3 Rows

4 Columns

column

Sl	Name	Place	→ Row
1	Khan	Karnataka	
2	~		

2 2.
R   C

3   4

3	3	3	3
3	3	3	3
3	3	3	3

*	d
+	+

3   3

3 3 3

3 3 3 ✓

2 2 1

?

Columns
(i)

rows→ 1 *   *   +
(i)
     2 +   +   +

     3 +   *   +
        1   2   3

Row
Colum

Nested loops.
↓
1→ another...

```
for(int i=1; i<=3; i++){
    for(int i=1; i<=3; i++){
        cout<<" * ";
    }
    cout<<endl;
}
```

output

*	*	*
+	+	+
+	+	+

i=1, i<=3 ✓
  → i=1   i<=3
  → i=2   2<=3 ✓
  → i=3   3<=3 ✓
  → i=4   4<=3 α

i=2, 2<=3 ✓
  → i=1
     i=2
     i=3
     i=4 α

i=3   3<=3 ✓
  ═
  ═
  ═ₐ
  i=4   4<=3 α

i=1
═
═

i=2
═
═

i=3
═
═

Square & Rectangle Patterns

1)Pattern1 : Solid Square

```
*   *   *   *
*   *   *   *
*   *   *   *
```

col(j)

row(i)

```
*  *  *  *
*  *  *  *
*  *  *  *
```

i j

─ x y

─ a b ✓
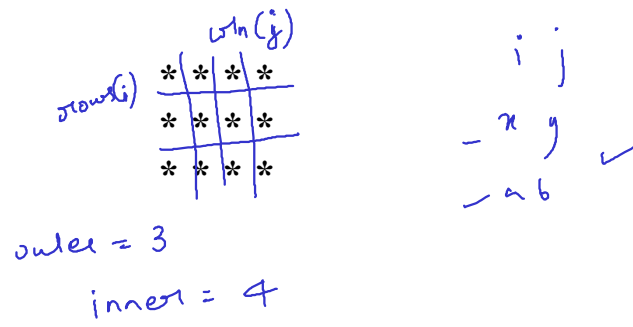
outer = 3

inner = 4

Pattern2 : Repeated Row Number Pattern in a Rectangle

```
1 1 1 1
2 2 2 2
3 3 3 3
4 4 4 4
```

$$\text{col} \quad (j) \quad \begin{array}{|l} \underline{1\ 1\ 1\ 1} \rightarrow row\ (i) \\ 2\ 2\ 2\ 2 \\ 3\ 3\ 3\ 3 \\ 4\ 4\ 4\ 4 \end{array}$$

outer = 4

```
1 1 1 1
2 2 2 2    inner-4
3 3 3 3
4 4 4 4
```

H/w

i=1
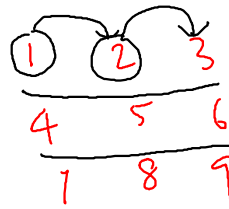≡ 1

i=3
≡ 3

i=2
≡ 2

i=4
≡ 4

Homework- Pattern3 :
Square Number Pattern with Column Number Repetition

```
1 2 3 4
1 2 3 4
1 2 3 4
1 2 3 4
```

```
1 2 3 4
1 2 3 4
1 2 3 4
1 2 3 4
```

outer = 4

i

Pattern4: Sequential Number Grid (3x3)

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


Sequential order.

3 rows
3 columns

num = 1

i x j x

num = 1
num = num+1
num++

i = 1

$j = 1 \rightarrow 1 \quad (2)$
$j = 2 \rightarrow 2 \quad (3)$
$j = 3 \rightarrow 3 \quad (4)$
endl!

i = 2

$j = 1 \rightarrow 4 \quad (5)$
$j = 2 \rightarrow 5 \quad (6)$
$j = 3 \rightarrow 6 \quad (7)$

i = 1

i = 2

i = 3

Pattern5: Alphabet Square

A B C D
A B C D
A B C D
A B C D

$i = 1$

≡ - A
  - B
  - C
  - D

$i = 2$

≡ - A
  - B
  - C
  - D

ASCII
(65) -> A
66 - B
67 -> C
68 - D

A B C D
A B C D
A B C · D
A B C D

rows = 4
cols = 4

$j = 1 + 64$

$j = 2 + 64$

$j = 3 + 64$

$j = 4 + 64$

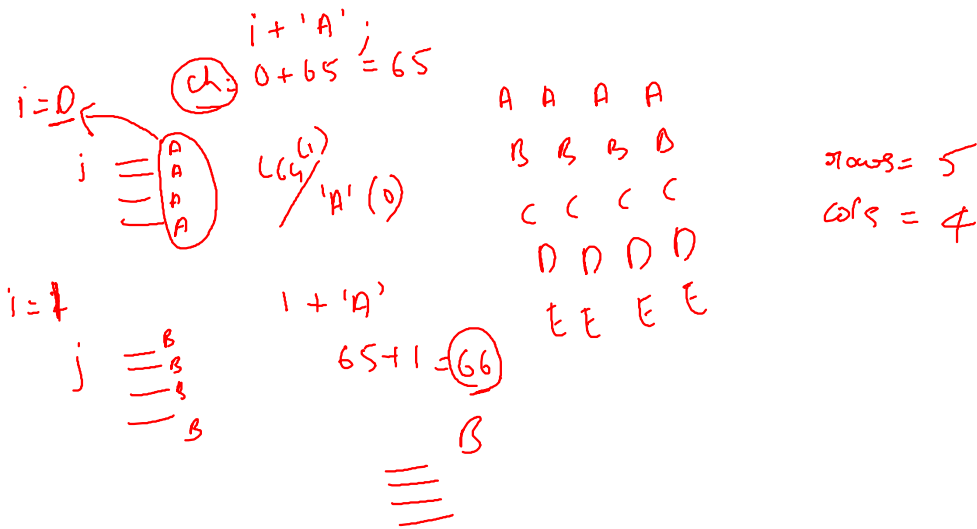**Homework – Pattern6: Alphabet Square with Repeated Row**

a b c d
a b c d
a b c d
a b c d

Pattern7: Alphabet Square with Repeated Row Characters

```
A  A  A  A
B  B  B  B
C  C  C  C
D  D  D  D
```

i + 'A' ;

ch 0 + 65 = 65

i = 0

j =

```
A
A
A
A
```

664 (1)

'A' (0)

i = 1

j =

```
B
B
B
B
```

1 + 'A'

65 + 1 = 66

B

A A A A

B B B B

C C C C

D D D D

E E E E

rows = 5

cols = 4

Homework-Pattern8:
Alphabet Square with Repeated Row-wise Lowercase Letters

```
a  a  a  a
b  b  b  b
c  c  c  c
d  d  d  d
```

Pattern9: Sequential Alphabet Grid (3x3)

A B C
D E F
G H I

num = 1

num
  ↳ +1

A B C
D E F
G H I
J K L

char = A'

char
  ↳ +1

Pattern10: Alphabet Shifted Rows Pattern (3x3)

A B C
B C D
C D E

i=0

j { 0 — A
    1 — B
    2 — C

'A' + j+i=) 65 (A)
'A' + j+i=) 66 (B)
'A' + 2+i=) 67 (C)

i=1

j { 0 — B
    1 — C
    2 — D

'A' + j+i= 65 (A) →66 (B)
                66 (B) 67 (C)
(static)   67 (C) 68 (D)
  } dynamic

i=2

j { 0 — C
    1 — D
    2 — E

'A'+j+i = 67 (C)
              68 (D)
              69 (F)

A B C ✓
B C D
C D E ✓

rows = 3
cols = 3

char('A' + j + i)

Triangle Patterns

Pattern1: Right-Angled Triangle Star Pattern

```
*
* *
* * *
* * * *
```

i=1 *****

i=2 *** ***

i=3 *** * ***

i=4 *** * * ***

j j j j
1 2 3 4

4 rows
4 columns.

i=1

* ——— j=1 ; j<=i .

i = 2

+ + —— 2

i=3

+ + +

 —— 3

i=4 + + + == —— 4
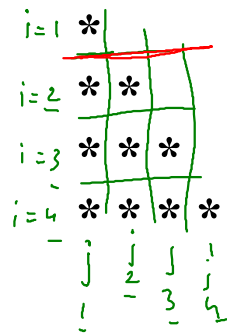
1ˢ row (i=1) * (j=1)

3ʳᵈ row (i=2) + + (j=2)

3ʳᵈ row(i=3) + + + (j=3)

1ᵗʰ row (i=4) + + + + (j=4)

Pattern2: Inverted Right-Angled Star Triangle

```
* * * *
* * *
* *
*
```

reverse ✓

$i = 4$

$j <= i \alpha$ ✓

$i = 3$ 2

$i = 3$ 3

$j = 4$ 4

	$j=1$	$j=2$	$j=3$	$j=4$
$i=1$	+	+	+	+
$i=2$	+	+	+	
$i=3$	+	+		
$i=4$	+			

rows = 4
cols = 4

Pattern3: Right-Angled Number Triangle Pattern

```
1
1 2
1 2 3
1 2 3 4
```

i = 1

p ——— 1

jc = i

i = 2

‥ ——— 1
‥ ——— 2

i = 3

═══ 1
      2
      3

i = 4

═══ 1
═══ 2
      3
      4

```
1
1  2
1  2  3
1  2  3  4
```

Homework- Pattern4: Number Triangle with Repeated Digits

```
1
2 2
3 3 3
4 4 4 4
```

Pattern5: Descending Number Triangle Starting from 4

```
4
4 3
4 3 2
4 3 2 1
```

4·1=3

i=1 4
___

4 3
___

4 3 2
___

i=4 4 3 2 1
___

⌐ 4

⌐ 4 3

⌐ 4 3 2

⌐ 4 3 2 1

cout << 4

j ≤ i

i = 1

j < i

$j=0$ — 4

i = 2

0 — 4-
1 — 3·1

cout << 4 - 0 = 4

4 - 0 = 4
cout << 4 - 1 = 3

i = 3

0 ___ 4   (4-0) = 4
1 ___ 3   (4-1) = 3
2 ___ 2   (4-2) = 2

i = 4

0 ___ 4   (4-0) = 4
1 ___ 3   (4-1) = 3
2 ___ 2   (4-2) = 2
3 ___ 1   (4-3) = 1

Homework- Pattern6: Odd Number Triangle Pattern

```
1
1 3
1 3 5
1 3 5 7
```

Hint =>

1 3 5 7 9 ...

{ odd
{ AP

1
1 3
1 3 5
1 3 5 7 9 ...

$T_n = a + (n-1)d$

:) $1 + (n-1)2$

:) $1 + 2n - 2$

:) $2n - 1$

(=> $2 + j - 1$)

Pattern7: Inverted Right-Angled Number Triangle

1 2 3 4 5
1 2 3 4
1 2 3
1 2
1

i=5
1 — 1
2 — 2
3 — 3
4 — 4
5 — 5

i=4
1 — 1
2 — 2
3 — 3
4

i=3
1 — 1
2 — 2
3 — 3

i=2
1 — 1
2 — 2

1   2   3   4 5
+   *   +   + α

i=1
1 — 1

Homework- Pattern8: Inverted Repeating Number Triangle Pattern

1 1 1 1
2 2 2
3 3
4

Pattern9: Sequential Number Triangle Pattern- Floyd's Triangle
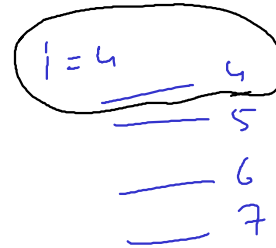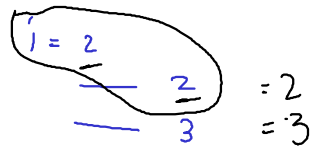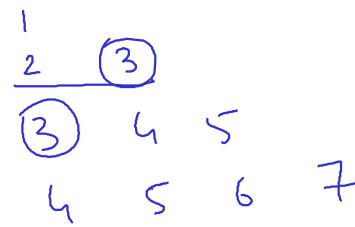
1
2 3
4 5 6
7 8 9 10

i=1 _____ n+1 ⟶) 1   num=1

i=2 _____ 2 — 2
    _____ 3 — 3

i=3 _____ 4   1.
    _____ 5
    _____ 6

Pattern 10: Incrementing Start Number Triangle Pattern

```
1
2 3
3 4 5
4 5 6 7
```

i = 1

num = i

i = 2

num = 2

i = 1   = 1

i = 2   = 2
    2
    3   = 3

i = 3
    3
    4   num = 3
    5

A B C
B C D

1
2 ③
③ 4 5
4 5 6 7

i = 4   4
         5
         6
         7

Pattern11: Reverse Number Triangle Pattern

```
1
2 1
3 2 1
4 3 2 1
```

$j = i$, $j \geq 1$

$i = 1$

$j = 1$ _____ 1

$i = 2$

$j = 2$ _____ 2

$j = 1$ _____ 1

```
1
2   1
3   2   1
4   3   2   1
```

$i = 3$

$j = 3$ _____ 3

$j = 2$ _____ 2

$j = 1$ _____ 1

$i = 4$

$j = 4$ _____ 4

3 _____ 3

2 _____ 2

1 _____ 1

Pattern12: Right-Angled Alphabet Triangle Pattern

```
A
A B
A B C
A B C D
```

j < i

i = 1
j = 0 —— A => 65 + 0 = 65

```
A
A  B
A  B   C
A  B   C   D
```

i = 2
0 —— A 65 + 0 = 65
1 —— B 65 + 1 = 66

i = 3
0 —— A => 65 + 0 = 65
1 —— B 65 + 1 = 66
2 —— C 65 + 2 = 67

i = 4
0 —— A 65 + 0 = 65
1 —— B 65 + 1 = 66
2 —— C 65 + 2 = 67
3 —— D 65 + 3 = 8

Homework- Pattern13: Alphabet Repeating Triangle Pattern

```
A
B B
C C C
D D D D
```

Pattern14: Sequential Alphabet Triangle Pattern

```
A
B C
D E F
G H I J
```

i = 2

char = 'A'

char++

Pattern15: Sliding Alphabet Triangle Pattern

A
B C
C D E
D E F G

i = 0

  0 —— A   65+0=65

i = 1

  0 —— B   65+0+1=65 (66)
  1 —— C   65+1+1= 66 (67)

A
B C
C D E
D E F G

i = 2

i = 3

  0 —— C   65+0+2= 65 (67)
  1 —— D   65+1+2= 66 (68)
  2 —— E   65+2+2= 67 (69)

  0 ═══ D
  1 ═══ E
  2 ═══ F
  3 ═══ G

65+0+3= 65 (68)
65+1+3= 66 (69)
65+2+3= 67 (70)
65+3+3= 68 (71)

Pattern16: Reverse Start Alphabet Triangle Pattern

```
D
C D
B C D
A B C D
```

H/W

i)

```
            2  1
    C   D     3  2  1
                4  3  2  1
    B   C   D
  A   B   C   D
```

Pattern17: Alternating Number and Alphabet Triangle Pattern

```
1
A B
1 2 3
A B C D
1 2 3 4 5
```

odd => number

even => Alphabet

$(i \% 2 \; != = 0)$

1st — 1

2nd ← A B

3rd 1   2   3

4th ← A   B   c   D

5th — 1   2   3   4   5

if else

$i = 1$

odd   j ——— 1

$i = 2$

even   j=0 ——— A + 0
        ——— B + 1

$i = 3$

odd   j=1 ——— 1
      2 ——— 2
      3 ——— 3

$i = 4$

even   0 ——— A + 0
       1 ——— B + 1
       ——— c   2
       3 ——— D 3

$i = 5$ 2 ——— 1
          3 ——— 2
odd   4 ——— 3
          5 ——— 4
            ——— 5

```
1
0 1
1 0 1
0 1 0 1
```

(2) $i=1 \mid j=1 \Rightarrow 1$

$i=2 \mid j=2 \Rightarrow 1$

$i+j \%2==0$)
cout $<<$"1"

$i=3 \mid j=1 =1$

6 $i=3 \mid j=3 = 1$

8 $i=4 \mid j=2 = 1$

8 $i=4 \mid j=4 = 1$

$j=1$

	$j=1$	2	3	
$i=1$	1	2		
2	0	1	3	
3	1	0	1	4
4	0	1	0	1

Pattern19: Right-Aligned Increasing Star Triangle

```
         *
       * *
     * * *
   * * * *
```

④

i = 1
i (3 spaces ⩽ 3
   (1 star — *

j = rows - i

k <= i

i = 2
(2 paces < 2.
(2 stars < *
          *

i = 3
1 space — 1.
3 stars = 1

i = 4
0 space . 0.
4 stars

Space →

→ *

Homework: Pattern20:
Right-Aligned Decreasing Star Triangle

```
* * * *
  * * *
    * *
      *
```

Homework: Pattern21:
Right-Aligned Descending Number Triangle

```
1 2 3 4
  2 3 4 ✓
    3 4
      4
```

Pattern22: Right-Aligned Inverted Repeating Number Triangle

```
1 1 1 1
  2 2 2
    3 3
      4
```

Pattern23: Right-Aligned Repeating Number Triangle (Single Space Indent)

```
   1
  2 2
 3 3 3
4 4 4 4
```

space

Number = i