

$$5 \geq 1$$

equation satisfy of the worst case.

iii) Big Θ (Average)

$$c_1(g(n)) \leq f_n \leq c_2(g(n))$$

$$f_n = 3n + 2$$

$$g_n = n$$

$$c_1(n) \leq 3n + 2 \leq c_2(n)$$

$$1(1) \leq 3(1) + 2 \leq 1(1)$$

$$1 \leq 5 \leq 1$$

$$4(4)/4$$

$$3(3) \leq 3(3) + 2 \leq 3(3)$$

$$\checkmark (9 \leq 11) \leq 9$$

$$3(4) \leq 3(4) + 2 \leq 4(4)$$

$$\checkmark 12 \leq 14 \leq 20$$

$$\boxed{\begin{matrix} c_1 = 3 \\ c_2 = 4 \\ n = 3 \end{matrix}}$$

$$\boxed{\begin{matrix} c_1 = 3 \\ c_2 = 4 \\ n = 3 \end{matrix}}$$

$$\boxed{\begin{matrix} c_1 = 3 \\ c_2 = 4 \\ n = 4 \end{matrix}}$$

③

$$12 \leq 14 \leq 20$$

equation satisfy of the Average
Case.

(4)

example # 2:

i) Big O (Best)

$$O \leq f_n \leq C(g(n))$$

$$f_n = n^2 + 1$$

$$g_n = n$$

$$O \leq n^2 + 1 \leq C(n) \quad C=1$$

$$O \leq (1)^2 + 1 \leq 1(1) \quad n=1$$

$$O \leq 2 \leq 1.$$

$$O \leq (2)^2 + 1 \leq 2(2) \quad C=2$$

$$O \leq 5 \leq 4 \quad n=2$$

$$O \leq (3)^2 + 1 \leq 3(3) \quad \boxed{\begin{matrix} C=3 \\ n=3 \end{matrix}}$$

$$O \leq 7 \leq 9$$

equation satisfy of the Best case.

(5)

ii) Big Ω (worst)

$$O \subseteq f_n \geq c(g_n)$$

$$f_n = n^2 + 1$$

$$g_n = n$$

$$f_n \geq c(g_n) \quad c=1$$

$$n^2 + 1 \geq c(n) \quad n=1$$

$$(1)^2 + 1 \geq 1 \cdot (1)$$

$$\checkmark \quad 2 \geq 1$$

equation satisfy of the worst
case.

(6)

Big O (Average)

$$O \leq c_1(g(n)) \leq f_n \leq c_2(g(n))$$

$$f_n = n^2 + 1$$

$$g(n) = n$$

$$c_1(n) \leq n^2 + 1 \leq c_2(n) \quad [c_1=1]$$

$$1(1) \leq (1)^2 + 1 \leq 1(1) \quad [c_2=1]$$

$$\boxed{1} \leq \boxed{2} \leq 1 \quad n=1$$

$$c_1(2) \leq (2)^2 + 1 \leq 2(2) \quad c_1=1$$

$$2 \leq 5 \leq 4 \quad c_2=2$$

$$n=2$$

$$1(3) \leq (3)^2 + 1 \leq 3(3) \quad c_1=3$$

$$3 \leq 7 \leq 9 \quad [c_2=3]$$

$$n=3$$

equation satisfy of the Average case.

(7)

Topic : Linear Search example # 1

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----

Key = 2

i

$$(2 == 8)$$

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----



$$(2 == 5)$$

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----



$$(2 == 11)$$

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----



$$(2 == 9)$$

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----



$$(2 == 2)$$

8	5	11	9	2	1	7	12	10
---	---	----	---	---	---	---	----	----

Number found = 2

Complete the iteration and end or
else break the flow.

(8)

Example # 2

5	4	2	9	7	6	15	14	1	9
---	---	---	---	---	---	----	----	---	---

Key = 15

$$i \quad (15 == 5)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 11)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 12)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 9)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 7)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 6)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

$$\rightarrow i \quad (15 == 15)$$

5	11	2	9	7	6	15	14	1	9
---	----	---	---	---	---	----	----	---	---

✓

Number found = 15

Now break the flow of Loop :

9

Topic: Binary Search

example: #1

5	11	12	14	16	20	24	30	50
---	----	----	----	----	----	----	----	----

$$\text{Key} = 14$$

low	mid	high						
5	11	12	14	16	20	24	30	50

$$\checkmark (14 < 16), \quad (14 > 16) \times \quad (14 = 16) \times$$

low	mid	high
5	11	12

$$\checkmark (14 > 11) \quad (14 < 11) \times (14 = 11)$$

low/mid	high
12	14

$$\neg (14 > 12) \times (14 < 12) \times (14 = 12)$$

low/mid 14 high

$\times (14 > 14) \quad \checkmark (14 == \text{mid} = 14) \quad \times (14 < 14)$

Number found = 14

while condition false. Loop end.

(10)

example # 2

1	5	7	9	10	12	16	18	21	24
---	---	---	---	----	----	----	----	----	----

Key = 16

low mid high

1	5	7	9	10	12	16	18	21	24
---	---	---	---	----	----	----	----	----	----

✓ ~~(16 > 10)~~ ~~(16 < 10)~~ (16 == 10)

low mid high

12	16	18	21	24
----	----	----	----	----

→ (16 < 18)

low/mid high

12	16
----	----

→ (16 > 12)

Low/mid

16

 high

→ (16 == 16)

Number found = 16
while condition false loop end.

(11)

Topic: Bubble Sort

example # 1

5	2	1	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

Iteration 1:

5	2	1	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J

if (arr[i] > arr[j])
 $(5 > 2)$ Swap

2	5	1	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i f J (2 > 1) swap

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($1 > 4$) false

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($1 > 7$)

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($1 > 6$)

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($1 > 8$) ($1 > 10$): ($1 > 9$) ($1 > 11$) false

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($1 > 14$) false.

After this all conditions are false:

(12)

Iteration : 2 :

1	5	2	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i I J

 $(5 > 2) \checkmark$

1	2	5	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J

 $(2 > 4) \times$

1	2	5	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i

J

After this all condition are false. $(2 > 14) \times$

Iteration : 3

1	2	5	4	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i I J

 $(5 > 4) \checkmark$

1	2	4	5	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i I J

 $(4 > 7) \times$

1	2	4	5	7	6	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

J

After this all condition are false.

(13)

Iteration : 4

1	2	4	5	7	6	8	9	11	10	14
i	J			(5 > 7)	X					:

1	2	4	5	7	6	8	9	11	10	14
i										(5 > 14) J

~~All~~ All the condition are false

Iteration : 5

→	1	2	4	5	7	6	8	9	11	10	14
	i	J			(7 > 6)	✓					

1	2	4	5	6	7	8	9	11	10	14
i	J				(6 > 8)	X				

→ After this all condition are false.

Iteration : 6

1	2	4	5	6	7	8	9	11	10	14
i	J				(7 > 8)	X				:

1	2	4	5	6	7	8	9	11	10	14
i										J

All conditions are false.

(14)

Iteration : 7 :

1	2	4	5	6	7	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($8 > 9$) X :

1	2	4	5	6	7	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i

J

All the conditions are false.

Iteration : 8

1	2	4	5	6	7	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($9 > 11$) X :

1	2	4	5	6	7	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i

J

All the conditions are false.

Iteration : 9

1	2	4	5	6	7	8	9	11	10	14
---	---	---	---	---	---	---	---	----	----	----

i J ($11 > 10$) ✓

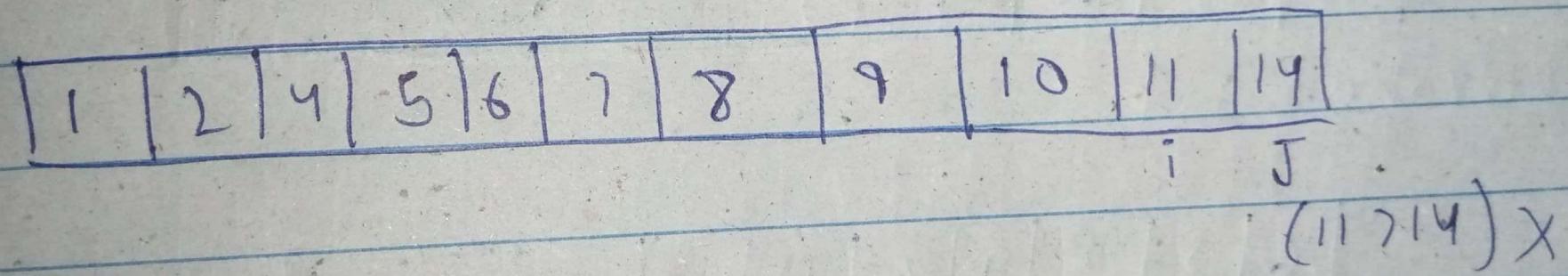
1	2	4	5	6	7	8	9	10	11	14
---	---	---	---	---	---	---	---	----	----	----

i J ($10 > 14$)

X

(15)

Iteration : 10



• Sorted Array:

1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14

(1)

example # 2 :

6	2	3	4	7	12	10	8	1	9
---	---	---	---	---	----	----	---	---	---

Iteration : 1

6	2	3	9	7	12	10	8	1	4
---	---	---	---	---	----	----	---	---	---

 // //
i j (6 > 2) ✓

2	6	3	9	7	12	10	8	1	4
i		J						(2>3) X	

2 6 3 4 7 12 10 8 1 4
i J (277) x

2	6	3	9	7	12	10	8	1	4
1				J				(2-7-11)	

2	6	3	9	7	12	10	8	11	4
i					j	(3, 210)			

2 | 6 | 3 | 4 | 7 | 12 | 10 | 8 | 1 | 9

1 | 6 | 3 | 9 | 7 | 12 | 10 | 8 | 2 | 4

$(1 \rightarrow 4) X$

(17)

Iteration # 2:

1	6	3	9	7	12	10	8	2	4
i	J								

 $(6 > 3) \checkmark$

1	3	6	9	7	12	10	8	2	4
i	J								

 $(3 > 9) \times$

1	3	6	9	7	12	10	8	2	4
i	J								

 $(3 > 7) \times$

1	3	6	9	7	12	10	8	2	4
i	J								

 $(3 > 12) \times$

1	3	6	9	7	12	10	8	1	4
i	J								

 $(3 > 10) \times$

1	3	6	9	7	12	10	8	2	4
i	J								

 $(3 > 8) \times$

1	3	6	9	7	12	10	8	2	4
i	J								

 $(3 > 3) \times$

1	2	6	9	7	12	10	8	3	4
i	J								

 $(2 > 4) \times$

(17)

Iteration : 43

1	2	6	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 9) X$

1	2	8	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 7) X$

1	2	6	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 12) X$

1	2	6	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 10) X$

1	2	6	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 8) X$

1	2	6	9	7	12	10	8	3	14
---	---	---	---	---	----	----	---	---	----

i J

 $(6 > 3) X$

1	2	3	9	7	12	10	8	6	14
---	---	---	---	---	----	----	---	---	----

i J

 $(3 > 4) X$

(19)

Iteration : 4

1	2	3	9	7	12	10	8	6	4
---	---	---	---	---	----	----	---	---	---

i j

 $(9 > 7) \checkmark$

1	2	3	7	9	12	10	8	6	4
---	---	---	---	---	----	----	---	---	---

i j

 $(7 > 12) \times$

1	2	3	7	9	12	10	8	6	4
---	---	---	---	---	----	----	---	---	---

i j

 $(7 > 10) \times$

1	2	3	7	9	12	10	8	6	4
---	---	---	---	---	----	----	---	---	---

i j

 $(7 > 8) \times$

1	2	3	7	9	12	10	8	6	4
---	---	---	---	---	----	----	---	---	---

i j

 $(7 > 6) \checkmark$

1	2	3	6	8	12	10	8	7	4
---	---	---	---	---	----	----	---	---	---

i j

 $(6 > 4)$

1	2	3	4	9	12	10	8	7	6
---	---	---	---	---	----	----	---	---	---

(20)

Iteration : 5

1	2	3	4	9	12	10	7	17	16
i	J								(6 > 12) X

1	2	3	4	8	12	10	8	1	6
i		J							(9 > 10) X

1	2	3	4	9	12	10	8	7	6
i			J						(9 > 8) ✓

1	2	3	4	8	12	10	9	7	6
i				J					(8 > 7) ✓

1	2	3	4	7	12	10	9	8	6
i				J					(7 > 6) ✓

1	1	2	3	4	6	12	10	9	8	7	6
i											

Iteration : 6

1	2	3	4	6	12	10	9	7	8
i		J							(12 > 10) ✓

1	2	3	4	6	10	12	9	8	7
i			J						(10 > 9) ✓

1	2	3	4	6	9	12	10	8	7
i				J					(9 > 8) ✓

1	2	3	4	6	8	12	10	9	7
i					J				(8 > 7) ✓

1	2	3	4	6	7	12	10	9	8
i									

(21)

Iteration : 7

1	2	3	4	6	7	12	10	9	8
i		J							
									(12 > 10) ✓
1	2	3	4	6	7	10	12	9	8
i		J							
									(10 > 9) ✓
1	2	3	4	6	7	9	12	10	8
i		J							
									(9 > 8)
1	2	3	4	6	7	8	12	10	9
i		J							

Iteration : 8

1	2	3	4	6	7	12	10	9	
i		J							
									(12 > 10) ✓
1	2	3	4	6	7	8	10	12	9
i		J							
									(10 > 9) ✓
1	2	3	4	6	7	8	9	12	10
i		J							

Iteration : 9

1	2	3	4	6	7	8	9	12	10
i		J							
									(12 > 10) ✓
1	2	3	4	6	7	8	9	10	12
i		J							

Sorted Array:

1, 2, 3, 4, 6, 7, 8, 9, 10, 12

(22)

Topic: Selection Sort

example #1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

Iteration :- 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✓ if ($5 > 2$) (index > j)

index = 5

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✓ if ($2 > 1$) update

index = 2

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 3$)

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 9$)

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 12$)

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 10$)

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 8$) ✗

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 6$) ✗

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 11$) ✗

index = 1

5	2	1	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

i j ✗ if ($1 > 14$) ✗

index = 1

1	2	5	3	9	12	10	8	6	11	14
---	---	---	---	---	----	----	---	---	----	----

(Swap)

(23)

Iteration : 2

1	2	5	3	9	12	10	8	6	11	14
9	J									

if ($2 > 5$) X

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($1.2 > 3$) X

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($2 > 9$) X

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($2 > 12$)

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($2 > 10$)

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($2 > 8$)

1	2	5	3	9	12	10	8	6	11	14
i	J									

J if ($2 > 6$)

1	2	5	3	9	12	10	8	6	11	14
i	J									

J if ($2 > 11$)

1	2	5	3	9	12	10	8	6	11	14
i	J									

J if ($2 > 14$)

1	2	5	3	9	12	10	8	6	11	14
										(swap)

(24)

Iteration : 3

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($5 > 3$) ✓

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($5 > 9$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 12$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 10$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 8$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 6$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 11$) ✗

1	2	5	3	9	12	10	8	6	11	14
i	J									

if ($3 > 14$) ✗

1	2	3	5	9	12	10	8	6	11	14

swap.

(245)

Iteration : 4

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 9) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 12) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 10) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 8) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 6) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 11) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

(5 > 14) X

1	2	3	5	9	12	10	8	6	11	14
i			j							

Swap

(26)

Iteration : 5

1	2	3	5	9	12	10	8	6	11	14
i		J								

(9 > 12) X

1	2	3	5	9	12	10	8	6	11	14
i		J								

(9 > 10) X

1	2	3	5	9	12	10	8	6	11	14
i		J								

(9 > 8) ✓

1	2	3	5	9	12	10	8	6	11	14
i		J								

(8 > 6) ✓

1	2	3	5	9	12	10	8	6	11	14
i		J								

(8 > 11) X

1	2	3	5	9	12	10	8	6	11	14
i		J								

(8 > 14) X

1	2	3	5	6	12	10	8	9	11	14
i		J								

Swap

Iteration : 6

1	2	3	5	6	12	10	8	9	11	14
i		J								

(12 > 10) ✓

1	2	3	5	6	12	10	8	9	11	14
i		J								

(10 > 8) ✓

1	2	3	5	6	12	10	8	9	11	14
i		J								

(8 > 9) X

1	2	3	5	6	12	10	8	9	11	14
i		J								

(8 > 11)

(27)

1	2	3	5	6	12	10	i	9	11	14
---	---	---	---	---	----	----	---	---	----	----

X J ($8 > 14$)

1	2	3	5	6	8	10	12	9	11	14
---	---	---	---	---	---	----	----	---	----	----

swap

Iteration : 7

1	2	3	5	6	8	10	i	12	9	11	14
---	---	---	---	---	---	----	---	----	---	----	----

J ($10 > 12$) X

1	2	3	5	6	8	10	12	i	9	11	14
---	---	---	---	---	---	----	----	---	---	----	----

J ($10 > 9$) ✓

1	2	3	5	6	8	10	12	i	9	11	14
---	---	---	---	---	---	----	----	---	---	----	----

J ($9 > 11$) X

1	2	3	5	6	8	10	i	12	9	11	14
---	---	---	---	---	---	----	---	----	---	----	----

J ($9 > 14$)

1	2	3	5	6	8	9	10	i	12	10	11	14
---	---	---	---	---	---	---	----	---	----	----	----	----

swap

Iteration : 8

1	2	3	5	6	8	9	12	i	10	11	14
---	---	---	---	---	---	---	----	---	----	----	----

J ($12 > 10$) ✓

1	2	3	5	6	8	9	12	i	10	11	14
---	---	---	---	---	---	---	----	---	----	----	----

J ($10 > 11$) X

1	2	3	5	6	8	9	12	i	10	11	14
---	---	---	---	---	---	---	----	---	----	----	----

J ($10 > 14$) X

1	2	3	5	6	8	9	10	i	12	11	14
---	---	---	---	---	---	---	----	---	----	----	----

swap

(28)
28

Iteration : 9.

1	2	3	5	6	8	9	10	12	11	14	index=12
i	J	(12 > 11)	✓								

1	2	3	5	6	8	9	10	12	11	14	index=11
i	J	(11 > 14)	X								

1	2	3	5	6	8	9	10	11	12	14	(swap)
---	---	---	---	---	---	---	----	----	----	----	--------

Iteration : 10

1	2	3	5	6	8	9	10	11	12	14	index=12
i	J	(12 > 14)	X								

1	2	3	5	6	8	9	10	11	12	14	swap
---	---	---	---	---	---	---	----	----	----	----	------

Sorted Array :

1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 14

(29)

example # 2;

2 | 1 | 3 | 5 | 6 | 8 | 7 | 10 | 11 | 14 |

Iteration : 1

Diagram showing an array [2, 1, 3, 5, 6, 8, 7, 10, 11, 14] with indices $i=2$ and $j=5$. The element at index 2 is 5, which is greater than 3 at index 5. A checkmark indicates this step is correct.

Diagram illustrating an array and an index assignment:

```

    [ 2 | 1 | 3 | 5 | 6 | 8 | 7 | 10 | 11 | 14 ] index=1
    i      j
  
```

The element at index 1 is 1, which is less than its predecessor 2. A bracket under the first two elements indicates they are part of a swap operation.

Diagram illustrating the state of an array and its indices:

- Array elements: $[2 | 1 | 13 | 5 | 6 | 3 | 7 | 10 | 11 | 14]$
- Indices: $i = 1$, $j = 5$, $k = 12$
- Subarray indicated by a bracket: $(13 \ 5 \ 6) \times$

2	1	3	5	6	8	7	10	11	14	index = 1
i				5					(1 > 8) X	

Diagram illustrating an array with index = 1. The array elements are 2, 1, 3, 5, 6, 8, 7, 10, 11, 14. The element at index 10 is circled, and the element at index 11 is crossed out.

2	1	3	5	6	8	7	10	11	14

index = 7
5(11 > 14) X

1	2	3	5	6	8	7	10	11	14	(swap)
---	---	---	---	---	---	---	----	----	----	--------

(30)

Iteration : 2 :

1	2	3	5	6	8	7	10	11	14
i	J								

(2 > 3) X

1	2	3	5	6	8	7	10	11	14
		J							

(2 7 5) X

1	2	3	5	6	8	7	10	11	14
			J						

(2 7 6) X

1	2	3	5	6	8	7	10	11	14
				J					

(2 > 8) X

1	2	3	5	6	8	7	10	11	14
					J				

(2 > 7) X

1	2	3	5	6	8	7	10	11	14
						J			

(2 > 10) X

1	2	3	5	6	8	7	10	11	14
							J		

(2 > 11) X

1	2	3	5	6	8	7	10	11	14
								J	

(2 > 14) X

1	2	3	5	6	8	7	10	11	14
									swap

(31)

Iteration : 3

1	2	3	5	6	8	7	10	11	14
i	J								

(3 > 5) X

1	2	3	5	6	8	7	10	11	14
i		J							

(3 > 6) X

1	2	3	5	6	8	7	10	11	14
i			J						

(3 > 8) X

1	2	3	5	6	8	7	10	11	14
i				J					

(3 > 7) X

1	2	3	5	6	8	7	10	11	14
i					J				

(3 > 10) X

1	2	3	5	6	8	7	10	11	14
i						J			

(3 > 11) X

1	2	3	5	6	8	7	10	11	14
i							J		

1	2	3	5	6	8	7	10	11	14
i							J		

(3 > 14) X

1	2	3	5	6	8	7	10	11	14
									swap

(32)

Iteration : 4

1	2	3	5	6	8	7	10	11	14
i		J							

(5 > 6) X

index = 5

1	2	3	5	6	8	7	10	11	14
i		J							

(5 > 8) X.

index = 5

1	2	3	5	6	8	7	10	11	14
i			J						

(5 > 7) X.

index = 5

1	2	3	5	6	8	7	10	11	14
i			J						

(5 > 10) X.

index = 5

1	2	3	5	6	8	7	10	11	14
i				J					

(5 > 11) X.

index = 5

1	2	3	5	6	8	7	10	11	14
i					J				

(5 > 14) X

index = 5

1	2	3	5	6	8	7	10	11	14
i						J			

swap

(33)

Iteration : 5

1	2	3	5	6	8	7	10	11	14
i	J								

(8 > 8) X

1	2	3	5	6	8	7	10	11	14
i	J								

(6 > 7) X

1	2	3	5	6	8	7	10	11	14
i		J							

(6 > 10) X

1	2	3	5	6	8	7	10	11	14
i		J							

(6 > 11) X

1	2	3	5	6	8	7	10	11	14
i			J						

(6 > 14) X

1	2	3	5	6	8	7	10	11	14
i									

Swap

Iteration : 6

1	2	3	5	6	8	7	10	11	14
*	i	J							

(8 > 7) ✓

1	2	3	5	6	8	7	10	11	14
i		J							

(8 > 10) X

1	2	3	5	6	8	7	10	11	14
i			J						

(7 > 11) X

1	2	3	5	6	8	7	10	11	14
i				J					

(7 > 14) X

1	2	3	5	6	7	8	10	11	14
i									

Swap

Iteration : 7

1	2	3	5	6	7	8	10	11	14	index=8
i						j				(8>10) X
1	2	3	5	6	7	8	10	11	14	index=8
i						j				(8>11) X
1	2	3	5	6	7	8	10	11	14	index=8
i						j				(8>14) X
1	2	3	5	6	7	8	10	11	14	swap

Iteration : 8

1	2	3	5	6	7	8	10	11	14	index=10
i						j				(10>11) X
1	2	3	5	6	7	8	10	11	14	index=10
i						j				(10>14) X
1	2	3	5	6	7	8	10	11	14	swap

Iteration : 9

1	2	3	5	6	7	8	10	11	14	index=11
i						j				(11>14) X
1	2	3	5	6	7	8	10	11	14	swap
1	2	3	5	6	7	8	10	11	14	

Sorted Array:

1, 2, 3, 5, 6, 7, 8, 10, 11, 14

(35)

Topic : Insertion Sort

example: #1

2	1	3	5	4	11	10	6	7	
---	---	---	---	---	----	----	---	---	--

Iteration : 1

2	1	3	5	4	11	10	6	7	J=0
	J	i							Key = 1

 $(J \geq 0 \text{ & } arr[i] > \text{key})$ $(\checkmark \text{ & } 12 > 1) \checkmark$

2	2	3	5	4	11	10	6	7	J=-1
---	---	---	---	---	----	----	---	---	------

 $(J \geq 0 \text{ & } arr[i] > (\text{key})) \times$

1	2	3	5	4	11	10	6	7	J=-1
	J	i							arr[J+1] = key

Iteration : 2

1	2	3	5	4	11	10	6	7	J=1
	J	i							Key = 3

 $(1 \geq 0 \text{ & } 2 > 3) \times$

1	2	3	5	4	11	10	6	7	J=1
	J	i							arr[J+1] = key

Iteration : 3

1	2	3	5	9	11	10	6	17
J	i							

J=2
key=5

$$(2 > 0 \& \& 3 > 5) \times$$

arr[J+1] = key

1	2	3	5	4	11	10	6	17
---	---	---	---	---	----	----	---	----

Iteration : 4

1	2	3	5	4	11	10	6	17
J	i							

J=3
key=4

$$(4 > 0 \& \& 5 > 4) \checkmark$$

1	2	3	5	15	11	10	6	17
---	---	---	---	----	----	----	---	----

$$(2 > 0 \& \& 3 > 5) \times$$

arr[J+1] = key

1	2	3	4	5	11	10	6	17
---	---	---	---	---	----	----	---	----

Iteration : 5

1	2	3	4	5	11	10	6	17
J	i							

key=11

$$(4 > 0 \& \& 5 > 11) \times$$

arr[J+1] = key

1	2	3	4	15	11	10	6	17
---	---	---	---	----	----	----	---	----

(37)

Iteration : 6

1	2	3	4	15	11	10	6	7	J=5
					J	i			key=10

 $(5 \geq 0 \text{ \& } 11 > 10) \checkmark$

1	2	3	4	5	11	11	6	7	J=4
					J	i			

 $(4 \geq 0 \text{ \& } 5 > 10) \times$

arr [J+1] = key

1	2	3	4	5	10	11	6	7
---	---	---	---	---	----	----	---	---

Iteration : 7

1	2	3	4	15	11	10	6	7	J=6
					J	i			key=6

 $(6 \geq 0 \text{ \& } 11 > 6) \checkmark$

1	2	3	4	5	10	11	11	7	J=5
---	---	---	---	---	----	----	----	---	-----

 $(5 \geq 0 \text{ \& } 10 > 6) \checkmark$

1	2	3	4	5	10	10	11	7	J=4
---	---	---	---	---	----	----	----	---	-----

 $(4 \geq 0 \text{ \& } 5 > 6) \times$

arr [J+1] = key

1	2	3	4	5	6	10	11	7
---	---	---	---	---	---	----	----	---

(38)

Iteration : 8

1	2	3	4	5	6	10	11	7	
j	i								key = 7

 $(7 >= 0 \text{ } \& \text{ } 11 > 7) \checkmark$

1	2	3	4	5	6	10	10	11	
j	i								

 $(6 >= 0 \text{ } \& \text{ } 10 > 7) \checkmark$

1	2	3	4	5	6	10	10	11	
j	i								

 $(5 >= 0 \text{ } \& \text{ } 6 > 7) \times$ or $[5+1] = \text{key}$

1	2	3	4	5	6	7	10	11	

Sorted Array :

1, 2, 3, 4, 5, 6, 7, 10, 11

(39)

example # 2

3	1	2	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

Iteration : 1

3	1	2	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

J = 0
key = 1
 $(0 >= 0 \text{ \& } 3 > 1) \vee$

3	3	2	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

J = -1
 $(-1 >= 0 \text{ \& } 4 > 1) \times$
 $\text{arr}[-1+1] = \text{key}$

Iteration : 2

1	3	2	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

J = 1
key = 2
 $(1 >= 0 \text{ \& } 3 > 2) \vee$

1	3	3	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

J = -1
 $(0 >= 0 \text{ \& } 1 > 2) \times$
 $\text{arr}[0+1] = \text{key}$
 $\boxed{1 \ 2 \ 3 \ 5 \ 8 \ 11 \ 7 \ 12 \ 6 \ 10}$

(40)

Iteration : 3

1	2	3	5	8	11	7	12	6	10	J=2
J	i									key = 5

$(2 > 0 \text{ \& } 3 > 5) \times$
or $[J+1] = \text{key}$

1	2	3	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

Iteration : 4

1	2	3	5	8	11	7	12	6	10	J=3
J	i									key = 8

$(3 > 0 \text{ \& } 5 > 8) \times$
or $[3+1] = 8$

1	2	3	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

Iteration : 5

1	2	3	5	8	11	7	12	6	10	J=4
J	J									key = 11

$(4 > 0 \text{ \& } 8 > 11) \times$

1	2	3	5	8	11	7	12	6	10
---	---	---	---	---	----	---	----	---	----

(41)

(~~42~~)

Iteration : 6

1	2	3	5	8	11	17	12	16	10
J	i								

J=5
key=7

1	2	3	5	8	11	17	12	16	10
J									

$(5 > 0 \ \& \ 11 > 7) \checkmark$
 $(4 > 0 \ \& \ 8 > 7) \checkmark$

1	2	3	5	8	11	17	12	16	10
J									

$(3 > 0 \ \& \ 5 > 7) \times$
arr[3+1] = key

1	2	3	5	7	8	11	12	16	10
J									

Iteration : 7

1	2	3	5	7	8	11	12	16	10
J	i								

J=6
key=12

$(6 > 0 \ \& \ 11 > 12) \times$
arr[3+1] = key

1	2	3	5	7	8	11	12	16	10
J									

(42)

Iteration : 8

1	2	3	5	7	8	11	12	6	10
				J		J			

J=7
Key=6

 $(7 > 0 \text{ RR } 12 > 6) \checkmark$

1	2	3	5	7	8	11	12	10
				J				J

J (6 > 0 RR 11 > 6) \checkmark

1	2	3	5	7	8	11	12	10
				J				J

~~(5 > 0 RR 8 > 6)~~

 $(5 > 0 \text{ RR } 8 > 6) \checkmark$

1	2	3	5	7	8	8	11	12	10
				J				J	

 $(4 > 0 \text{ RR } 7 > 6) \checkmark$

1	2	3	5	7	7	8	11	12	10
				J				J	

 $(3 > 0 \text{ RR } 5 > 6) \times$

corr [3 7] = key

1	2	3	5	6	7	8	11	12	10

(43)

Iteration : 9

1	2	3	5	6	7	8	11	12	10	J=8
										J i key = 10

1	2	3	5	6	7	8	11	12	12	J=7
										(8>0 & 12>10) ✓

1	2	3	5	6	7	8	11	11	12	J=6
										(7>0 & 11>10) ✓

1	2	3	5	6	7	8	10	11	12	
										(6>0 & 8>10) X arr[6+4] = key

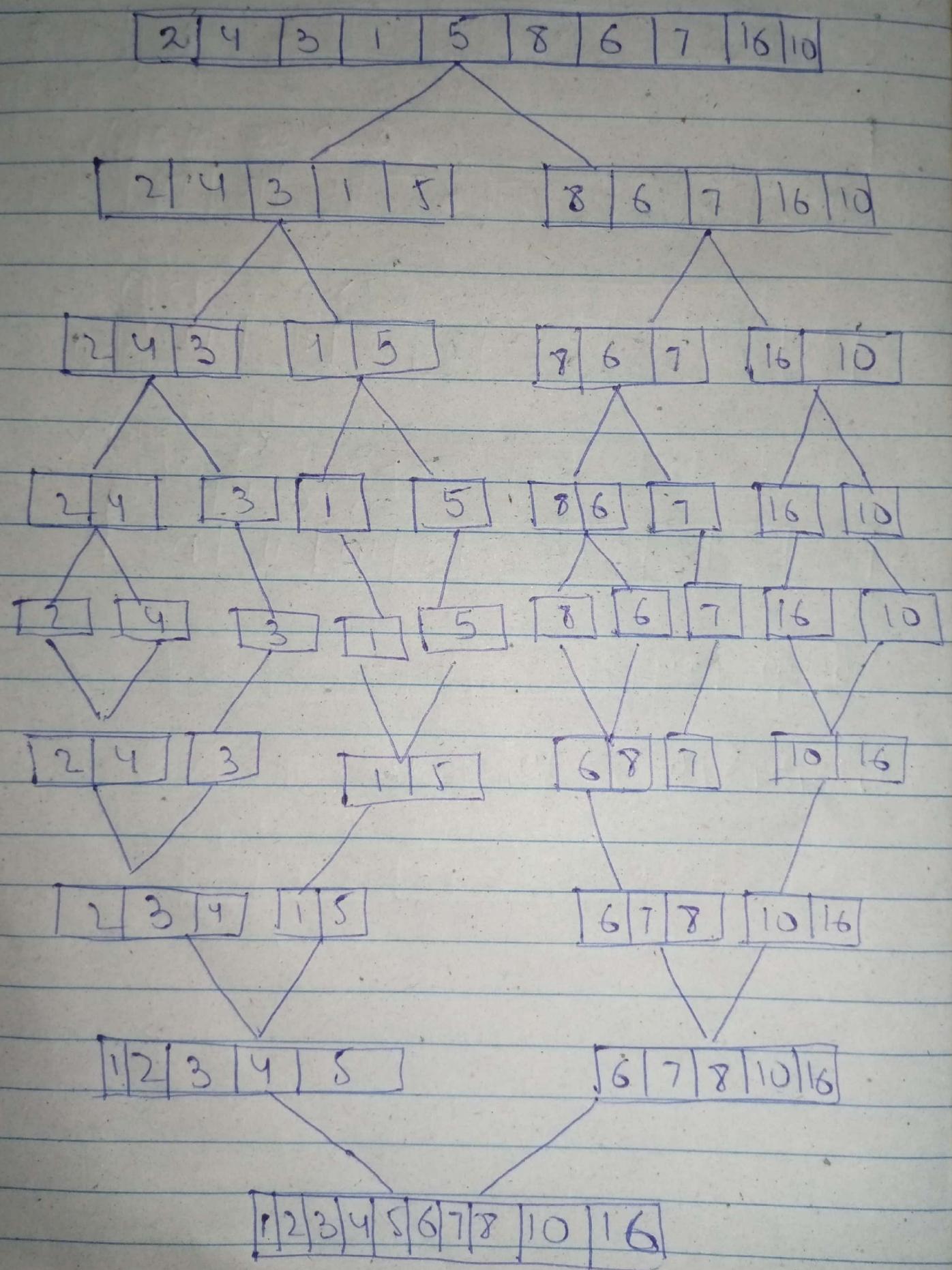
Sorted Array :

1, 2, 3, 5, 6, 7, 8, 10, 11, 12

(44)

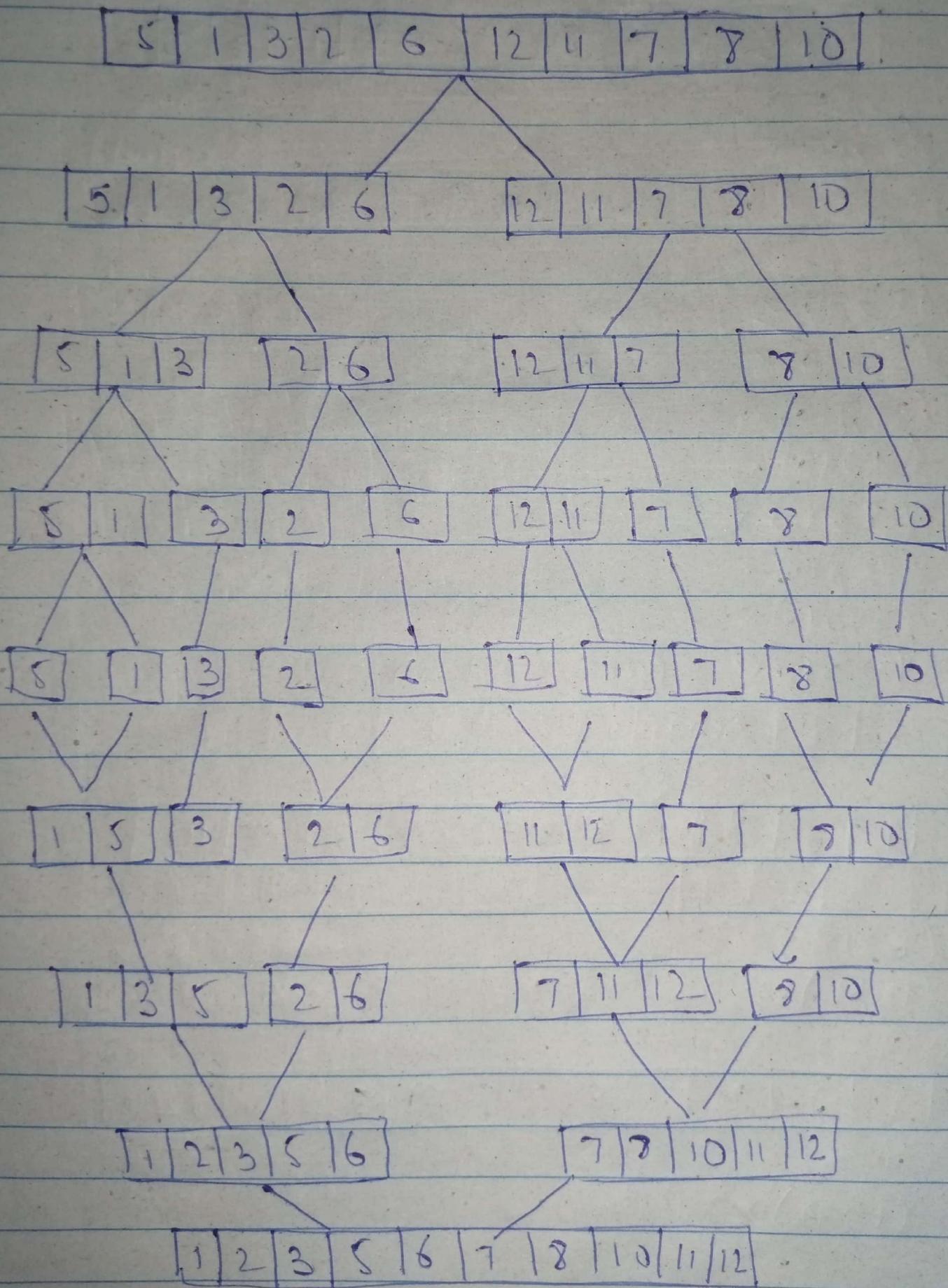
Topic: Merge Sort:

example # 1



(45)

example # 2



Topic: Quicksort

example #1

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

$i \rightarrow i \rightarrow i \rightarrow i \rightarrow i \rightarrow i \rightarrow i \rightarrow J$ → pivot
 $(i > \text{pivot})$ $(J < \text{pivot})$

if I stop then the J run after it.

 $(1 > 10) \times$ $(6 < 10) \checkmark$ $(3 > 10) \times$ $(2 > 10) \times$ $(4 > 10) \times$ $(8 > 10) \times$ $(7 > 10) \times$ $(5 > 10) \times$ $(12 > 10) \checkmark$ now J will run

swap i with J

1	3	2	4	8	7	5	9	6	12	10
---	---	---	---	---	---	---	---	---	----	----

 $J \leftarrow J$ → pivot $(6 > 10) \times$ $(6 < 10) \checkmark$ $(12 > 10) \checkmark$

(i > J) pivot with will swap with i

1	3	2	4	8	7	5	9	6	10	12
---	---	---	---	---	---	---	---	---	----	----

i

J → pivot

 $(1 > 12) \times$

(47)

1	3	12	4	8	7	5	9	6	10	12
i	-j	$\rightarrow i \rightarrow j$	Pivot							

 $(3 > 12) \times$ $(2 > 12) \times$ $i > j$ now Pivot swap with $(4 > 12) \times$ $(8 > 12) \times$ $(5 > 12) \times$ $(9 > 12) \times$ $(6 > 12) \times$ $(10 > 12) \times$ $(12 > 12) \times$

1	3	12	4	8	7	5	9	6	10	12
i	-j	$\rightarrow i \rightarrow j$	Pivot							

Sorted

 $(17, 10) \times$ $(3 > 10) \times$ $i > j$ Pivot will swap $(2 > 10) \times$ $(4 > 10) \times$ $(8 > 10) \times$ $(7 > 10) \times$ $(9, 5 > 10) \times$ $(9 > 10) \times$ $(6 > 10) \times$

Sorted

1	3	12	4	8	7	5	9	6	10	12
i	-j	$\rightarrow i \rightarrow j$	Pivot							

(48)

1	3	2	4	8	7	5	9	6
---	---	---	---	---	---	---	---	---

$i \rightarrow i \rightarrow i \rightarrow i \rightarrow i \rightarrow j \leftarrow j \rightarrow \text{pivot}$

$(1 > 8) \times \quad (9 < 6) \times$

$(3 > 6) \times \quad (5 < 6) \checkmark$

$(2 > 6) \times$

$(4 > 6) \times$

$(8 > 6) \checkmark$

Now J

1	3	2	4	5	7	8	9	6
---	---	---	---	---	---	---	---	---

$j \rightarrow i \rightarrow j \leftarrow j \rightarrow \text{pivot}$

$(5 > 6) \times \quad (7 < 6) \times$

$(7 > 6) \checkmark \quad (5 < 6) \checkmark$

$(i > j) \checkmark \text{ pivot swap}$

1	3	2	4	5	6	8	9	7
---	---	---	---	---	---	---	---	---

left small value Right big values

1	3	2	4	5	6	8	9	7
---	---	---	---	---	---	---	---	---

$i \rightarrow i \rightarrow i \rightarrow i \rightarrow i \rightarrow \text{pivot}$

$j \leftarrow j \rightarrow j \rightarrow \text{pivot}$

$(1 > 5) \times$

$(8 > 9) \times$

$(3 > 5) \times$

$(9 > 7)$

$(2 > 5) \times$

$(8 > 7) \checkmark$

$(4 > 5) \times$

$(9 < 7) \times$

$(5 > 5) \times \quad (i > j) \text{ pivot swap}$

$(i > j) \quad (8 < 7) \times$
pivot swap

(49)

[1]	[3]	[2]	[4]	[5]	[6]	[7]	[9]	[8]
-----	-----	-----	-----	-----	-----	-----	-----	-----

$i \rightarrow i \rightarrow i > j, i \neq \text{not}$

$j \rightarrow j > i, j \neq \text{not}$

$(1 > 4) \times$

$(7 > 8) \times \quad (9 < 8) \times$

$(3 > 4) \times$

$(9 > 8) \vee \quad (7 < 8) \vee$

$(2 > 4) \times$

$(i > j) \text{ pivot swap}$

$(4 > 9) \times (i > j) \text{ swap}$

[1]	[3]	[2]	[4]	[5]	[6]	[7]	[8]	[9]
-----	-----	-----	-----	-----	-----	-----	-----	-----

$j \rightarrow j > i, j \neq \text{not}$

sorted

$(1 > 2) \times \quad (3 < 2)$

$(3 > 2) \vee \quad (1 < 2) \vee$

$(i > j) \text{ swap}$

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[12]
-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------

Sorted array:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12

(50)

example # 2

0	1	2	3	4	5	6	7	8	9
9	8	2	1	7	5	10	6	20	12

i → i → i → i → i → i → i → $i > j$ → Pivot

 $(9 > 12) \times$ $(8 > 12) \times$ $(2 > 12) \times$ $(1 > 12) \times$ $(7 > 12) \times$ $(5 > 12) \times$ $(10 > 12) \times$ $(6 > 12) \times$ $(20 > 12) \checkmark$ $(i > j)$ swap pivot.

9	8	12	1	7	5	10	6	12	20
i → i → i → i → i → i → i → $i > j$ → Pivot									

 $(9 > 12) \times$ $(8 > 12) \times$ $(2 > 12) \times$ $(1 > 12) \times$ $(i > j)$ swap pivot $(7 > 12) \times$ $(5 > 12) \times$ $(10 > 12) \times$ $(6 > 12) \times$ $(12 > 12) \times$

Sorted

51

Date
Page

Sorted.

9	8	2	1	7	5	10	6	12	20
---	---	---	---	---	---	----	---	----	----

i → J ← J → Pivot

(9 > 6) ✓ swap

(10 < 6) ✗

(5 < 6) ✓

5	8	2	1	7	9	10	6	12	20
---	---	---	---	---	---	----	---	----	----

i → i → J ← J ← J → Pivot

(5 > 6) ✗ swap

(9 < 6) ✗

(8 > 6) ✓

(7 < 6) ✗

(1 < 6) ✓

5	1	2	8	7	9	10	6		
---	---	---	---	---	---	----	---	--	--

i → i → iJ → J ← J → Pivot

(1 > 6) ✗

(8 < 6) ✗

(2 > 6) ✗

(2 < 6) ✓

(8 > 6) ✓ (i > j) pivot swap.

5	1	2	6	7	9	10	8	12	20
---	---	---	---	---	---	----	---	----	----

left small values right big values

5	1	2	6	7	8	10	12	12	20
---	---	---	---	---	---	----	----	----	----

i → i → iJ → i → Pivot

J ← J ← J → J → Pivot

(5 > 6) ✗

(9 > 8) ✓ (10 < 8) ✗

(i > 6) ✗ (i > j) swap

(i > j) ✗ (9 < 8) ✗

(2 > 6) ✗

Pivot swap

(6 > 6) ✗

(52)

sorted										
5	1	2	6	7	8	9	10	9	12	20

5	1	2	6	7	8	10	9	12	20	
---	---	---	---	---	---	----	---	----	----	--

$i \rightarrow j$ Pivot
 $(5 > 2) \checkmark$ $(1 < 2) \checkmark$
~~swap~~

1	5	2
---	---	---

$i \rightarrow i, j$ Pivot
 $(1 > 2) \times$ $(5 < 2) \times$
 $(5 > 2) \checkmark$ $(1 < 2) \checkmark$
 ~~$i > j$~~
pivot swap

1	2	5	7	8	9	10
---	---	---	---	---	---	----

sorted

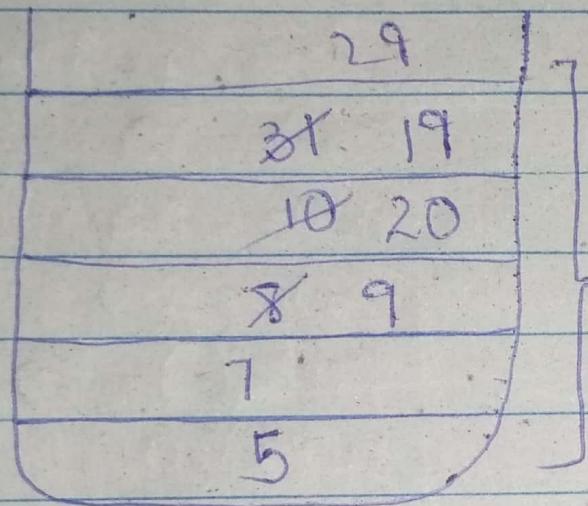
Sorted Array.

1, 2, 5, 6, 7, 8, 9, 10, 12, 20

(53)

Topic : Stack

example # 1.



Push = 5

Push = 7

Push = 8

Peek () = 8

Pop ()

Peek = 7

Push = 9

Push = 10

Peek = 10

Pop ()

Push = 20

Push = 31

Pop ()

Peek = 20

Push = 19

Push = 29

isEmpty = false

isFull = True

POP : 31, 10, 8

PUSH: 5, 7, 8, 9, 10, 20, 31, 19

29.

Peek

(54)

example # 2

8
7 8
5 6
50
30 40
20
10

isempty = True

push = 10

push = 20

push = 30

peek() = 30

pop() = 30

push = 40

isfull = false

push = 50

push = 5

pop()

push = 6

push = 7

peek() = 7

isempty = False

pop()

push = 8

push = 9

isfull = True

(55)

TOPIC : Polish Notations:

example #1

Infix to PostFix:

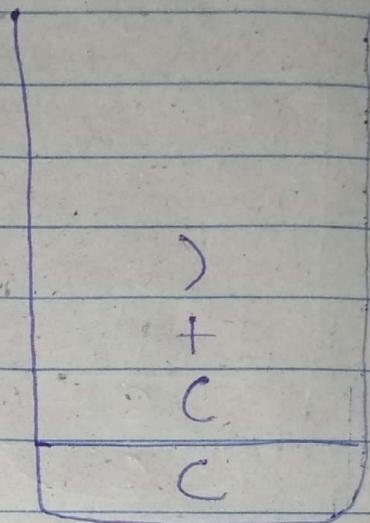
$$(A+B) \div (C+D)$$

push = C, C

if Any Alphabet come don't push.

Result

AB

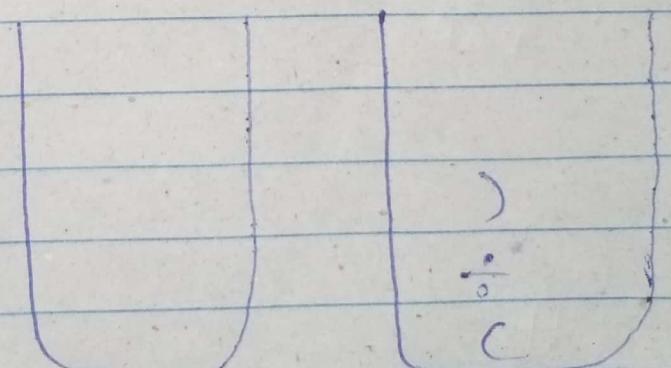
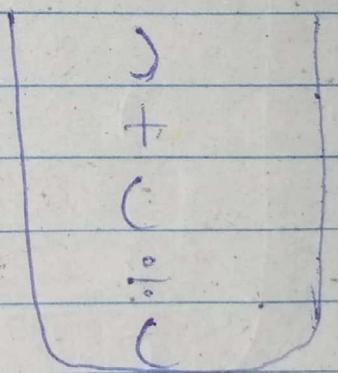


if close bracket came pop unless open bracket came.

if any operator came pop that →
and write in result

Result

AB+C D+÷



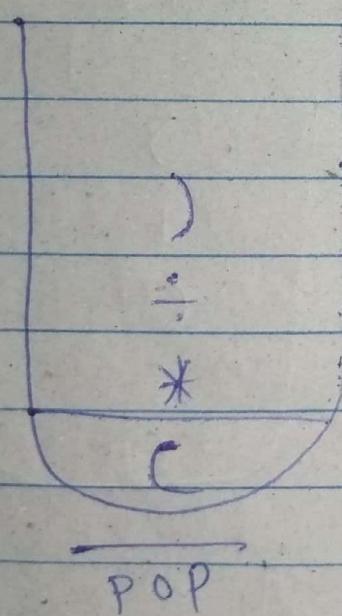
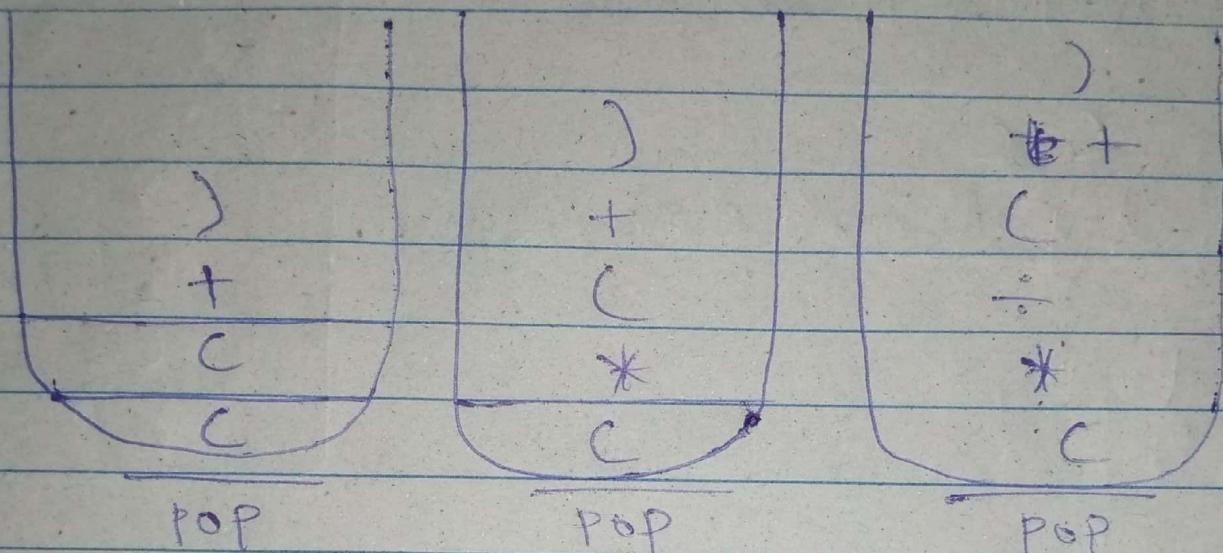
Stack is
empty Now.

(Pop) till
open bracket

example #2

Infix to postfix:

$$((A+B)*(C+D)\div(E+F))$$



Result

$$AB+C D+E F+\div *$$

(57)

Infix to Prefix

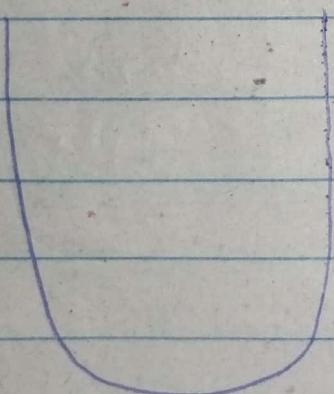
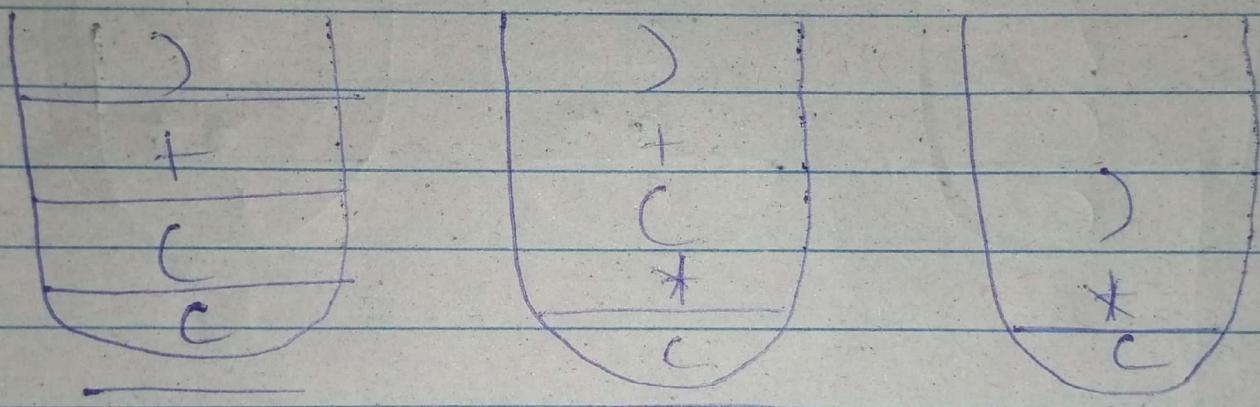
example # 1

$$\text{infix} = ((A+B)*(C+D))$$

According to the Rule first reverse the whole equation:

$$((D+C)*(B+A))$$

Now do the postfix thing here.



→ Stack empty.

Result

DCT + B A + * Now reverse the output

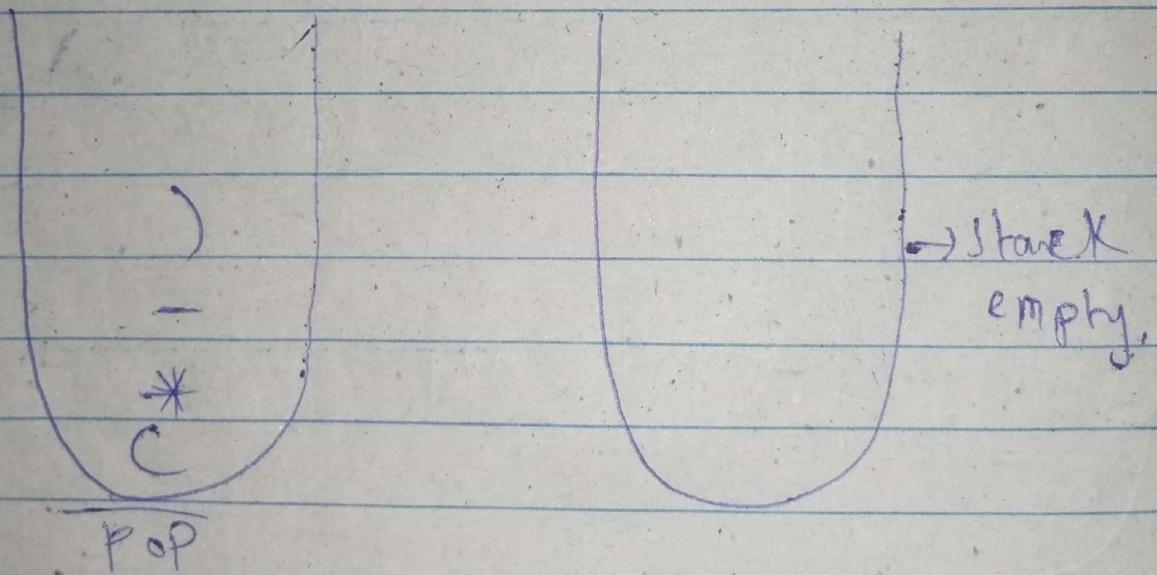
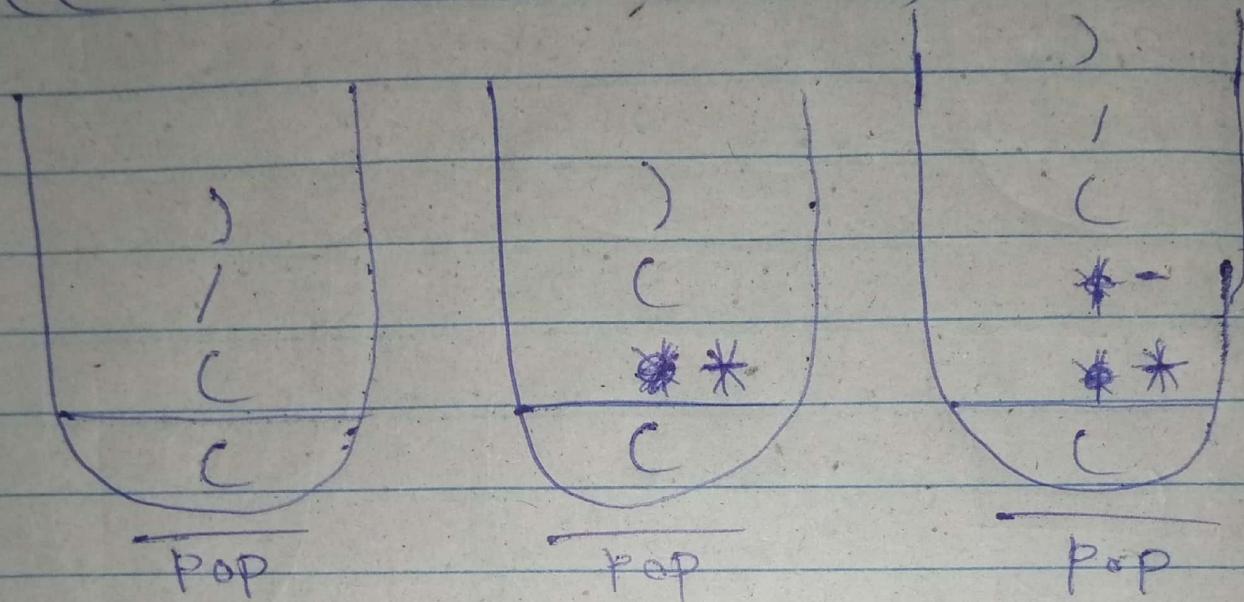
~~Re~~ prefix :

* + AB + CD

example # 2
Infix to prefix

$$\text{Infix} = ((a+b) - (c) * (d/e))$$

$$((e/d) * (c) - (b+a))$$



Result

ed / c b a / - *

prefix

* - / ab c / de

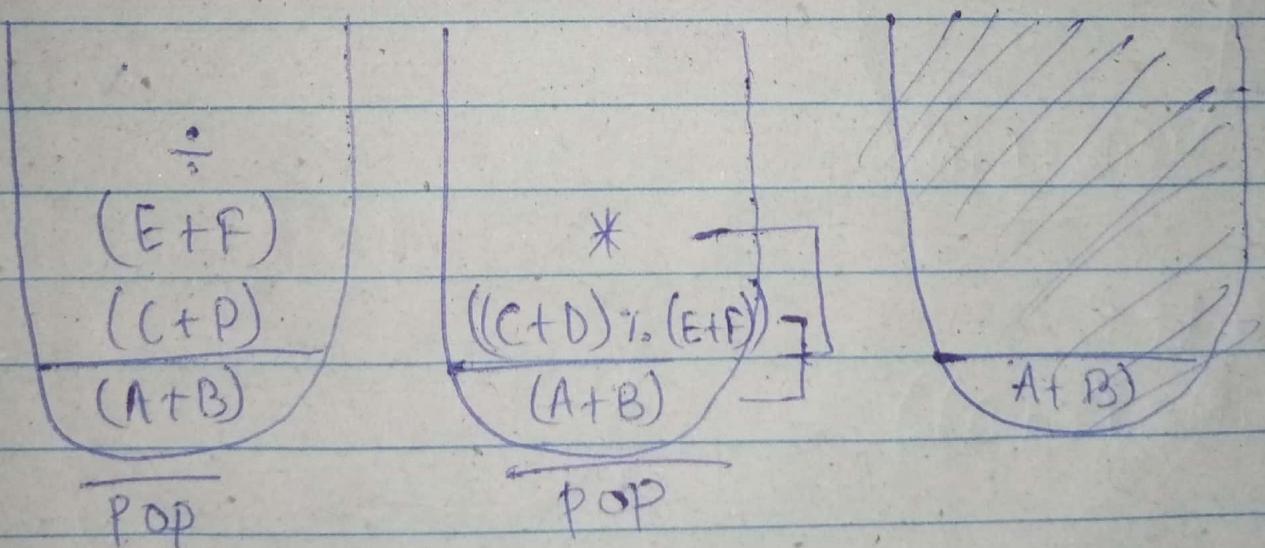
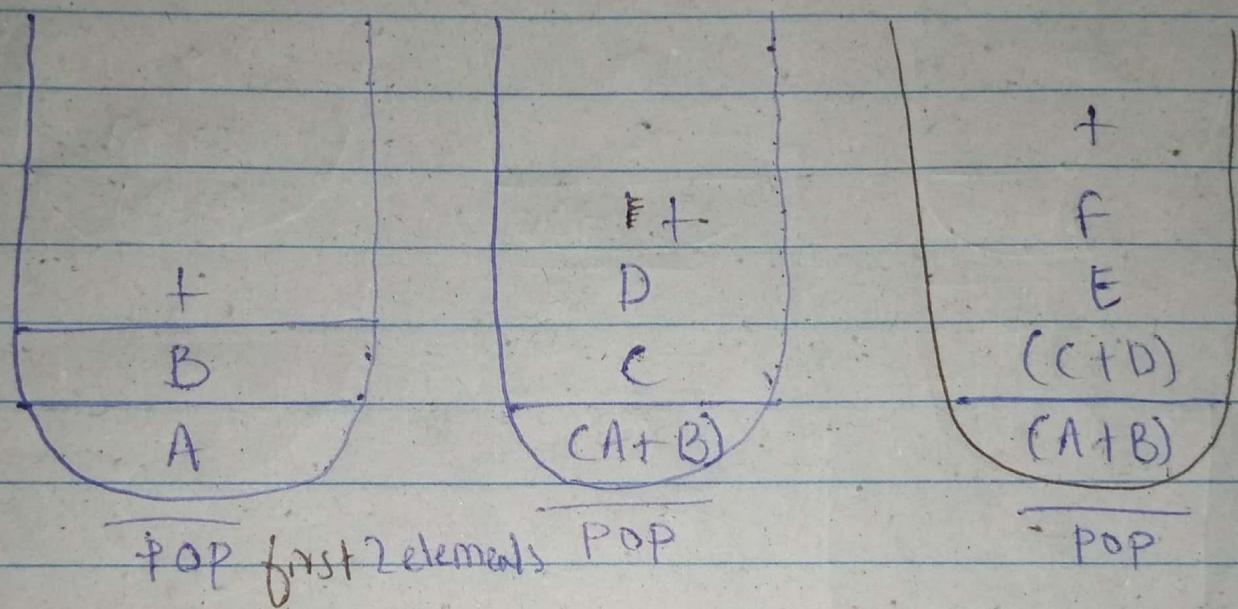
Topic: Postfix to Infix

example # 2

Postfix : ed / cd / e / *

Postfix

AB + CD + EF + ÷ *



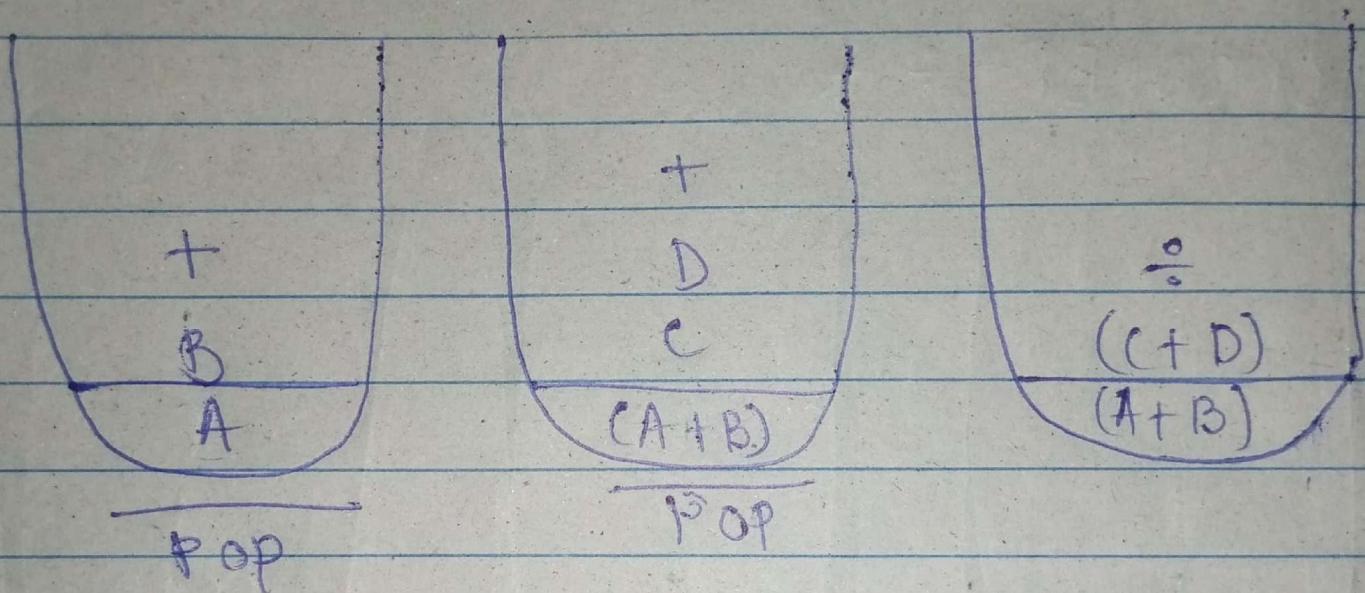
Result

$$((A+B) * ((C+D) \div (E+F)))$$

(60)

example # 2

Postfix : AB+ CD+ ÷



$$((A+B) \div (C+D))$$

Result :

$$((A+B) \div (C+D))$$

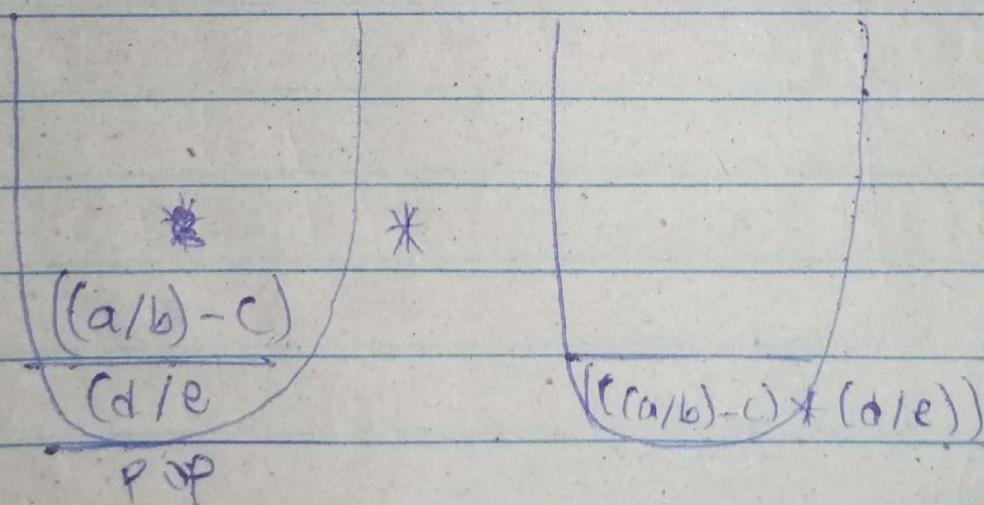
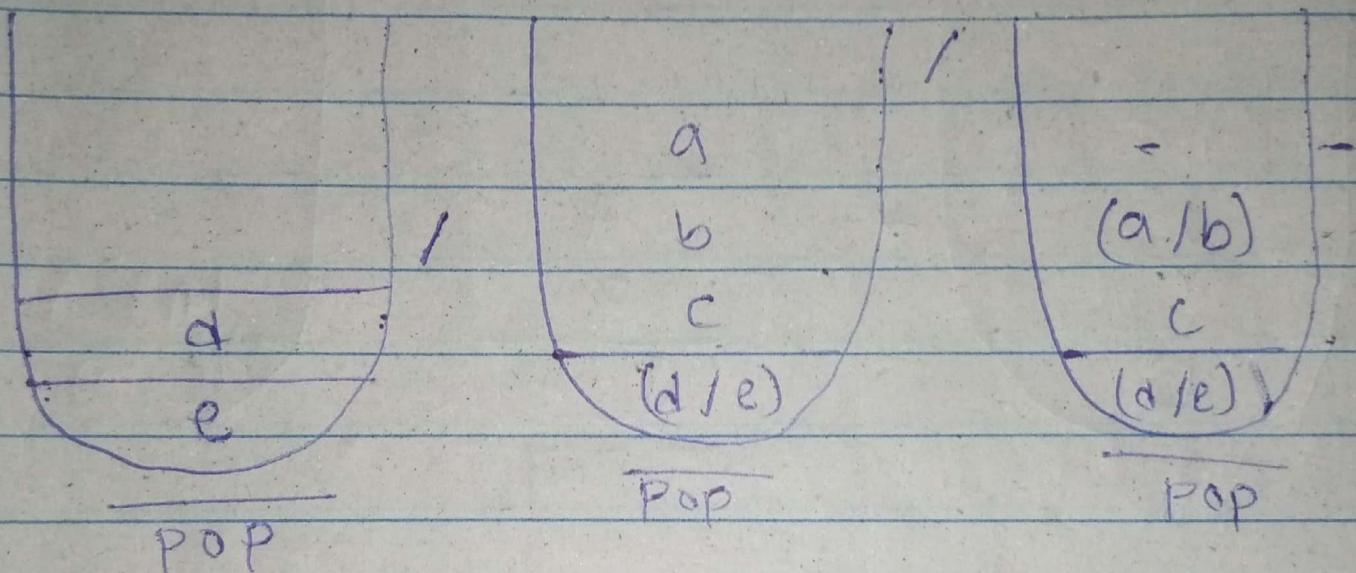
(61)

Topic: Prefix to infix

example # 1

Prefix: * / a b c / d e

* - / a b c / d e



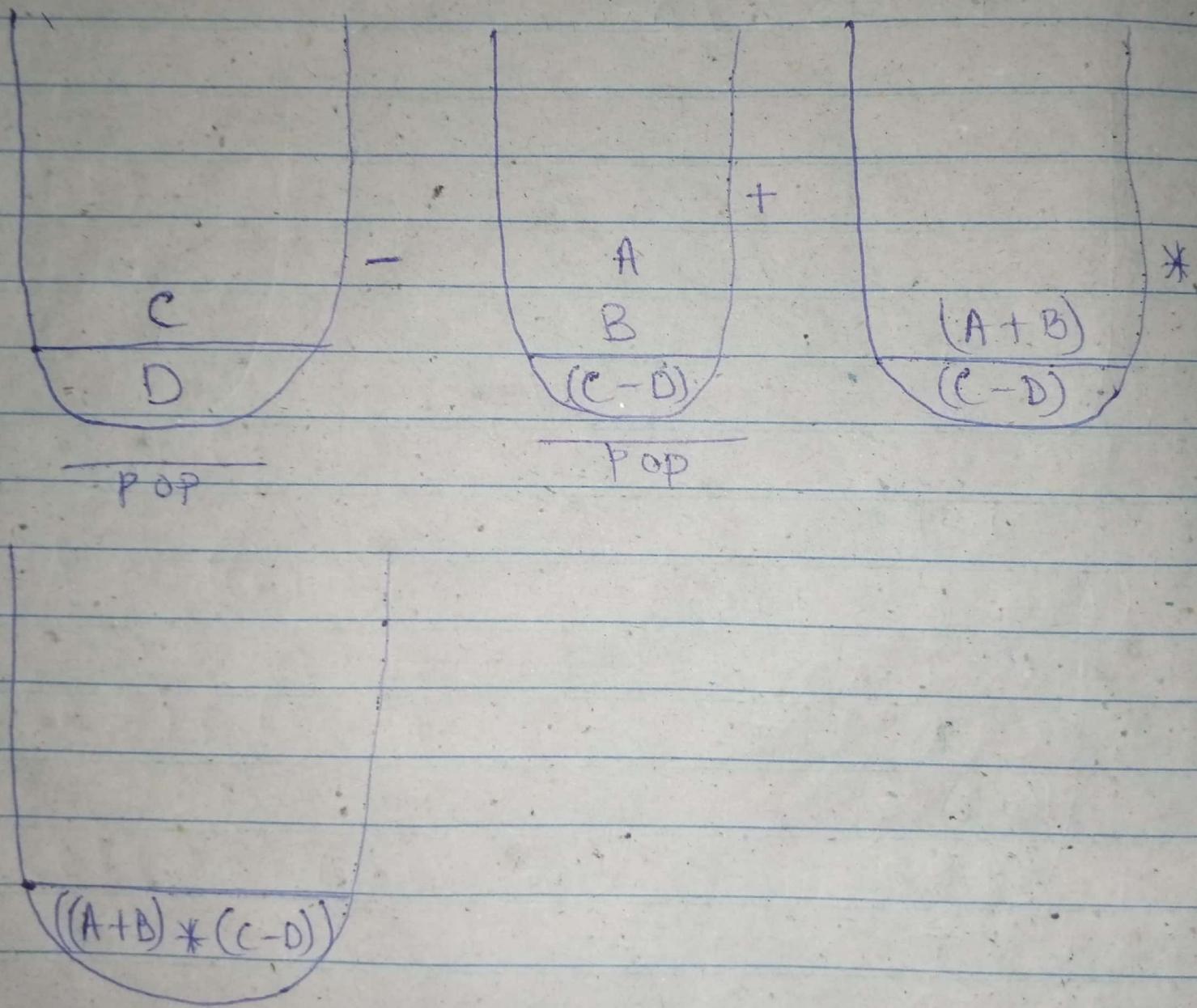
Result

 $((a/b) - c) * (d/e)$

(62)

example #.2

Prefix: * + A B - C D ← start from right



Result :

$$((A+B)*(C-D))$$

(63)

Topic : Postfix to Prefix example # 1

Postfix : AB + CD -

Direct Method for Postfix to Prefix

$\begin{array}{c} AB + \\ \boxed{+} \\ (A+B) \end{array}$ (A) operator (B)

$\begin{array}{c} CD + \\ \boxed{+} \\ (C+D) \end{array}$

$\begin{array}{c} (A+B) (C+D) - \\ \boxed{-} \end{array}$

$((A+B)-(C+D))$

Now reverse

$\underline{\underline{(D+C)}} - \underline{\underline{(B+A)}} \quad$ Now postfix

$\begin{array}{c} A D C + B A + - \\ \boxed{+} \end{array}$

Now reverse this

$- + A B + C D$

Result

$- + A B + C D$

(64)

example #2

Postfix : AB - CD + EF * / +

Direct Method :

$$\begin{array}{c} A \\ \downarrow \\ AB \\ \downarrow \\ - \end{array}$$

$$\begin{array}{c} (A-B) \\ \quad \quad \quad C \\ \uparrow \\ CD+ \end{array}$$

$$\begin{array}{ccccccc} (A-B) & (C+D) & E & F & * \\ & & \downarrow & & & & \end{array}$$

$$\begin{array}{c} (A-B) (C+D) (E*F) / \\ \uparrow \end{array}$$

$$\begin{array}{c} (A-B) ((C+D)/ (E*F)) + \\ \uparrow \end{array}$$

$$((A-B) + ((C+D)/ (E*F)))$$

Now reverse

$$\underline{\underline{(((F * E) / (D + C)) + (B - A))}}$$

Now ;

$$FE * DC + / BA - +$$

$$+ - AB / + CD * EF$$

$$\text{Postfix : } + - AB / + CD * EF$$

(65)

TOPIC: Prefix to Postfix

example #1

Prefix: * - AB + CD ←
Direct Method:

$$\begin{array}{c} \text{DC} \\ \text{+} \\ \text{(C+D) BA} \\ \text{-} \\ \text{(C+D) } \text{(A-B)} \end{array}$$

((A-B)* (C+D)) → Prefix

Now.

((A-B) * (C+D))

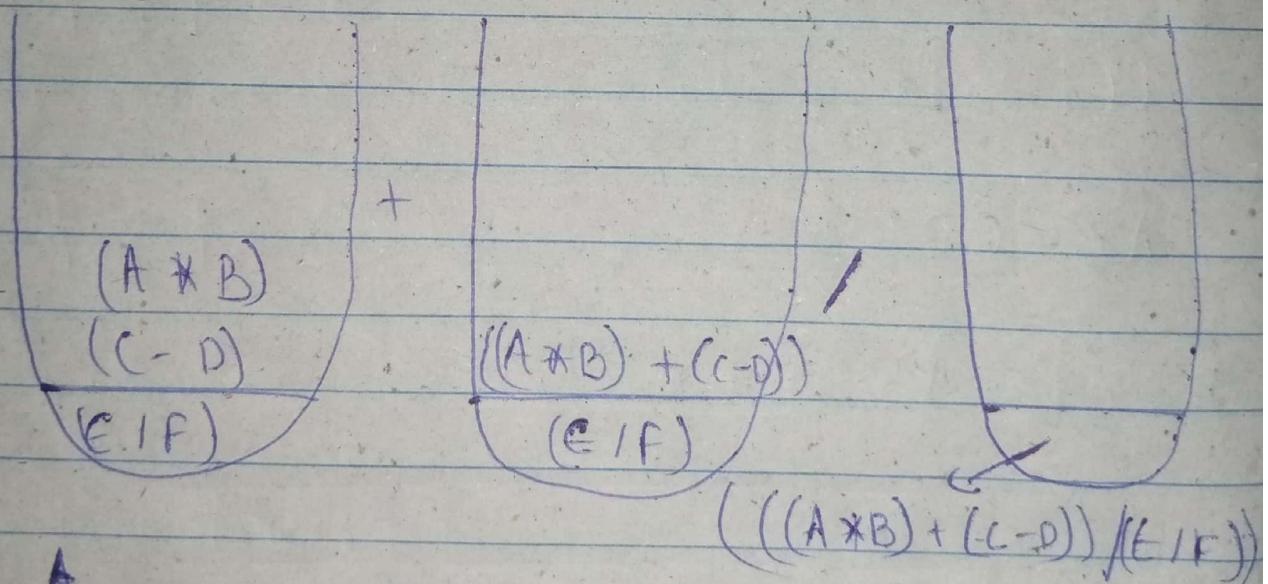
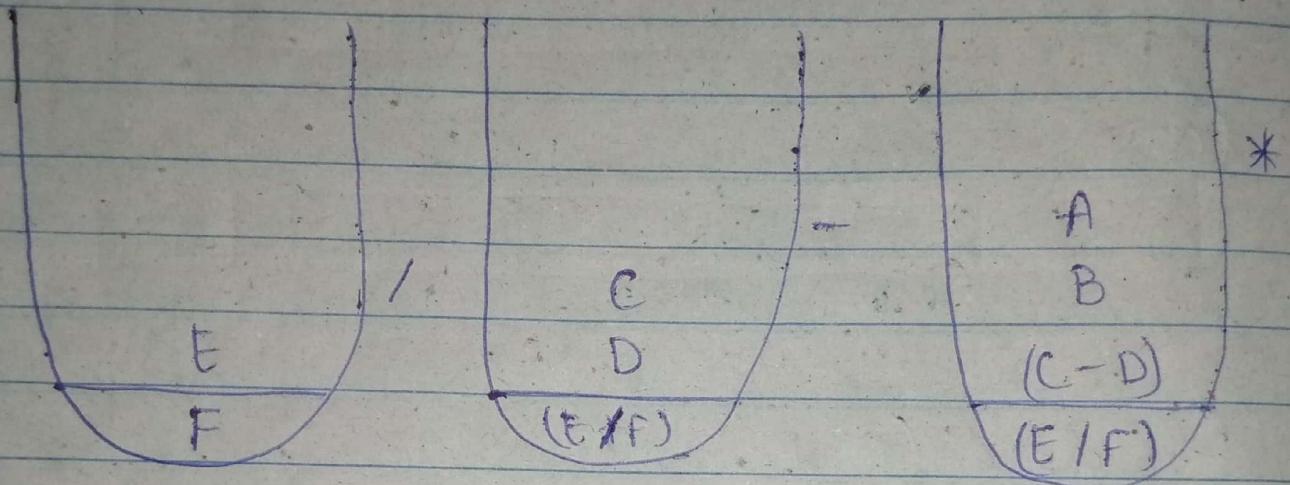
AB - CD + *

Post Fix: AB - CD + *

example : # 2

Prefix : $A * AB - CD / EF$

Sol:-



Now;

$$\underline{\underline{((A * B) + (C - D)) / (E / F)}}$$

$AB * CD - EF / / \rightarrow \text{Postfix}$

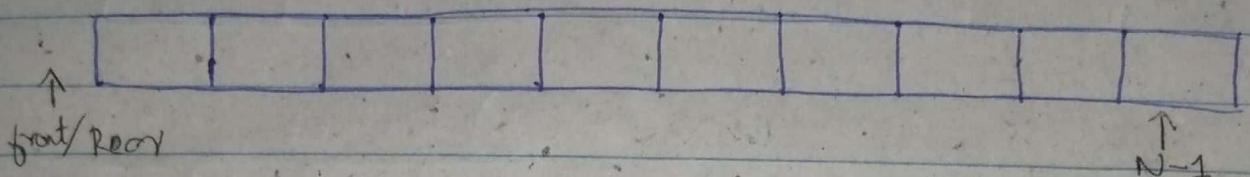
Result: $AB * CD - EF / /$

Topic: Queue

example # 1

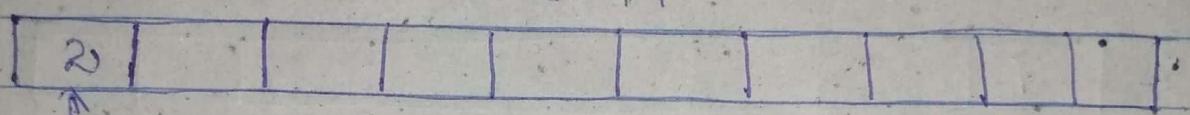
Size = 10

$$\text{Front} = \text{Rear} = -1$$



enqueue(2)

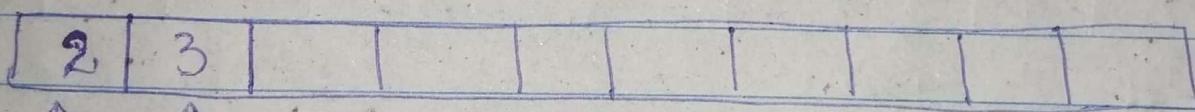
if (Rear == N-1) X
Rear++



front/Rear

enqueue(3)

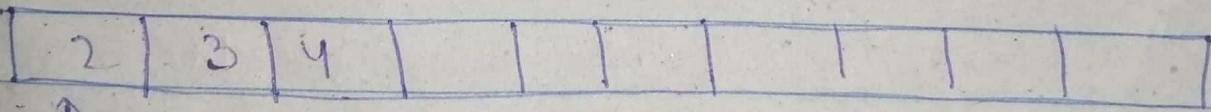
is full = false
Rear++



front Rear

enqueue(4)

is full = false
Rear++

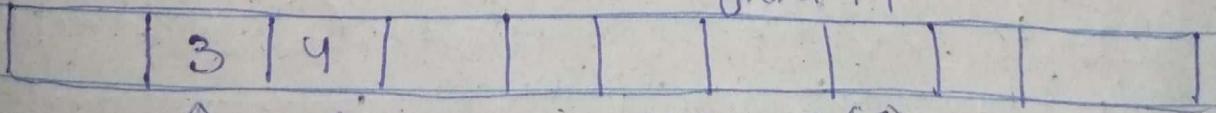


front

Rear

dequeue()

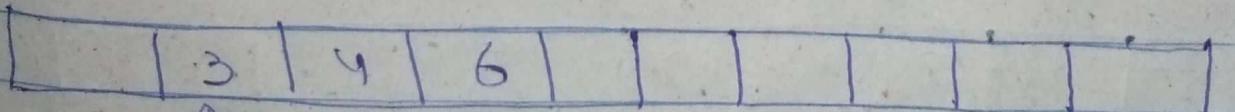
if is empty = false
front++



front Rear

enqueue(6)

is full = false
Rear++



front

Rear

these are basic operations of Queue

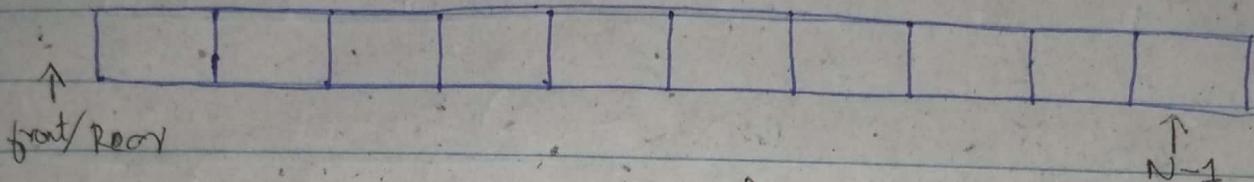
(67)

Topic: Queue

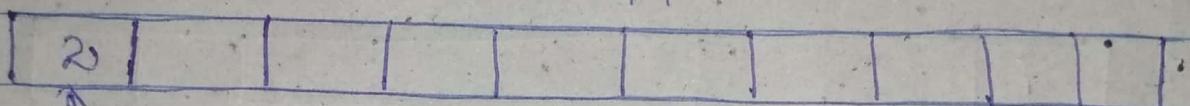
example # 1

Size = 10

front = rear = -1

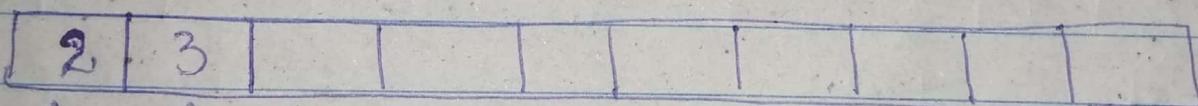


enqueue(2)

if (rear == N-1) X
rear++

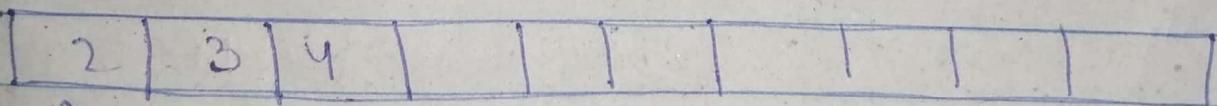
front/rear

enqueue (3)

is full = false
rear++

front rear

enqueue (4)

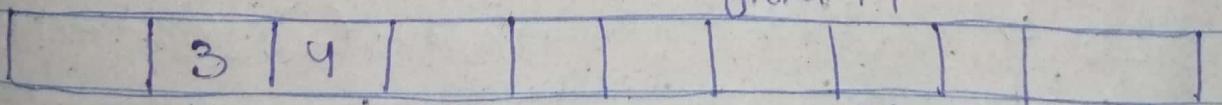
is full = false
rear++

front rear

dequeue ()

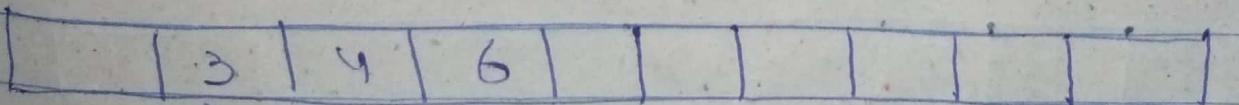
if is empty = false

front++



front rear

enqueue (6)

is full = false
rear++

front

rear

these are basic operations of Queue

example # 2

front = Rear = -1

Size = 8

$\frac{1}{6/8}$

enqueue (2) Rear++

2

↑
front

7
Rear

enqueue (7) Rear++

2

↑
front

7
Rear

enqueue (8) Rear++

2

↑
front

7
Rear

enqueue (9) Rear++

2

↑
front

7
Rear

dequeue () front++

7

↑
front

8
Rear

enqueue (10) front++

7

↑
front

8
Rear

dequeue () front++

8
front

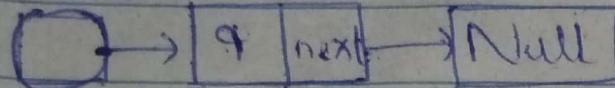
9
Rear

10
Rear

Topic : linked list

example #1

head



insert(9)

✓ (Root = Null)

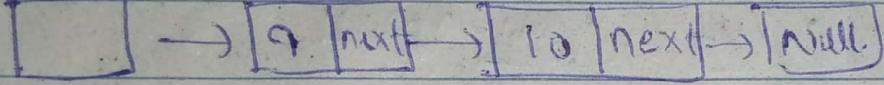
Newnode.next
= Null.

head

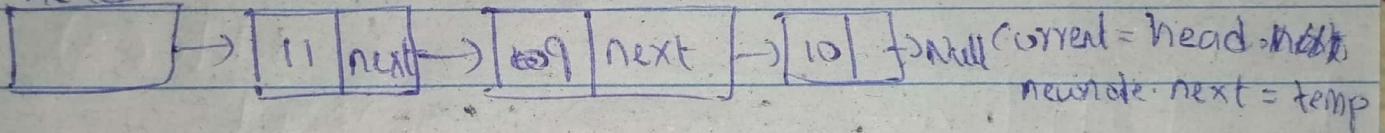


insert(10)

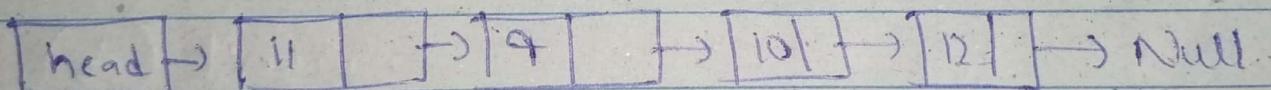
head

insertAt
first(11)

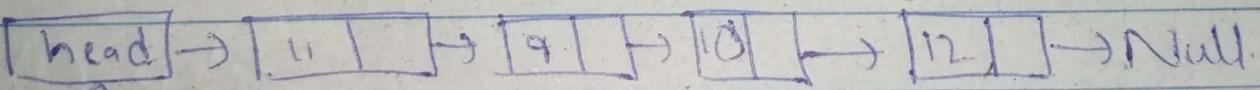
head



insert(12)

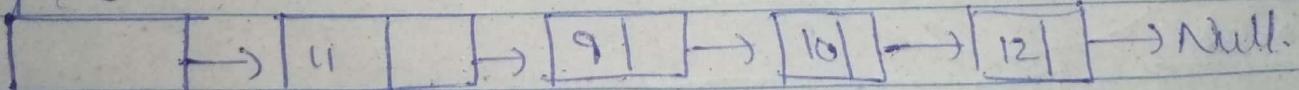


delete(9)

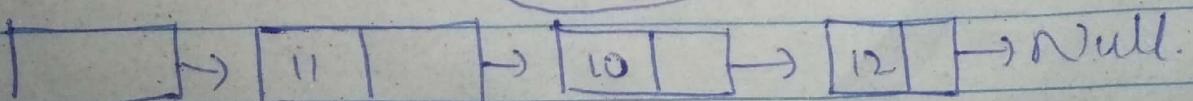
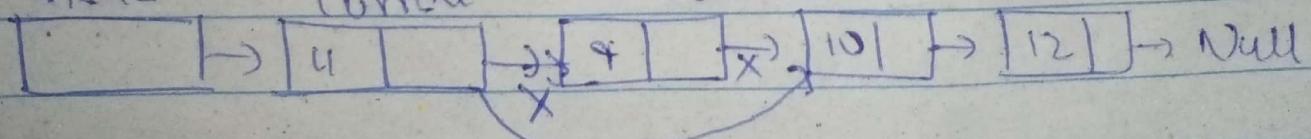


Current (current.data == key) X

Delete case 1



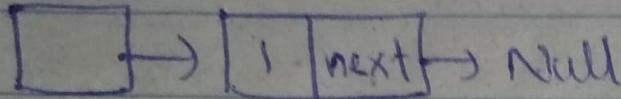
head current → ↑ current



(7D)

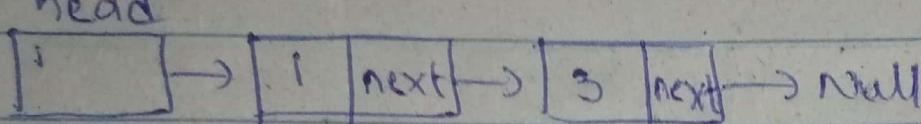
example # 2

head



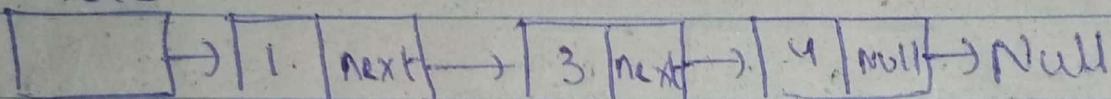
insert (1)

head



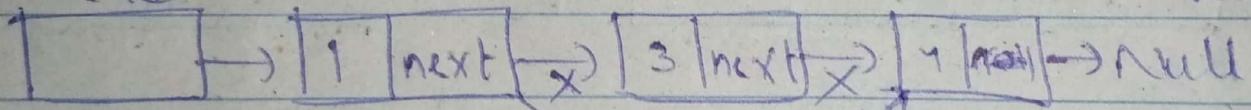
insert (3)

head



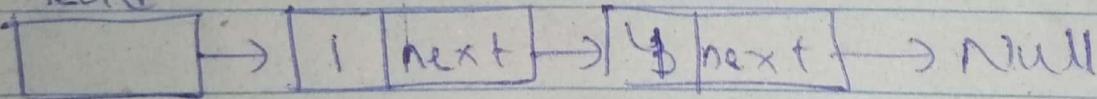
insert At last (4)

head



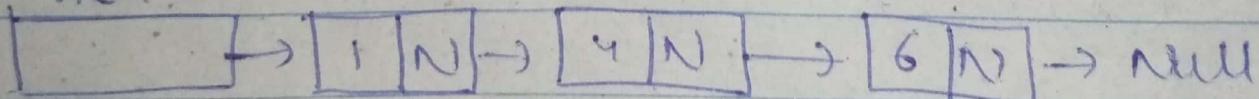
delete (3)

head



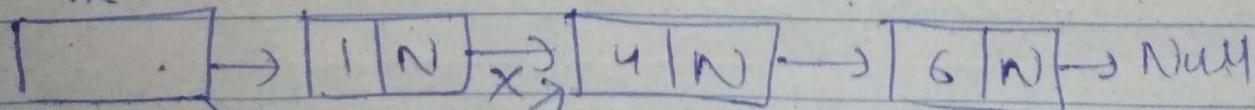
insert (5)

head

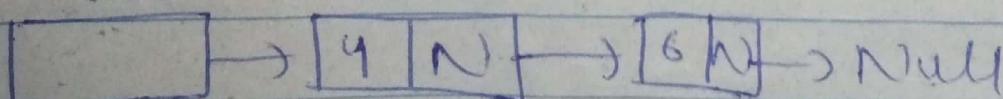


delete (1)

head



head

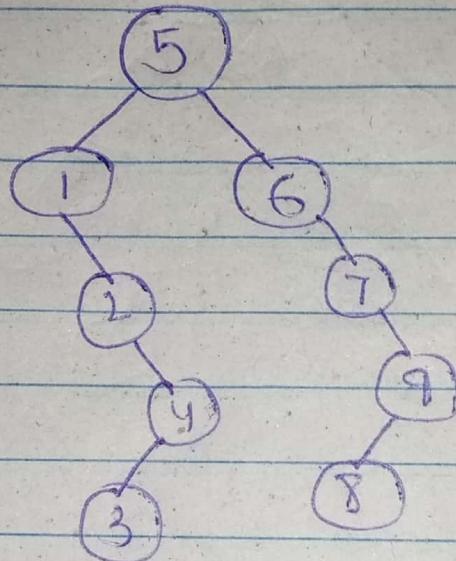


(71)

Topic: Binary Search tree

example #1

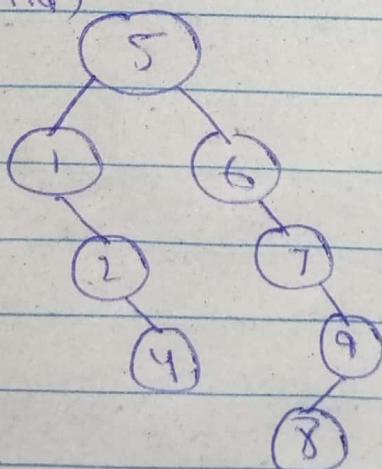
insert : 5 1 6 2 4 7 9 8 3
 $\frac{1 \rightarrow}{\text{Root}} \rightarrow$



left ($1 < 5$) ✓
 Right ($6 > 5$) ✓
 Left ($2 < 5$) ✓
 Right ($2 > 1$) ✓
 left ($4 < 5$) ✓
 Right ($4 > 2$) ✓
 Right ($7 > 5$) ✓
 Left ($7 < 6$) ✗
 Right ($7 > 6$) ✓
 " ("9 > 5") ✓
 " ("9 > 6") ✓
 " ("9 > 7") ✓
 Right ($8 > 5$) ✓
 Right ($8 > 6$) ✓
 Right ($8 > 7$) ✗
 Left ($8 < 9$) ✓
 Left ($3 < 5$)

Delete : 3, 9, 5

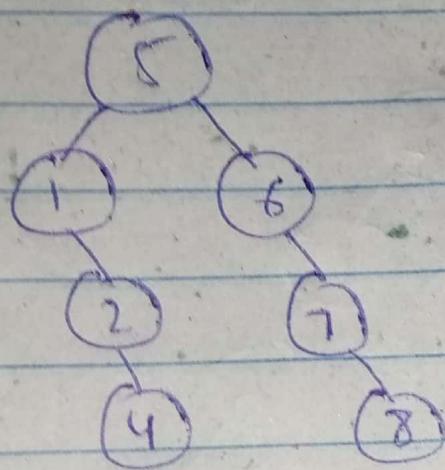
Case 1 (No child)



Right ($8 > 5$) ✓
 Right ($8 > 6$) ✓
 Right ($8 > 7$) ✗
 Left ($8 < 9$) ✓
 Left ($3 < 5$)
 Right ($3 > 1$)
 Right ($3 > 2$)
 Left ($3 < 4$)

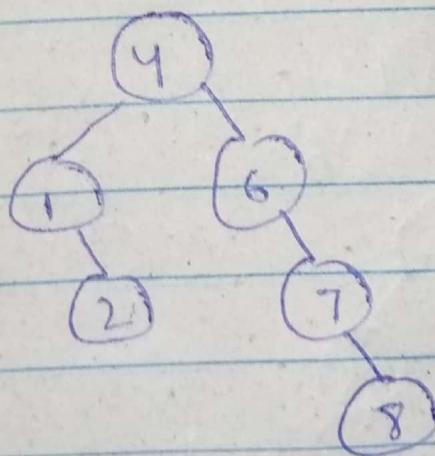
72

Case: 2 (only 1 child)



Case: 3 : 5. (both child)

Left the maximum or Right the minimum.



Inorder : 1 2 4 6 7 8

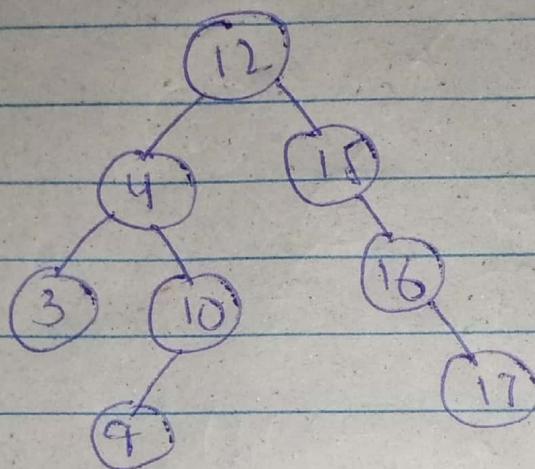
Preorder: 4 1 2 6 7 8

Postorder: 2 1 8 7 6 4

(73)

example # 2

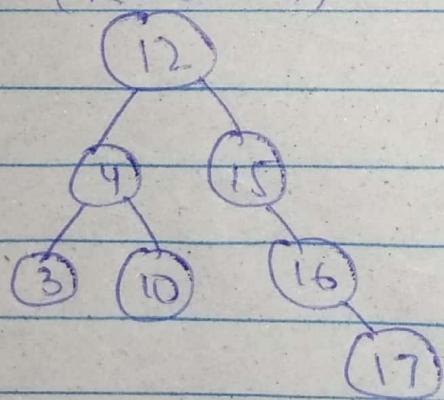
insert: 12 4 10 15 16 3 9 17



(12) Root
(4 < 12) Left
(10 < 12) "
(10 > 4) Right
(15 > 12) Right
(16 > 12) "
(16 > 15) Right
(3 < 12) Left

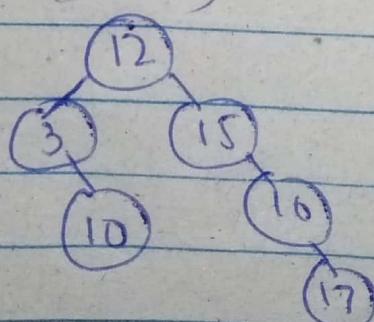
Deletion 9, 4, 17

Case 1: 9 (No child)



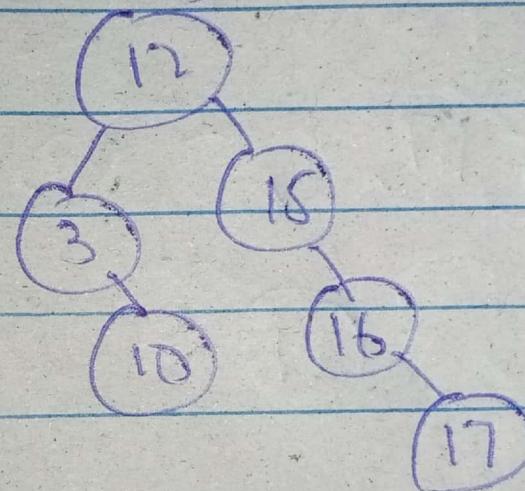
(3 < 4) Left
(9 < 12) Left
(4 > 3) Right
(9 < 10) Left
(17 > 12) Right
(17 > 15) Right
(17 > 16) Right
(8)

Case 3: 4 (both child)



(74)

Case 2: 17 (No child.)



Preorder

inorder : 3 10 12 15 16 17

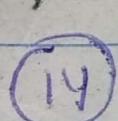
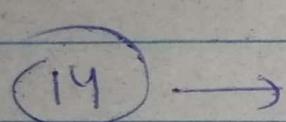
Preorder : 12 3 10 15 16 17

Postorder : 10 3 17 16 15 12

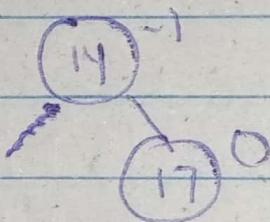
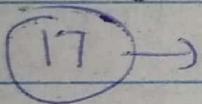
(75)

Topic : AVL Tree

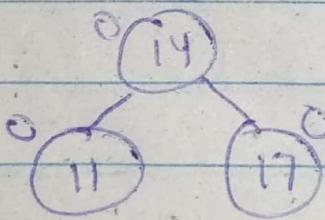
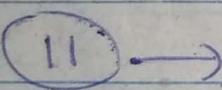
Insert: 14, 17, 11, 7, 53, 4, 13, 12, 8



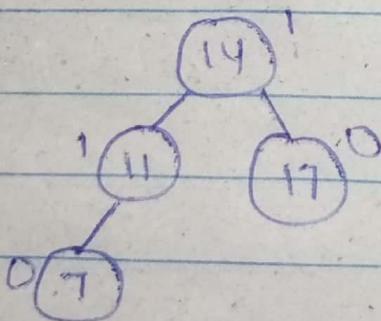
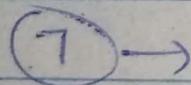
Balance factor = 0
(L - R)



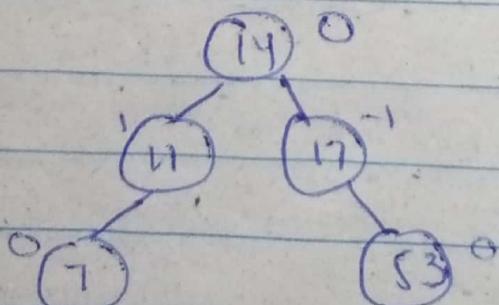
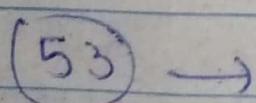
(17 > 14) Right



(11 < 14) Left



(7 < 11) Left
(7 < 14) Left

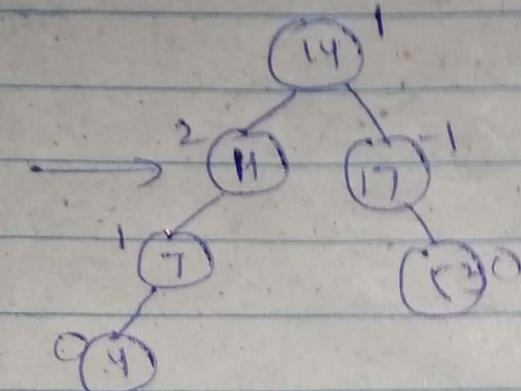


(53 > 17) Right
(53 > 14) Right

(16)

(4) →

LL



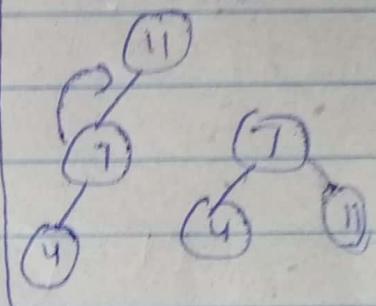
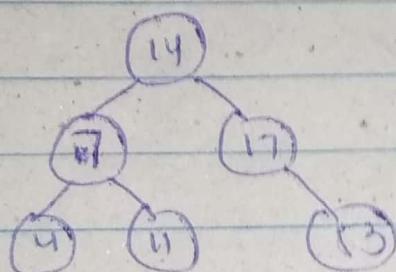
(4 < 14) left

(4 < 11) "

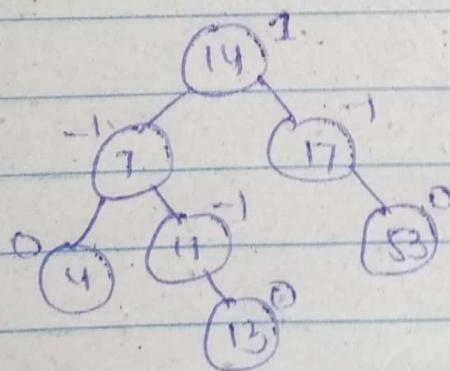
(4 < 7) "

LL Case

→ (13)



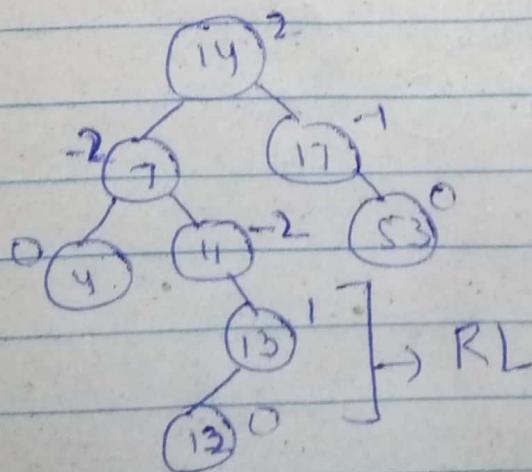
→ (12)



RA (13 < 14) left

(13 > 7) Right

(13 > 11) Right



(12 < 14) L

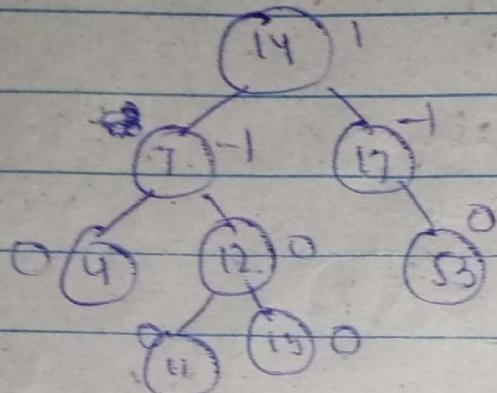
(12 > 7) R

(12 > 11) Right

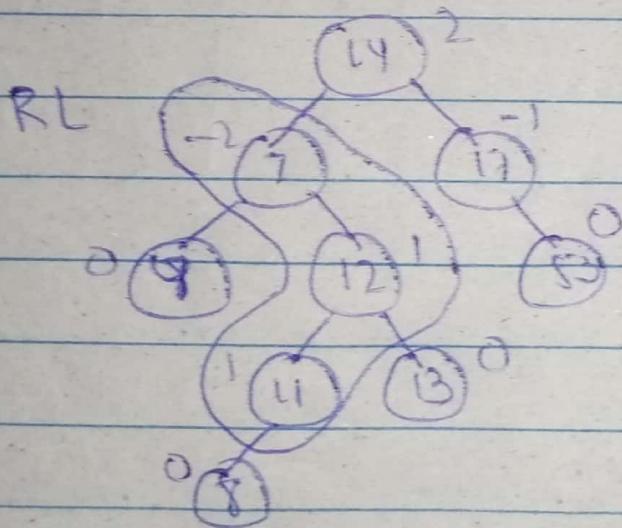
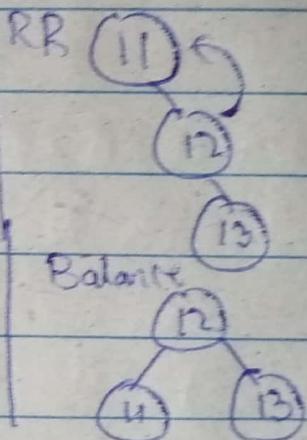
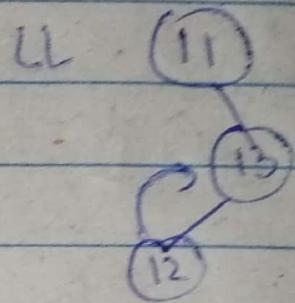
(12 < 13) Left

(77)

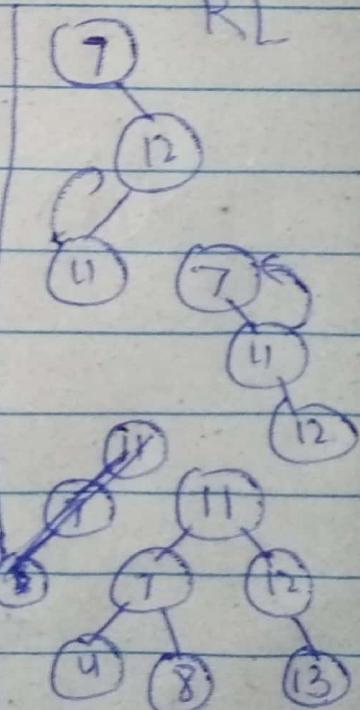
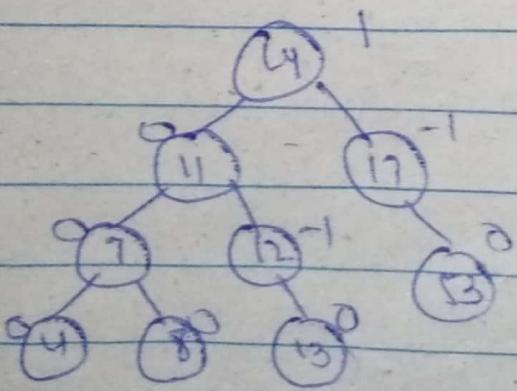
(5) →



RL



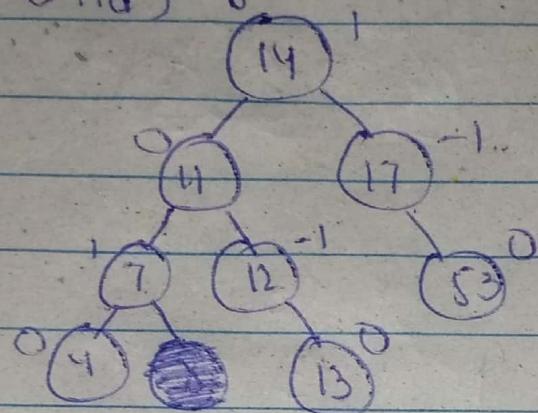
RL



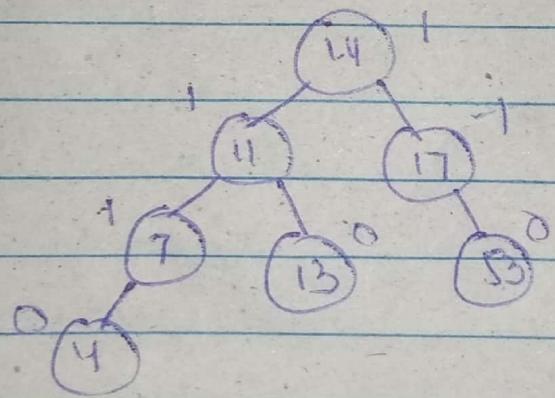
(78)

Deletion: 8, 12, 17

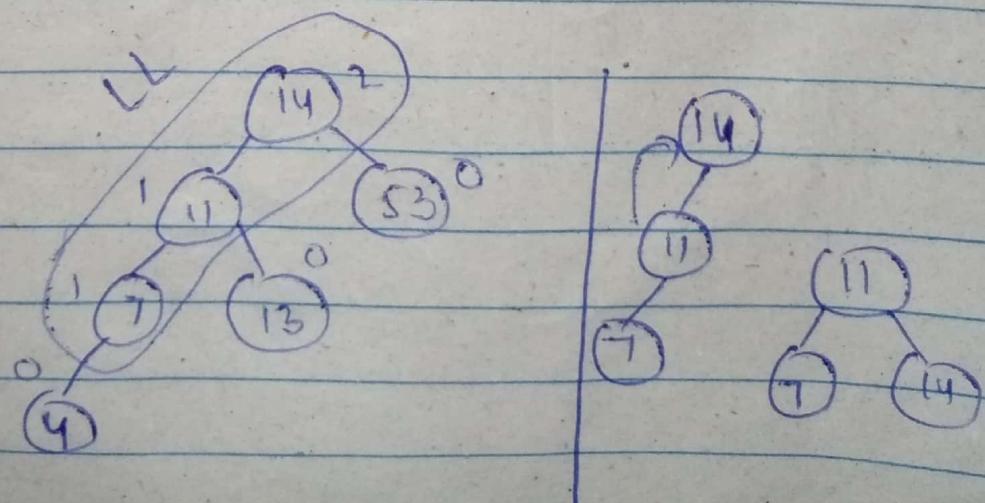
(Case 1: (no child) 8



Case 2: (only one child) 12

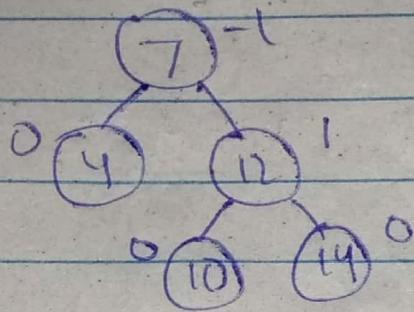


Case 3: (only one child) 17



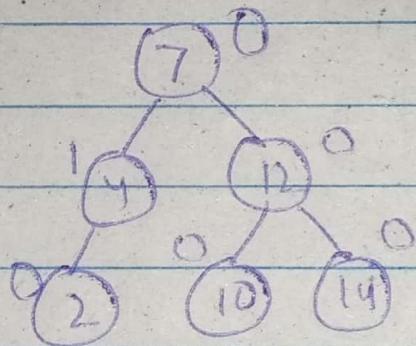
(81)

(14) →



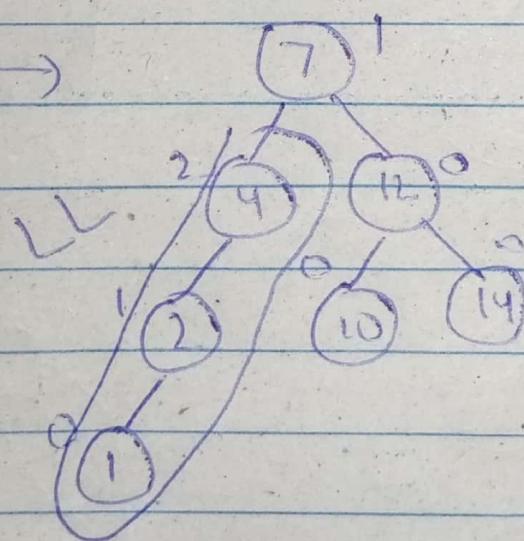
(14 > 7) R
(14 > 12) B

(2) →



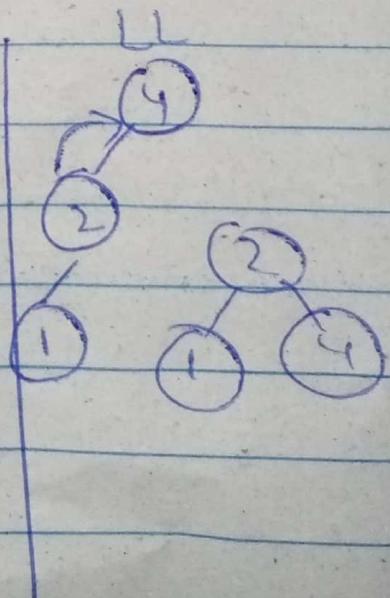
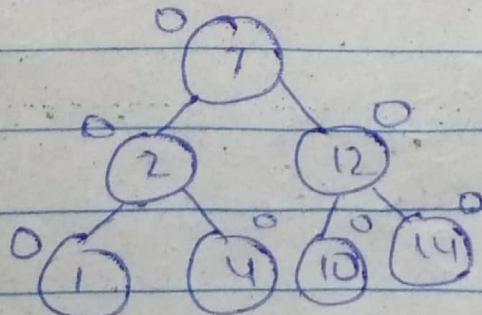
(2 < 7) L
(2 < 4) L

(1) →

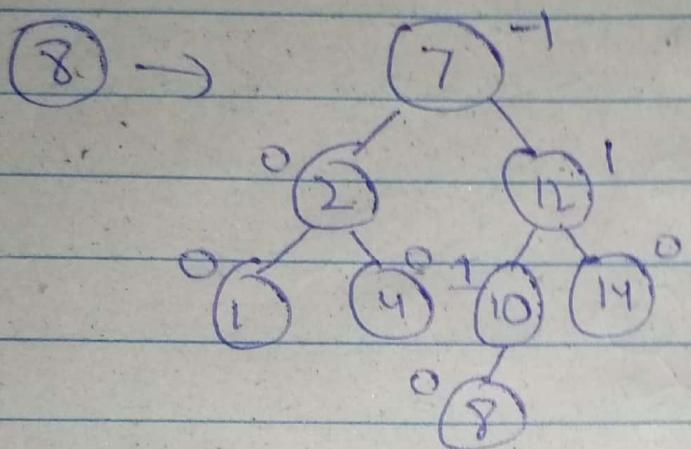


(1 < 7) L
(1 < 4) L
(1 < 2) L

(3) →



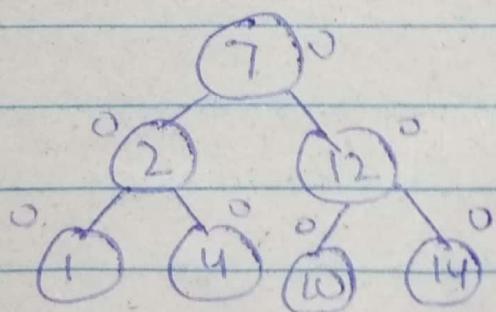
(82)



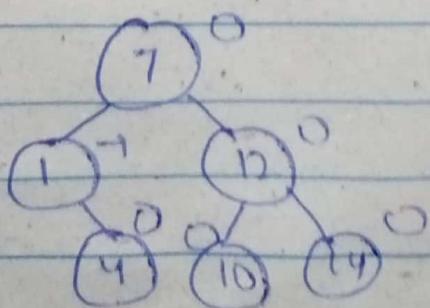
(8 > 7) R
(8 < 12) L
(8 < 10) L

Deletion: 8, 2, 14.

Case 1: 8 (only no child)

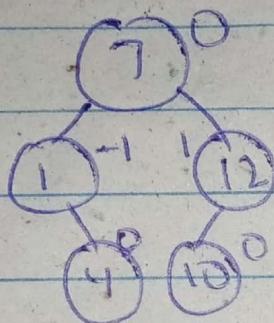


Case 3: 2 (both child)



(83)

Case 1 : (No child) 14



inorder : 1 4 7 10 12

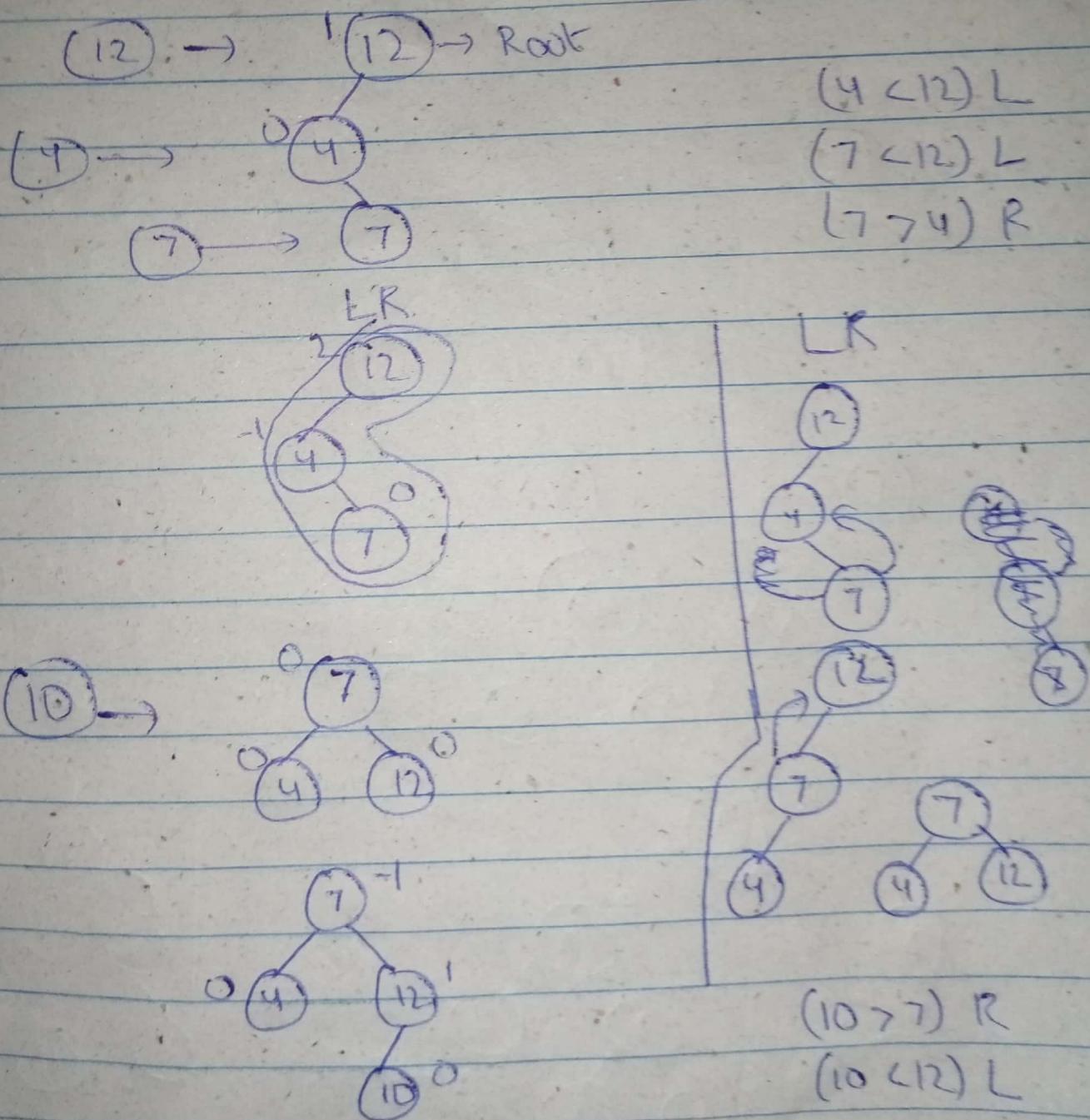
preorder : 7 1 4 12 10

postorder : 1 4 1 10 12 7

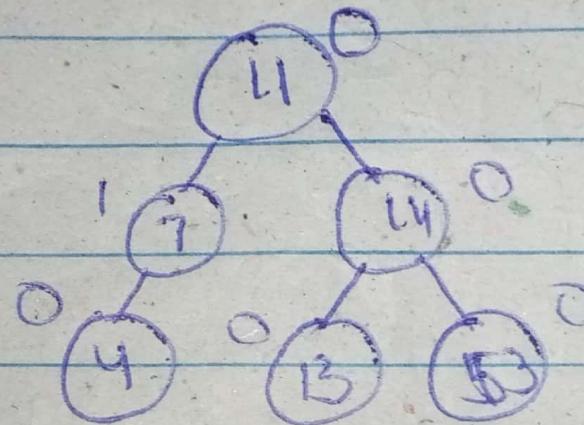
(80)

example # 2)

insert: 12, 4, 7, 10, 14, 2, 1, 8



(79)



Inorder : 47 11 13 14 53

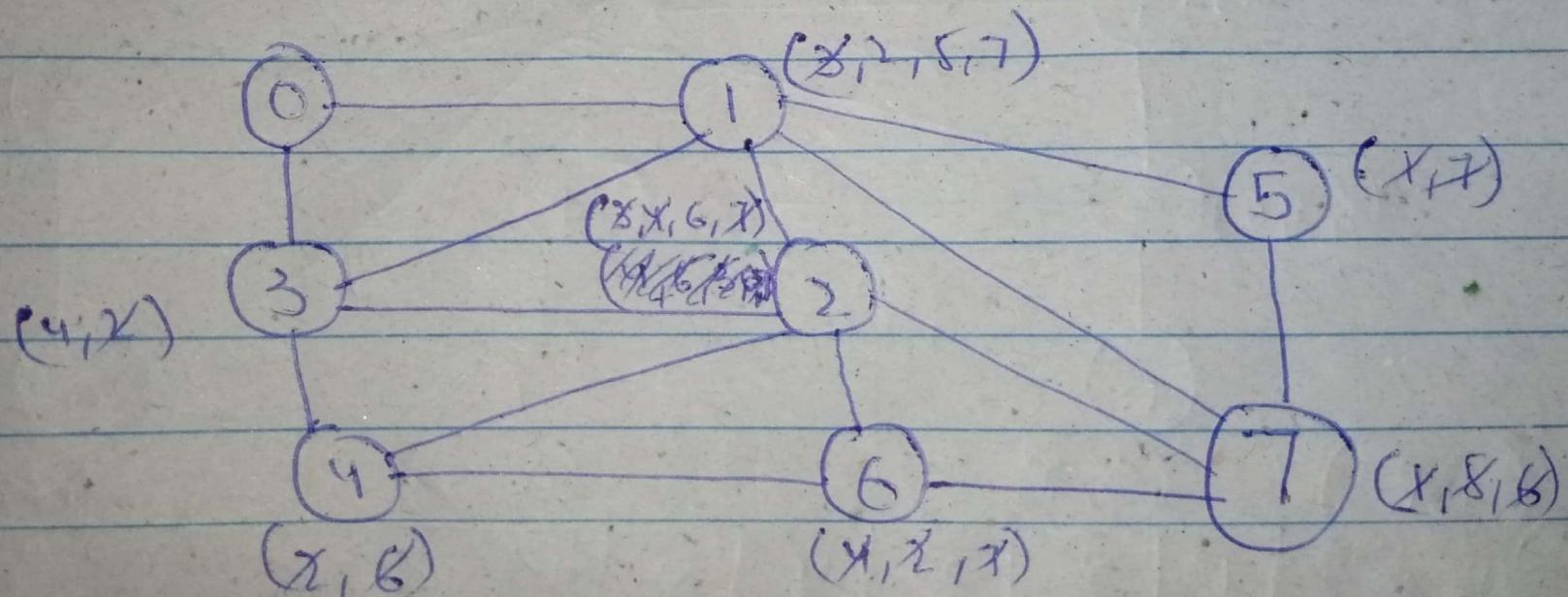
Preorder : 11 7 4 14 13 53

Postorder : 4 7 13 53 14 11

(84)

Topic : Graphs

example #1



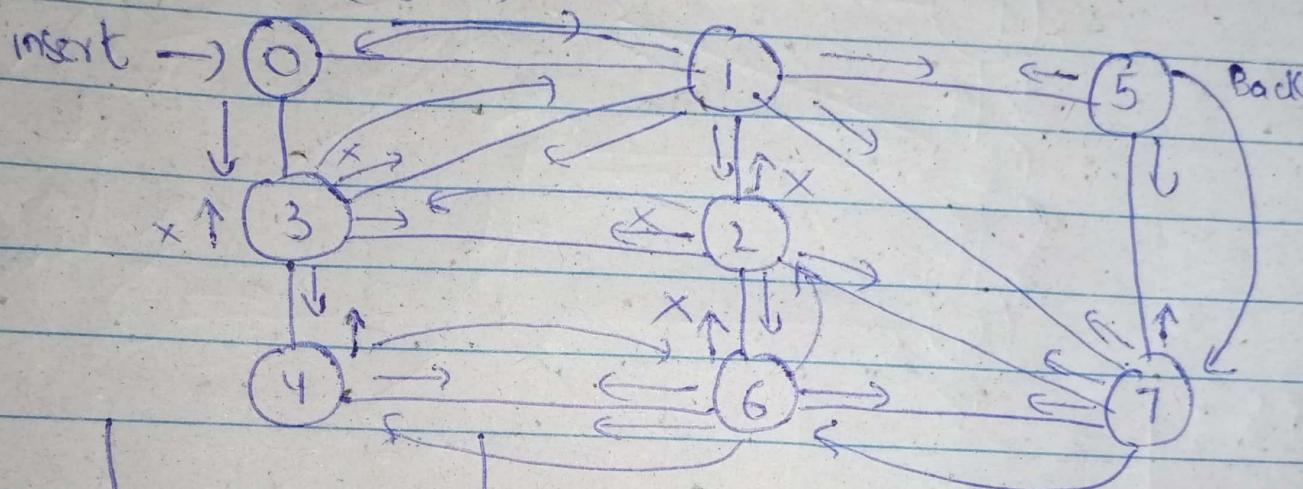
BFS : [0 | x | 3 | 1 | 8 | 2 | 5 | 7 | 4 | 6]

Result : 0 1 3 2 5 7 4 6

BFS : $\emptyset \times \emptyset \emptyset \emptyset \emptyset \emptyset \emptyset$

Result: 0 1 3 2 5 7 4 6

(any one)



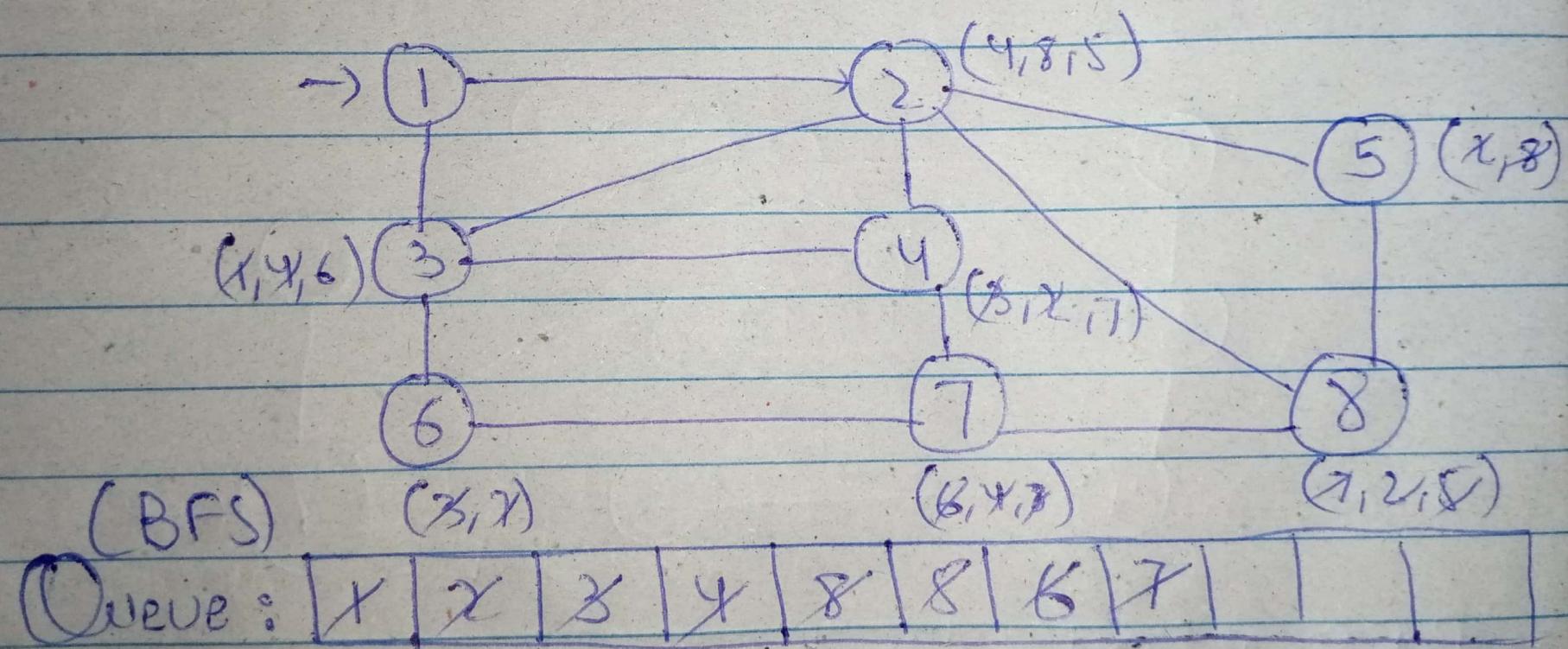
DFS⁰

0	X
1	
2	
3	
4	
5	
6	
7	

Result: 0 1 3 2 6 7 5 4

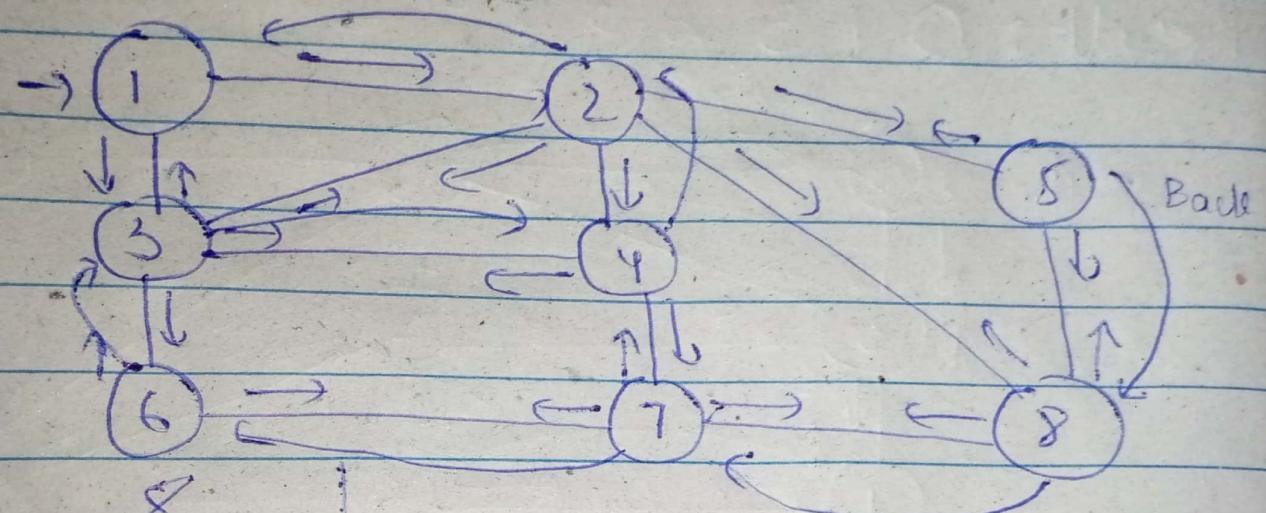
(8.8)

example # 2



Result : 1 2 3 4 8 5 6 7

Result : 1 2 3 4 8 5 6 7



DFS :

8
8
7
6
3
4
2
x

Result : 1 2 4 3 6 7 8 5