COMPUTER PROGRAMMING

FIRST YEAR NOTES

-AKSHANSH CHAUDHARY

Computer Programming Notes, First Edition

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☆ Problem solving with computers:

D
AM
DAM

1. Clearly define the problem.
2. Analyse the problem and formulate a method to solve it.
3. Describe the solⁿ in the form of an algorithm.
4. Draw a flow chart of the algo.
5. Write the computer program.
6. Compile & run the program.
7. Test the program.
8. Interpretⁿ of results.

A
F
W
C

R
T
I
RTI

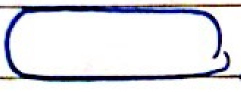
☆ Algorithm

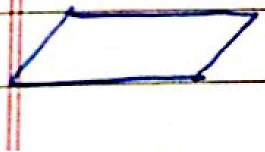
- a step-by-step description of the solⁿ
- can be written in a non-formal lang. & structure.

☆ Flow chart

- logical flow of solⁿ in a diagramatic form.
- provides a plan for writing comp. program.
- logical flow of an algo can be traced through the flow chart.

→ Std. flow chart symbols:


Start/Stop.


Input/Output

▭ Computation (Processing)

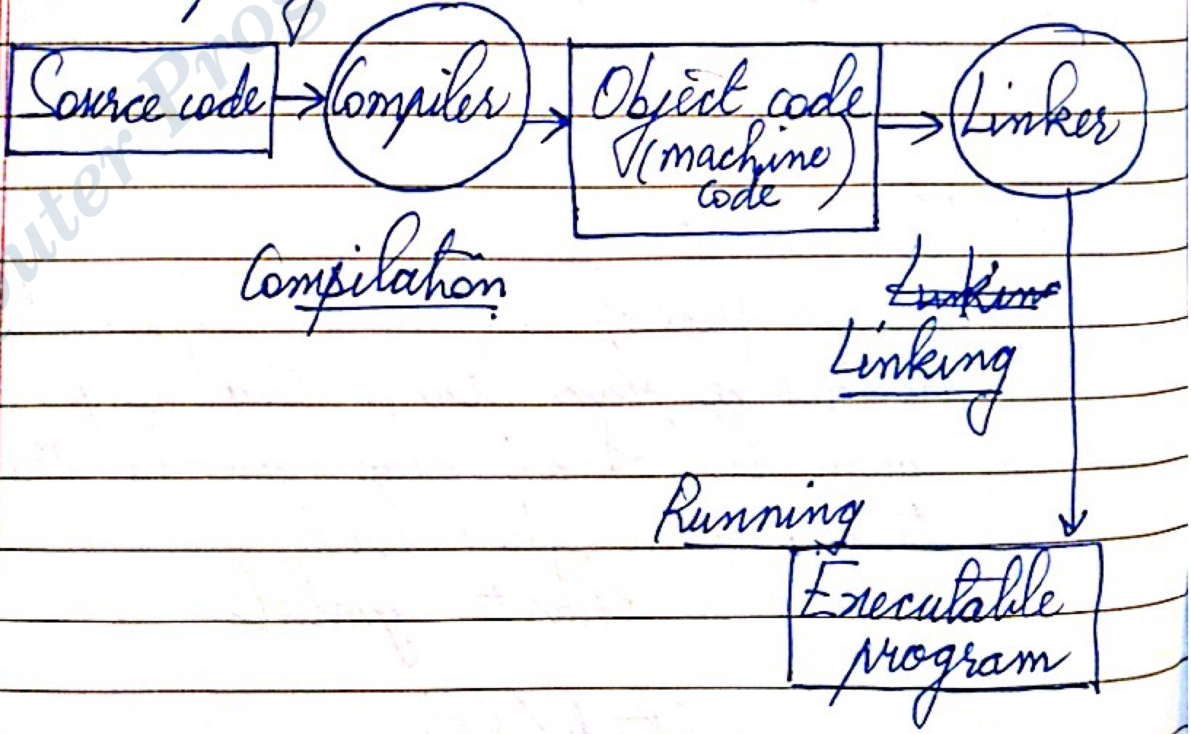
◇ Decision making (Decision box)

⬡ Repitition Structure (Looping statements)

↓ → Dir^n of control flow.

⫰ Connects the flow chart b/w pages.

★ Compiling a source code into executable m/c program:

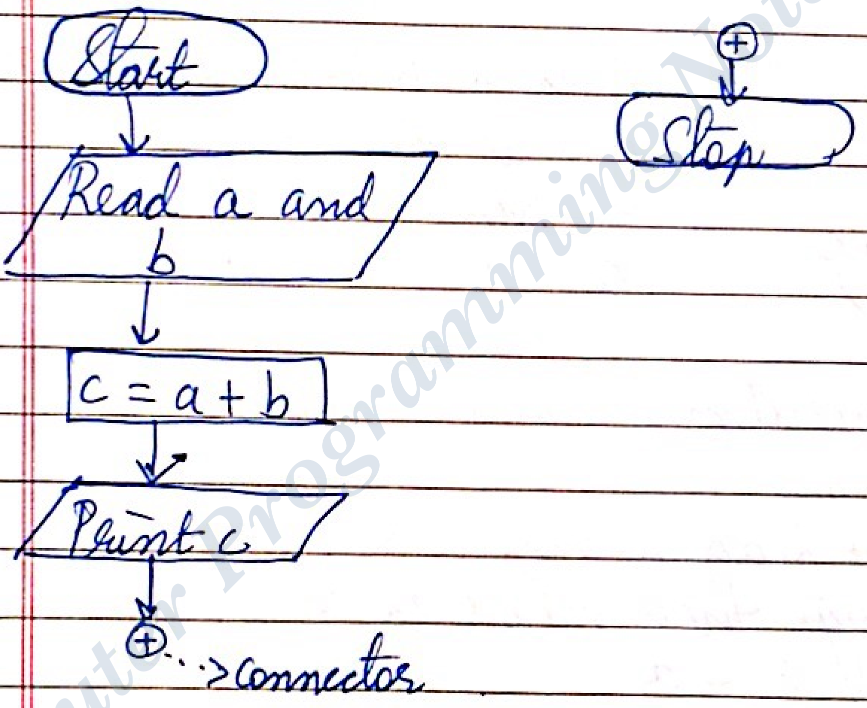


Problem Read 2 nos. & find their sum.

Algorithm

1. Start
2. Read 2 nos. in a & b.
3. Compute their sum as c = a+b.
4. Print c.
5. Stop.

Flow chart

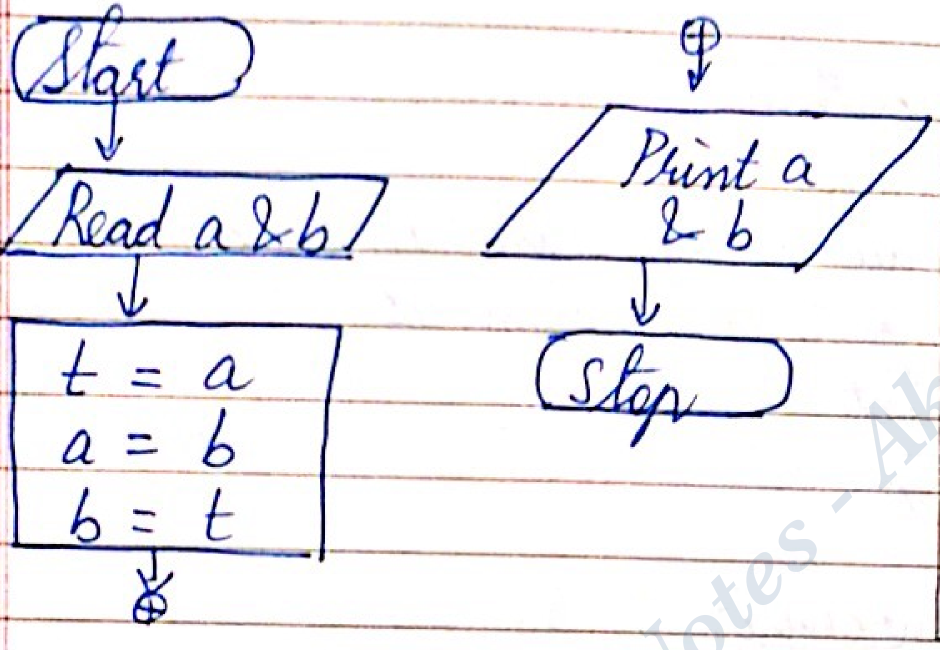


Problem: Read 2 nos. a & b and swap them.

Algorithm.

1 Start
2. Read 2 nos. in a & b
3. Assign ~~t~~ 'a' to a temp. variable 't'.
4. Assign 'b' to 'a'
5. Assign old value of 'a' in 't' to 'b'.
6. Print a&b, 7. Stop

Flow chart.



Aliter

* a = a+b
b = a-b
a = a-b

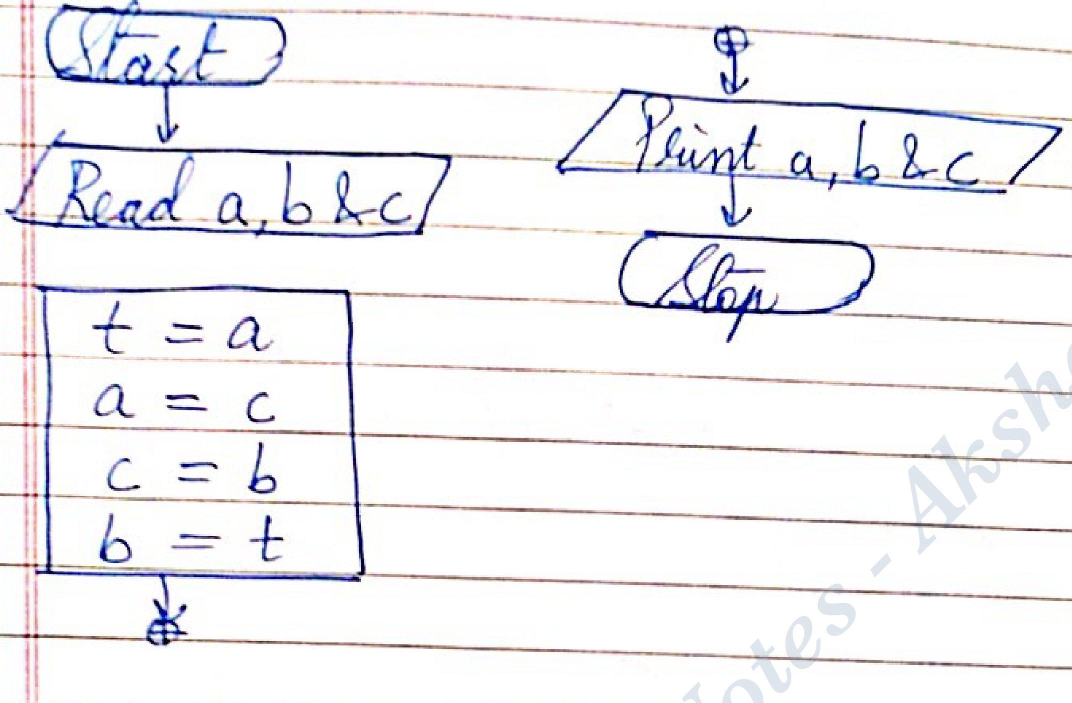
Program: Given 3 values a, b & c, rotate their values s.t b has value of a
c has value of b
a " " " c.

$$\begin{tikzcd} a \arrow[r] & b \arrow[r] & c \arrow[ll, bend left] \end{tikzcd}$$

Algorithm

1. Start
2. ~~Red~~ Read 2 nos. a & b
3. Assign these values to variables
   t = a
   a = c
   c = b
   b = t
4. Print a, b & c
5. Stop.

Flow chart

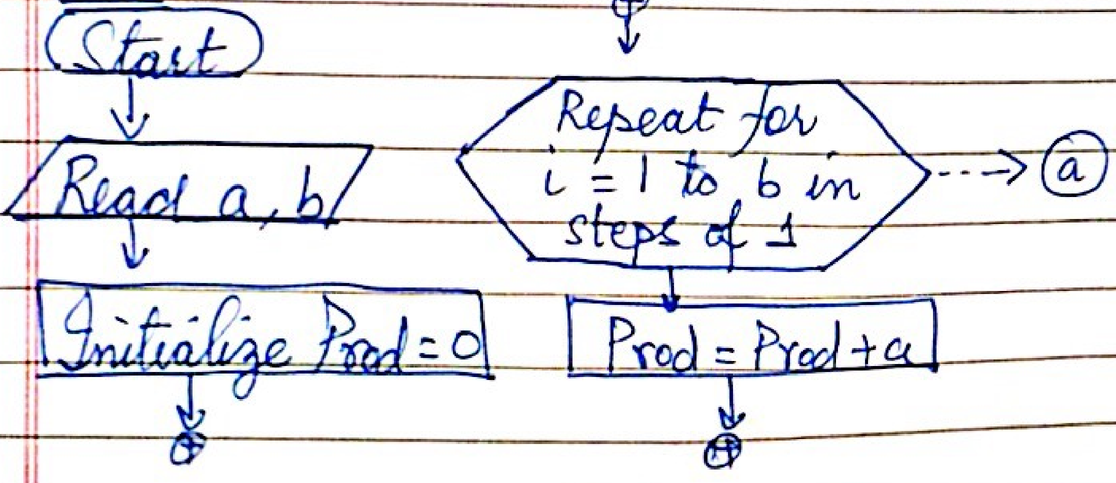


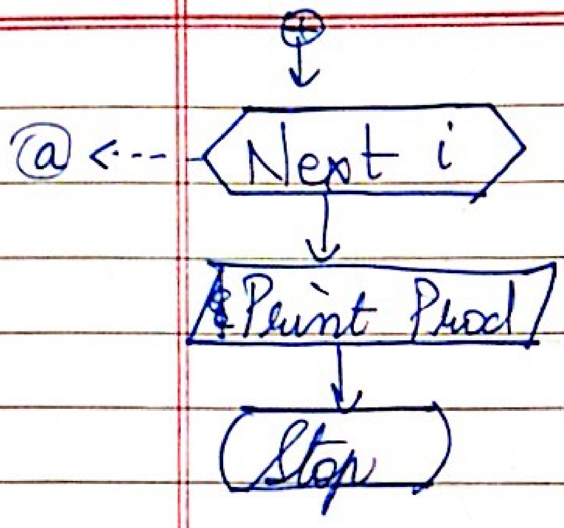
Program: Write the algorithm & draw the flow chart to find the product of 2 nos. a & b.

Algorithm

```
1. Start
2. Read 2 nos. a & b; 3. Initialize Prod = 0.
4. Repeat Step 5
   for i = 1 to b in increments of 1.
5. Prod = Prod + a.
6. Print Prod.
7. Stop.
```

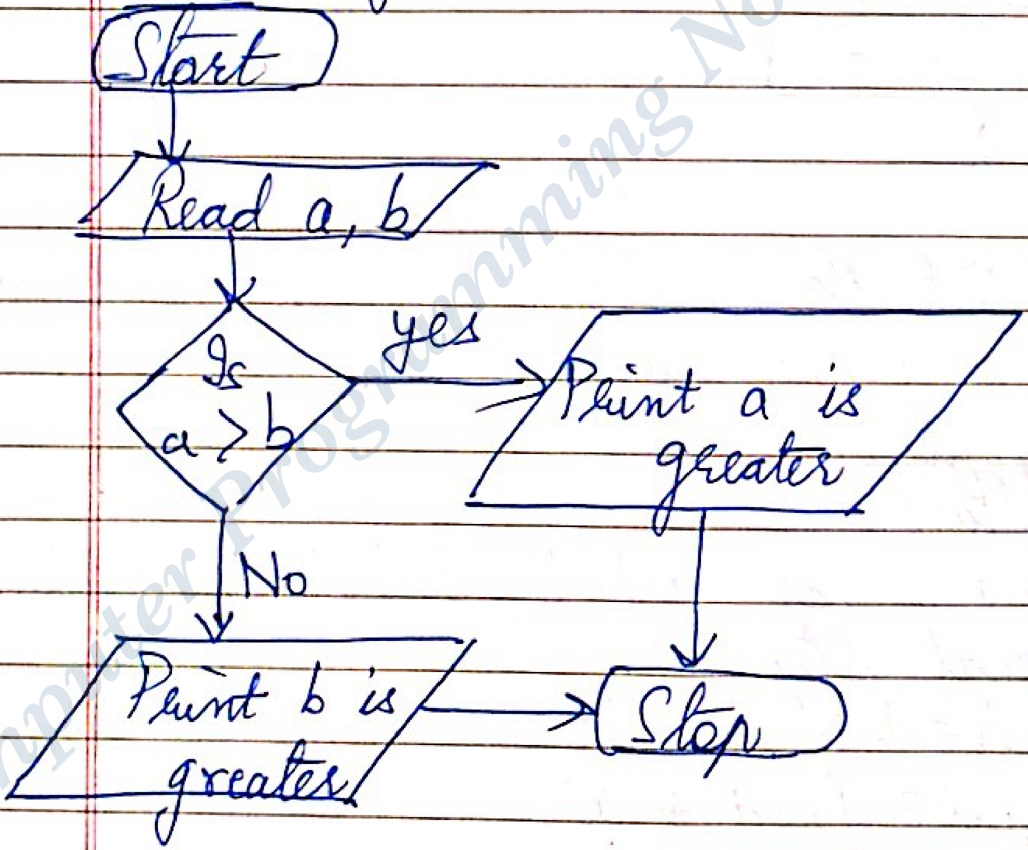
F.C





Program: To see greater of 2 nos.

FC



C

- case sensitive language.

* Data types

- a set of values & set of oper^{ns} on those values.

~~flat~~ float, double — real values
int — integer values.

- constraints → + or − sign
  → no comma (like ~~15,000~~)
- variables.

* Data type unit

- whole nos.
- −32767 through 32768 → including zero
- perform arithmetic oper^{ns} :

+ add^{n}, subtraction, multiplic^{n}, div^{n}, compar two integers.

* Data type DOUBLE

- real no.
- has → integral part & fractional part.
  → separated by decimal pt.
- double : eg : 3.14159, 0.0005 . . .

- very large & very small nos. scientific notⁿ
- arithmetic operⁿˢ & comparison.

eg: $1.23 \times 10^5 = 123000.0$

$= 1.23e5 = 1.23E5$.

1.23 → mantissa → real, → Z

5 → exponent → Z

* Double Constants

Valid	Invalid
3.14159	150.0
0.005	0·12345e
12345.0	15e-0.3 → Z
15.0e-04 (0.0015)	12.5e.3
2.345e2 (234.5)	34,500.99
1.15e-3 (0.00115)	
12e+5 (1200000.0)	

* Data type FLOAT

- to represent real nos.

* Data type CHAR :-

'A', '2', 'z', '+', ' ' → blank space

- compare
- arithmetic operⁿˢ.

classmate
Date 7/2/22
Page

* Data type VOID : empty value.

Chapter 2

2.1

÷ C language elemts :

- resembles everyday English.
- 2 parts
  - → Pre-processor directives
    - Cmds that give instructions to a C pre-processor.
    - Modifies the text before compil^n.
    - Begins with symbol → #.
  - → Main f^n.

* 2 common preprocessor directives.

1. #include.
2. # define.

1. #include: used for using library f^ns in a program. Some library f^ns are ~~sa~~ scanf(), printf(),

$\underbrace{\text{scanf(), printf()}}_{\text{Input/output } f^{ns}}$

⇓

Header file : stdio.h
(primary.extension)

Pow(), sqrt(), sin(), cos(), ...

⇓

Header file : math.h

for compiling any program under math.h header file, type "cc filename.c -lm" instead of "cc filename.c"

- Library: Useful info. ut ~~of~~ collection of symbols

* Library f^ns :-

- predefined
- grouped into header files ——— .h

1 I/O f^ns	Math f^n	String f^n
stdio.h	math.h	string.h
scanf()	sin()	strlen()
printf()	cos()	strcmp()
gets()	sqrt()	⋮
⋮	pow()	
	log()	
	⋮	

Format :: #include< header filename >
eg: #include <stdio.h>, #include <math.

- Users can also create library f^ns.

2. # define
You can give a name to a constant.
eg: # define pi 3.14.
Format :: # define symbolicname constant

* To make a comment in a program
/* . . . . . —— — — */

- non executable statements.

Second

* Function (main):

Syntax:

```
int main()    or    main()
{                   {
   fn body             fn body
}                   }
```

- fn body.

declarn part

executable stmt. part.

. which memory cells will be used in the program. Variable names tells which memory cells will be used.

eg: int main(void).

```
{
  printf("\n Hello \n");
  return(0);
}
```

* Reserved words : (Std. identefiers).

- has a special - fixed meaning.

ex: int void double return if for ....

• Keywords

- have fixed meaning
- written in lower case.

eg: auto for int if case
break goto float char default.

* Identifiers : Defined by users.
- names of variables, f^{ns}, arrays.

* Rules to be used for selecting identifier :-
1. 1st char : must be alphabet.
2. Consists of only letters, digits or underscore. (only underscore is allowed in special char.)
3. Only 1st 31 char, are significant.
4. Shouldn't be a keyword.
5. No white space, no limit on length.

* Stmt terminator :- " ; "

Variable names

Valid	Invalid
letter=1	1 letter
Letter_2	double
inches	int
cent	TWO * FOUR
Rate	joe's
rate	Letter-1
RATE	

CASE SENSITIVE { Rate, rate, RATE } will be treated as diff^t variable names

* General practice
- Symbolic constants : Upper case
- Rest of the program : Lower case

* Variable name should signify its usage in the program.

* For int variable, memory allocated = 2 byte
char 1 byte

* Variable declar^{n}

Syntax: data type variable name,..., . . ;

* Assignment Statement:

Assigning values to variables used in a program :-

(i) using an assignment stmt :-

Syntax: variable name = constant ;

↳ done at compil^{n} time

- Initializ^{n} :-

eg: int final-value = 10 ;

(ii) through input f^{ns} :-

↳ called as Runtime assignments done to variables

Syntax: scanf("controlstring", &variable1, &variable 2,...);

↳ address of input variable 1 & value of it

- Format / Control String:

→ The format in which the user should input values.

%d : integer

%f : float, double

%c : character

%s : string (no &)

like scanf("%d@%d", &a, &b);

Then, enter values as a@b

* Output function : printf

Syntax: printf("Format string", variable 1, var 2....);

→ only the value of variable (not the address)

* Escape sequence :

Character constts used for formatting the output. Begin with '\'.

Newline character '\n'

Horizontal tab '\t'.

Program :- Program to generate the following pattern of astericks :-

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

```
#include<stdio.h>

main()
clrscr();
{
printf(" *\n**\n***\n");

return(0);
}
```

★ **Operators :**
Symbols - mathematical / logical manipulations

★ **Types :**

A . Arithmetic operators
R . Relational "
L . Logical "
A . Assignment "
I . Increment & decrement
C . Conditional
B . Bitwise
S . Special

A A B C D
L
R S

★ **Expression :**
Combin^n of operands (constants / variables) by operators $\xrightarrow[\text{gives}]{\text{on evaluation,}}$ a single value.
Eg: 10+15
Result : 25 (any type, except VOID).

★ **Arithmetic operators**

★ Only with integer operand

Operator	Meaning
%	modulo division (remainder) (Z) integer

★ Binary : 2 operands for 1 operator.
★ Unary : 1 operand for 1 operator.
★ No operator for exponentiation — pow( )
★ Data type of operand = Data type of result.
★ When operators are in mixed mode — implicit type conversion is followed (Hierarchy).

* For modular operator, the sign is followed of 1st operand.

eg: $-14 \% 3 = -2$

$-14 \% -3 = -2$

$14 \% -3 = 2$.

* If one operand is integer & other is real

⇓

Mixed mode arithmetic

One operand	: $\mathbb{Z}$
Other operand	: $\mathbb{R}$
Result	: $\mathbb{R}$

eg: $15/10.0 = 15.0/10.0 = 1.5$.

But $15/10 = 1$.

eg②:

```
int a=5;
int b=2;
float c;
c = a/b.
  = 2.0
```

get actual value →

EXPLICIT TYPECASTING

```
int a=5;
int b=2;
float c;
c = (float) a/b
  = 5.0/2
  = 2.5
or → a/(float) b
  = 5/2.0
  = 2.5
```

Program:- Using arithmetic operators, read a 3 digit no. & find sum of its digits.

eg: 123

No	Digit = N%10	Sum = sum+digit	N=N/10
123	3	0+3 = 3	12
12	2	2+3 = 5	1
1	1	1+5 = 6	0

1/10 = 0

1 % 10 = 1

Program:-

```
#include <stdio.h>
main()
{
int num, d, sum=0; printf("Enter no");
scanf("%d", & num);
d = num % 10 ;
 sum = sum +d ;
 num=num/10 ;          } first digit

                10
d = ~~##~~ num % ~~d~~ ;
sum = sum+d ;          } second digit
num = num/10 ;

  d
~~num~~ = num % 10;
 sum = sum +d;         } 3rd digit

or
 sum = sum+ num ;

printf("%d", sum);
}
```

Program 2 :- WAP to read the radius of a circle and find its area, using symbolic constant.

```
#include<stdio.h>↵ #define PI 3.14
main ()
{
int r; ~~area~~ float area;
printf("Enter the radius of circle");
scanf("%d", &r);
~~PI~~ area = PI ~~3.14~~ * r * r;
printf("\nThe area of circle is %f", area);

return (0);
}.
```

Program 3 : WAP to read the area of a triangle given its three sides, a, b & c.

Hint, $s = \frac{a+b+c}{2}$

$area = \sqrt{s(s-a)(s-b)(s-c)}$

```
#include<math.h>
#include<stdio.h>.
main ()
{
int a,b,c, ~~s, area~~;
float s, area
printf("\nEnter the values of three sides
        of triangle a, b and c");
scanf("\n %d %d %d", &a,&b,&c);
 s = (a+b+c)/2.0;
 area = sqrt(s*(s-a)*(s-b)*(s-c));

printf("\n The area of triangle is %f",
        area);

return (0);
}
```

☆ Relational operators

↳ relational expression arrives from them.

Priority : arithmetic ~~expression~~ operators (ae) > Rel^{nal} ~~expression~~ operators

Types of operator

- <
- <=
- >
- >=
- ==
- !=

Relational expression

ae-1 rel^{nal} operator ae-2

eg: 4.5 <= 10

(a+b) == (c+d)

→ arithmetic expression

Operator	Its complement
>	<=
<	>=
==	!=

* Logical Operators

↳ combines 2 or more arithmetic expression (ae.)

Operator	Meaning
&&	logical AND
||	logical OR
!	logical NOT

If ((age > 55) && (salary < 1000))

* Shorthand assignment operator

v op = exp.   v: variable

op: oper^n : linear, arithm

exp: expression

eg: a = a+10. ≡ a += 10

x = x + (y+2) ≡ x += y+2

a = a*(n+1) ≡ a *= n+1

* Increment and decrement operator.

- ++ and --
- unary, have only variables as operands

m++ ≡ m=m+1 ; m-- ≡ m=m-1.

* Prefix and Postfix form

(Pre-increment & post increment)

Pre	Post	Ex.	ex
++m	m++	a=5	a=5
--m	m--	b=a++	b=++a

		Result
		a=6
		b=5
			Result
			a=6
			b=6

first value of a is assigned to b, then incremented

* Conditional Operator

Symbol : ? :

Syntax : $\underbrace{exp1}_{\text{rel}^{\text{nat}}\text{/logical}}\ ?\ \underbrace{exp2}_{\text{evaluated if exp1 is true}}\ :\ \underbrace{exp3}_{\text{evaluated if exp1 is false}}$;

eg : a = 10, b = 5

X = (a>b) ? a : b ;

↳ used to compare 2 nos.

* Evaluation of expressions :

Using of Precedence (Priority) & associativity

- Operator (arithmetic) Priority

* / %	high
+ −	low

- Operators on same level have same priority. So, if they occur together, use associativity :- LEFT TO RIGHT.

eg:- $\underbrace{\underbrace{\underbrace{a*b}_{①}/c}_{②}-d}_{③}$

- Parenthesis : highest priority.

eg: $\underbrace{a*\underbrace{(\underbrace{(b/c)}_{1}-d)}_{2}}_{3}$

* In case of nesting of parenthesis, the innermost parenthesis is evaluated first.

* Rules for evaluating expressions :

(a) Parenthesis Rule :

(b) Operator Precedance rule

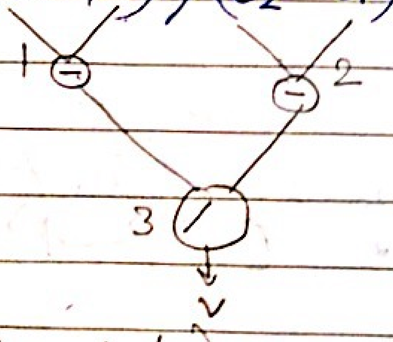
Operator	Precedance
• f^n ~~calls~~ calls (eg sqrt)	highest
• !, +, -, &, (unary), size of, (type) — type casting	
• * / %	
• + −	
• < <= >= >	
• = !=	
• &&	
• ||	
• =	Lowest

(c) Associativity rule

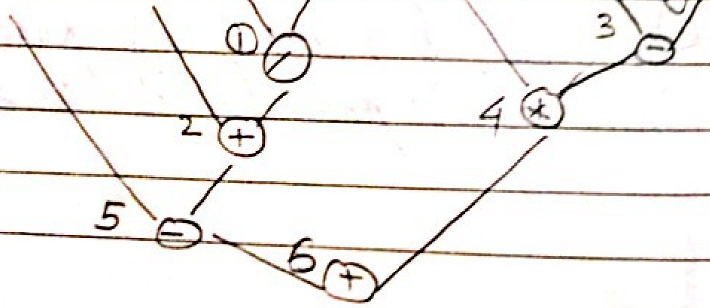
Unary operator : Right to left

Binary operator : left to right.

eg: $V = (p_2 - p_1)/(t_2 - t_1)$



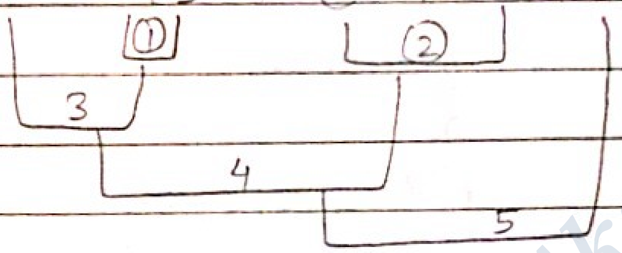
eg ② $z - (a + b/2) + w * - y$



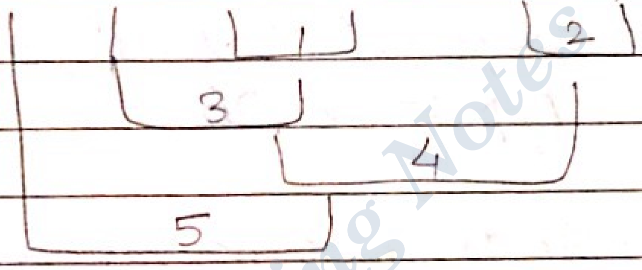
ex :- $x = a - b/3 + c * 2 - 1$

if $a = 9,\ b = 12,\ c = 3$

$x = a - b/3 + c * 2 - 1 = 10$.



ex :- $9 - 12/(3+3) * (2-1) = \boxed{7}$



* BITWISE OPERATORS :

- manipulates data at bit level
- testing bits, shifting them right/left.
- may not be applied to float or double

Operator	Meaning
&	bitwise AND
|	" OR
^	" exclusive OR
<<	shift left
>>	" right.

gives output as 1 only if the input operands are different

* Special operators.

(2) Comma operator :

- Link the related expr^{ns} together.
- Left → Right ; result is right most expr^{n}.

eg : value = (x=10, y=5, x+5);

(b) Size of operator :

```
eg:- int sum;
        m = sizeof (sum)        | m = 2
        n = size of(float)      | n = 4
eg: main()
     {
     int a,b,c,d
     a=15; b=10; c= ++a-b;
     d = b++ +a;
     printf(" %d %d", c,d);
     O/p :- 6 26
```

Program:- WAP to check whether a given no. is odd or even.

```
#include<stdio.h>
main()
{
int a, b ;
printf("\n Enter the no. to check");
scanf("\n%d", &a);
b = a%2
  (b = = 0) ? printf(" No. is even"); :
    printf("\n No. is odd");
return(0);
```

Check

Program:- WAP to find largest of 2 given nos.

```
#include<stdio.h>
main ()
{
```

a,b

(a>b)? printf("_ _"): printf(

```
int a, b ;
printf(" \nEnter the 2 nos to compare ");
scanf("\n%d %d", &a, &b);
 (a>b)? printf("\n a is greater ):
  printf("\n b is greater") ;
return(0);
}.
```

Program: WAP to read 3 integer nos. and find largest of them using conditional operators.

```
 #include <stdio.h>
main()
{
int a, b, c, d;
printf("\nEnter the 3 nos. to compare");
scanf("%d %d %d", &a, &b, &c);
```

```
(a>b)? ((b>c)? printf("\na>b>c"): printf
      ("\n a>c>b")): ((a>c)? printf("\nb>a>c")
      : printf("\n b>c>a ."));

return(0);
}.
```

✱ Formatting nos. in Program Output :-

Formatting int :-

%wd

w :- field width ; right justified

Value	Format	Displayed Outpu
234	%4d	␢ 234
234	%5d	␢␢234
234	%6d	␢␢␢234
234	%1d	234
-234	%4d	-234
-234	%5d	␢-234
-234	%6d	␢␢-234
-234	%2d	-234

Formatting double

% w.df

w: field width , d: no. ~~of~~ /... of digit / output column after the decimal point, sa up to d pos^ns.

- Output is right justified.

ex :- %6.2f

Value of x	Displayed output
-99.42	-99.42
.123	␢␢0.12
-9.536	␢-9.54
-25.554	-25.55

Value	Format	Output
3.14159	%.5.2f	ƀ3.14
3.14159	%.3.2f	~~ƀ6~~3.14
3.14159	%.5.3f	3.141
.1234	%.4.2f	0.12
-0.006	%.8.3f	ƀƀ-0.006

☆ int main(void)
→ after running the program in main, the f^n goes to OS to return a value zero.
So, we type return(0); in the end.

Chapter - 7

* Representⁿ & conversion of numeric types.

- Data is stored internally as binary strings.
- Binary string of int 13 is diffᵗ from float 13.0

type int	type double	
binary no.	mantissa	exponent

```
# include<stdio.h>
# include< limits.h> /*INT_MAX*/
#include <float.h> /*DBL_MIN, DBL_M*/
main()
 {
printf("Range of +ve values of type int :...
      ...%d\n", INT_MAX);
printf("Range of +ve values of type double
     : %e.......  %e\n", DBL_MIN,
        DBL_MAX);
```

%e : Meant for a real no. to be printed in exponent form

* signed : +ve as well as -ve values

* unsigned : only +ve values.

* The for stmt. is meant for int. variables.
eg: in real variables,

```
for (trial = 0.0; trial < 10.0; trial = trial + 0.1)
  {
     —
  }.
```

Some compilers run → 100 times,
others → 101 times. So, avoid.

* Automatic conversion of data type occurs in mixed mode arithmetic.
↳ Conversion done from lower level of hierarchy to higher level.

* Representn & conversion of type char.
- char – 'A', '+' 'a' '$'
- char values can be compared using relnal operator
  = =; ! =; <; <=; >; >=

ex:- char next-letter; /* char var */
        next-letter = 'A';
        if (next-letter < 'Z')

* Character values/codes (ASCII) are from 48 to 57 for 0 to 9

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Chapter - 4.

Control Structures

↳ decide order of program execution

sequential (by default)
Writing the program in a sequence/order & executing it

selective
Execute stmts & by pass other stmts based on test cond^{ns}.

Types :-
↳ single alternative

① Simple if

```
If (cond^n)
    stmt ;
```

② If ... else

```
if (cond^n)
    ~~else {~~ stmt;
else
        stmt;
```

③ ~~Else~~ Nested ... if stmt

```
~~Else~~ { If (cond^n)
            stmt
Else
    {If (cond^n)
        stmt
    Else
        stmt
    }
}.
```

repetitive (or Iterative)
Multiple alternative nested if i.e If-else-if statement

```
If (cond^n)
    stmt;
else if (cond^n)
    stmt;
    :
    :
else if (cond^n)
    stmt;
else
    stmt;
```

↳ executed if all above cond^{ns} are false.

Program :- Read 3 nos. a, b & c to find largest of them

```
#include<stdio.h>
main()
{
int a,b,c;
printf("\nEnter 3 nos. a, b & c")
scanf("%d %d %d",&a,&b,&c);

if (a>b)
  {
   if (a>c)
       printf("\n a is largest \n");
   else
       printf("\n c is largest \n");
  }
else
  {
    if (b>c)
        printf("\n b is largest \n");
    else
        printf("\n c is largest \n");
  }

return(0);
}
```

Aliter

```
    if ((a>b)&&(a>c))
        printf("\n a");
    else if ((b>a)&& (b>c))
        printf("\n b");
    else
        printf("C");
```

—x—

* GOTO STATEMENTS

: unconditional transfer of program control

Syntax :-
```
goto label;
  - - -
  - - - -
                         } Forward jump
label :                  } - bypass some
     statement;          }      statements

label :
     statement           } backward
  - - -                  }     jump.
  - - - -                }
   goto label;           } - forms a loop
```

Program :- WAP to read the marks of a student in 8n subjects & find the total and average.

```
#include <stdio.h>
main()
{
int n, sum=0, m, count=0;
float avg;
```

```
    printf("\n Enter the no. of subjects");
    scanf("\n %d", & n);
l1: printf("\n Enter the marks in a subject");
    scanf("%d", & m);
    Sum = Sum + mark;
    count = count ++ ; (or count = count + 1 ;)
    if (Count <= n)
            goto l1;
    else
        printf("\nThe total marks are %d", sum);
                          typecasting operator
    avg = (float)sum/n;

    printf("\n The average is %f\n");

    return(0);
    }
```

★ Number System & representations

- Binary system : Base - 2 (0, 1)
- Decimal system : Base - 10 (0 to 9)
- Octal System : Base - 8 (0 to 7)
- Hexadecimal Sys. : (0 to 9) & (A to F)

A - 10 D - 13 : Base - 16.
B - 11 E - 14
C - 12 F - 15

Decimal	Binary	Octal	Hexadecimal
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	-	8
9	1001	-	9
10	1010	-	A
11	1011	-	B
12	1100	-	C
13	1101	-	D
14	1110	-	E
15	1111	-	F

↓

To remember, write them as

8(0's)↓ 4(0's) 2(0's) 1(0)
2(1's) 1(1)
8(1's)↓ 4(1's) 2(0's) 1(0)
4(0's) 2 1(1)

* Convert decimal to binary

eg:- $(41)_{10} = (?)_2$

```
2 | 41
2   20 — 1
2   10 — 0
2    5 — 0
2    2 — 1
     1 — 0
```

Ans → $(101001)_2$

eg

```
2 | 45
2   22 - 1
2   11 - 0
2    5 - 1
2    2 - 1
     1 - 0
```

$(45)_{10} = (101101)_2$

* Decimal to octal

eg $(41)_{10} = (?)_8$

```
8 | 41
    5 — 1
```

Ans = $(51)_8$

eg:

```
8 | 324
8   40 — 4
     5 — 0
```

Ans = $(504)_8$.

* Decimal to hexademical

eg) $(41)_{10} = (?)_{16}$

$$\begin{array}{r|l} 16 & 41 \\ \hline & 2 - 9 \end{array} \quad = (29)_{16}$$

eg) $(45)_{10} = (?)_{16}$

$$= \begin{array}{r|l} 16 & 45 \\ \hline & 2 - 13 \end{array} \quad \text{Ans} = (2D)_{16}$$

* Binary to decimal

eg $(10110)_2 = (?)_{10}$

$$2^0 \times 0 + 2^1 \times 1 + 2^2 \times 1 + 2^3 \times 0 + 2^4 \times 1$$

$$= 2 + 4 + 16$$

Ans $= (22)_{10}$

* Octal to decimal

(eg) $(172)_8 = (?)_{10}$

$$2 \times 8^0 + 7 \times 8^1 + 1 \times 8^2$$

$$= 64 + 2 + 56$$

Ans $= (122)_{10}$

* Hexadecimal to decimal

256
×16
4096
×7
28672

eg $(7A1E)_{16} = (?)_{10}$

$E \times 16^0 + 1 \times 16^1 + A \times 16^2 + 7 \times 16^3$

$= 14 \times 16^0 + 1 \times 16^1 + 10 \times 16^2 + 4096 \times 7$

$= 14 + 16 + 2560 + 28672$

Ans $= (31262)_{10}$

28672
+2560
+30
31262

* Binary to hexadecimal

eg $\underbrace{1011}_{B}\,\underbrace{0101}_{5}$ (Group bits into 4 starting from right. If bits are less, put zeroes to make group.)

Ans $(B5)_{16}$

eg :- 11 0101

$= \underbrace{0011}_{3}\ \underbrace{0101}_{5}$ Ans $= (35)_{16}$

eg: $\underbrace{0110}_{6}\,\underbrace{1011}_{B}\,\underbrace{1000}_{8}\,\underbrace{1100}_{C}$

Ans $= (6B8C)_{16}$

* hexadecimal to binary

(write 4 bit binary equivalent of each hexadecimal)

eg) $(374F)_{16} = (?)_2$

3	7	4	F
0011	0111	0100	1111

Ans → $(0011\ 0111\ 0100\ 1111)_2$

* Converting fractions : decimal to binary

eg $(0.182)_{10} = (?)_2$

			Integer
0.182×2	=	0.364	0
0.364×2	=	0.728	0
0.728×2	=	1.456	1
0.456×2	=	0.912	0
0.912×2	=	1.824	1
0.824×2	=	1.648	1
0.648×2	=	1.296	1

Ans :- $(.0010111)_2$ ~~0.0010~~

- Proceed till the fractional part becomes zero or till the no. of digits got gives the required accuracy.

eg $(0.125)_{10} = (?)_2$

0.125×2	=	0.25	0
0.25×2	=	0.5	0
0.5×2	=	1.0	1
0×2	=	0.0.	

⇒ Ans = $(.001)_2$.

eg) $(41.125)_{10} = (?)_2$.

Convert integer part & fractional part separat

$(0.125)_{10} = (.001)_2$.

* Fractional binary to decimal

eg: $(.001)_2$
$\times 2^{-1}$
$\times 2^{-2}$
$\times 2^{-3}$

$$
\begin{array}{l|ll}
2 & 41 & \\
2 & 20 & 1 \\
2 & 10 & 0 \\
2 & 5 & 0 \\
2 & 2 & 1 \\
 & 1 & 0
\end{array}
$$

Ans $= (101001)_2$

$\Rightarrow (41.125)_{10} = (101001.001)_2$

* Decimal fraction to octal

ex:- $(0.125)_8 = (?)_8$

$0.125 \times 8 = 1.0$ ——— 1

$\therefore (0.125)_{10} = (0.1)_8$

* Decimal fraction to hexadecimal

eg $(0.9)_{10} = (?)_{16}$

$0.9 \times 16 = 14.4$	14	E
$0.4 \times 16 = 6.4$	6	6
$0.4 \times 16 = 6.4$	6	6

$\Rightarrow (0.9)_{10} = (.E66)_{16}$

* Binary fraction to decimal

eg: $(0.11)_2 = (?)_{10}$

$= 1 \times 2^{-1} + 1 \times 2^{-2}$

$= \frac{1}{2} + \frac{1}{4} = \frac{3}{4} = (0.75)_{10}$

eg $(45.75)_{10} = (\ .\ )_2$

```
2|45            (101101)₂
2 22  1
2 11  0         .75 × 2 = 1.5    1
2  5  1         .5 × 2  = 1.0    1   (0.11)₂
2  2  1         Ans:-
   1  0         (101101.11)₂
```

$1\times2^0 + 0\times2^1 + 1\times2^2 + 1\times2^3 + 0\times2^4 + 1\times2^5$

$1 + 4 + 8 + 32 = 45$

$1\times2^{-1} + 1\times2^{-2} = \frac{1}{2} + \frac{1}{4} = 0.75$

$\Rightarrow (45.75)_{10}$

* How to represent nos. in a computer?

- Numbers : signed, unsigned, integers, floating point, rational . . .
- Text : characters, strings
- Images : pixels, colors
- Sound : multimedia data
- logical : true, false

1) Unsigned integers :

- For representing memory addresses.
- weighted pos^{nal} not^{n} – like decimal nos.

- LSB : Least significant Bit
- MSB : Most significant Bit

eg 3 2 9 → 10^2, 10^1, 10^0
= 300 + 20 + 9 = 329

MSB ← 1 0 1 → LSB → 2^2, 2^1, 2^0
= 1 + 4 = 5.

★ An n-bit unsigned integer represents 2^n values : from 0 to $2^n - 1$

eg: n = 3, values = $2^3 = 8$
range = 0 to 7.

unsigned integers	= decimal equivalents
0 0 0	0
0 0 1	1
0 1 0	2
0 1 1	3
1 0 0	4
1 0 1	5
1 1 0	6
1 1 1	7

★ Binary addition on unsigned integers
- add from right to left, propagating carry

```
ex:-  1 0 0 1 0
    +   1 0 0 1
    -----------
      1 1 0 1 1

ex:-  1 0 0 1 0
    +   1 0 1 1
    -----------
      1 1 1 0 1
```

Truth table

a	b	sum	carry
1	0	1	0
0	1	1	0
0	0	0	0
1	1	0	1

★ 2) Signed Integers
- +ve & -ve Z.
- with n-bits, 2^n distinct values.
- assign half to ~~posn~~ +ve integers (+1) through 2^{n-1} -
- assign half to -ve integers $-(2^{n-1}-1)$ through -

- one value for 0, one not used.

eg: $n = 5$, values : $2^5 = 32$

+ve Z_s = 1 through $2^4 - 1$
= 1 through 15. 15

-ve Z_s = -15 through -1 15

one pattern = 0 1

one not used 1

$2^5 = 32$

* +ve Z_s :-

· Just like their unsigned equivalents.

· Zero is in MSB.

eg:- $\textcircled{0}0101 = 5$

* -ve Z_s

(a) Sign magnitude form :- · MSB = 1
· other bits same as its unsigned equivalent

ex:- $\textcircled{1}\overbrace{0101}^{5 \text{ bits}} = -5$, $\underbrace{10000101}_{8 \text{ bits}} = -5$

(b) One's complement

(i) Write the represent^n of +ve equivalent

(ii) flip each bit.

eg:- 5 bit represent^n :- 5 = 00101

flip the bits (0 to 1 & vice versa) :- 11010

*(c) 2's complement

· 1's complement + 1.

· Taking 2's complement is same as negating the number.

2's complement of X.

i.e $\boxed{X + (-X) = 0}$

original X

eg:- 2's complement of 5 → 00101

+ve equivalent

1's complement → 11010
+ 1

11011 → 2's complement

To prove: 2's complement + Original value = 0

```
    00101   (5)
 +  11011   (-5)
  ① 00000   (0)
```

carry → ignore

* Binary Subtraction

ex:- $7_{10} - 5_{10} = 7_{10} + (-5)_{10}$

(Using 4 bits) → 2's complement of 5.

7 in binary 0111_2

-5 in binary 1011_2

```
0101   original
1010   1's
  +1
1011   2's
```

```
   7      0111
+ (-5)    1011
        ① 0010
```

→ Ignore the carry.

eg. Add -25_{10} to 18_{10} using 6 bit represent^n

```
2|25       011001        -25₁₀ = 100111.
2 12  1  → 100110
2  6  0       +1
2  3  0    100111
   1  1    → 25.
```

2	18	
2	9	0
2	4	1
2	2	0
	1	0

$18_{10} = (10010)_2$

So, $18_{10} = (010010)_2$

~~0~~

$$\begin{aligned}(-25)_{10} &= 100111\\ (18)_{10} &= +010010\\ \hline &\ \ \ 111001 \text{ Ans.}\end{aligned}$$

Check:-

Find decimal equivalent

$(1\times(-32)_{10}) + (1\times 16_{10}) + (1\times 8_{10})$

∵ MSB = 1
So, -ve no.

$+ (1\times 2^0_{10}) = -7_{10}$.

Program: Read the coefficients a, b & c of a quadratic eqn
$ax^2+bx+c=0$
& find its roots.

```
#include<stdio.h>
main()
{
float a, b, c, d, rp, ip, r1, r2;
 int i;
printf("\n Enter the values of a, b & c
       for the equation ax^2+bx+c=0\n")
scanf("%f %f %f \n");
d = sq(b) - 4*a*c;

if ( d ==0)

      r1 = (-b)/2*a ;
      r2 = (-b)/2*a ;
      printf("\n The roots are equal and
      equal to %f and %f \n",r1,r2);

else if (d>0)
         r1 = (-b + sqrt(d))/2*a;
         r2 = (-b - sqrt(d))/2*a;
         printf(" \n The roots are real and
         unequal and are %f and %f",
         r1,r2);

else if (d<0)
         rp = (-b)/2*a;
          ip = (sqrt(abs(d)))/2*a ;
         r1 = rp + i(ip);
         r2 = rp - i(ip);
         printf("\n The roots are imaginary
          and equal to %f & %f \n", r1,
          r2);

return(0);

}
```

✱ Switch Statement

Syntax:

```
switch (controlling expression)
       {
       Case label set 1;
                 statements ;
                 break;
       Case label set 2:
                 statements ;
                 break;
       default :
              statements ;
       }
```

int or char

int or char

any number of them can be used

optional

Break: It is reqd for making only that stmt. to execute.

eg :-

```
   switch (watts)
      {
       case 25 :
              life = 2500;
              break;
       Case 40 :
       Case 60 :
              life = 1000;
              break;
      }case 75:
       Case 100 :
              life = 750;
       default :break;
   }          life = 0;
```

multiple labels can be given. Each label must have its own case.

Program:- Read a no. from 1 to 10 & print its name.

```
# include <stdio.h>
main ()
 {
 int n;
 printf ("\n Enter the number from 1 to
 10 to print its name \n");
 scanf ("%d", &n);
  switch (n)
      {
          case 1 :
                  printf("\n One");
                  break;
          Case 2 :
                  printf ("\n Two");
                   break;
          Case 3:
                 printf(" \n Three");
           ©     break;
          Case 4 :
                 printf(" \n Four");
                 break;
          Case 5:
                 Printf (" \n Five");
                 break;
              :
              :
          default :
                 printf(" \n Number entered is
          } break; more than 10 \n");
}
```

★ Char values in case & switch

eg
```
main ()
 {
 char c='x';
  switch (c)
   {
    case 'v':
       printf("\n I am in case v \n");
       break;
    case 'a':
       printf("\n I am in case a \n");
       break;
    case 'x':
      printf("\n I am in case x \n");
      break;
    default:
      printf("\n I am in default \n");
    }
  }
```

★ Note: We can mix integer & character values in diff^t^ cases of a switch.

★ Mix int & char values

```
main ()
 {
  int c=3;
  switch (c)
   {
    case 'v':
          printf("\n case v");
          break;
     case 3 :
          printf("\n I am in case 3");
          break;
     default:
          printf("Default case");
     }
}
```

Program: WAP using if & goto to find sum of the series :-

$1^2 + 2^2 + 3^2 + \ldots + 10^2$.

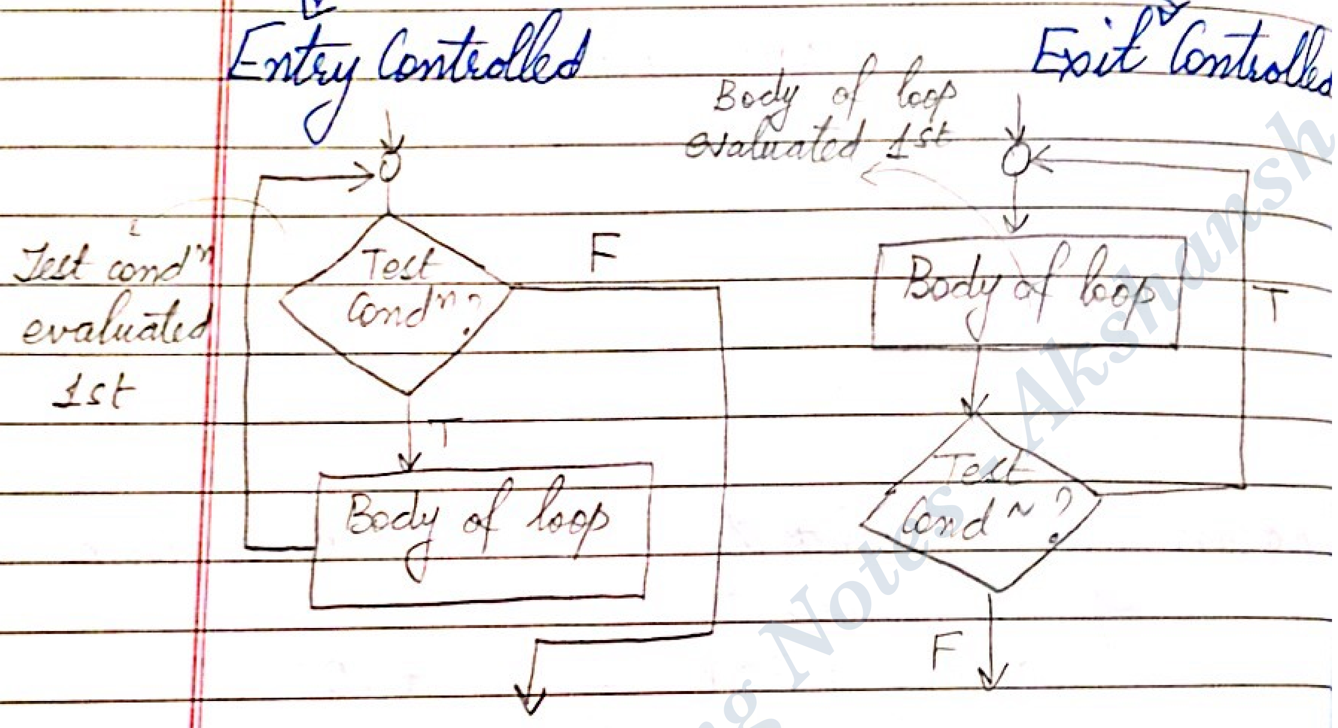
```
#include<stdio.h>
main()
{
int n=1, sum=0;

    ab:

    sum = sum + n*n;
    n++;
    If (t<=10)
          goto ab;
    printf("\n Sum = %d", sum);
}
```

*Program can be written with counter also.

* Looping / Repititive Control Structures



* Looping Statements

- WHILE stmt.
- DO-WHILE
- FOR

Q1 While stmt.

Syntax: While (test cond^n)

```
{
    body of the loop ;
}
```

- While : entry controlled looping structure.

Way * initialize counter variable ;

while (test cond^n or counter variable) ; not there

```
{
    ~~test cond~~ body of loop ;
        update counter ;
}
```

Program:- WAP to find sum of series 1+2+3+ - - - +10 using while loop.

```
# include< stdio.h>
 main()
 {
 int  n=1, sum=0;

 while ( n <=10)
 {
   Sum= Sum+ n;
   n++
 }
 printf("\n The sum of 1+2+...+10= %d"
   , sum);
}
```

eg:- WAP to find sum of series 2-4+6-8+10.

```
# include <stdio.h>.
# include< math.h>
main()
{ int  n=2, Sum= 0, i=0;
  while ( n <=10)
   {
     Sum = Sum + pow(-1, i)* n;
     n = n+2;

       i += 1;
   }
   printf("\n Sum is %d", Sum);
}
```

§ 2. DO WHILE stmt. (exit controlled looping stmt) f

SYNTAX :-

```
do
{
    body of loop;
}
while (test condn) ;
```

§ 3. FOR stmt.

Syntax:

```
for (initializn ; test condn ; update)
{
    body of loop ;
}.
```

; not there

ex:- WAP to find sum 1+2+3+ - - - +10 using for stmt.

```
int sum = 0;
for (i=1, i<=10, i++)
{
    Sum = sum + i ;
}
printf ("\n Sum is %d", sum);
```

{ } are not reqd in case of single stmt.

using do while stmt.

```
sum = 0 ; i = 1 ;
do
{
    sum = sum + i ;
    i = i + 1 ;
}
while ( i <= 10 )
```

Program - WAP to read a no. & check whether its a Palindrome or not.

```
# include < stdio. h>
 main ()
 {
 int  n, Sum, rev=0;

 printf("\n Enter the no. ");
 scanf(" %d", & n); a=n;
  while ( n!=0)
   {
 rev = rev* 10 + n % 10;
  n = n/10 ;
  }
   if ( rev= =a)
      printf("\n It is a palindrome");
  else
      printf(" \n It is not a palindrome");

      return(0);
      }
```

save a copy of n.

Program:- WAP to read a no. & find sum of its digits.

```
#include <stdio.h>
main()
{
int n, sum = 0;

printf("\n Enter the no.");
scanf(" %d", &n);
for( i=1; n/10 != 0; i++)
{Sum = sum+ n%10;
 n= n/10;
}
printf("\n Sum of digits = %d ", sum);
return(0);
}
```

Q. Write output.

```
i=0;
while ( i<5)
{
printf("%3d  %3d\n", i,10-i);
 i = i+1;
}
```

O/P:

```
0  10
1  9
2  8
3  7
4  6
5  5
```

Q. If n=10, find O/p.

```
scanf("%d", &n);
 ev = 0;
 while (ev<n)
  {
   printf(" %3d ", ev);
   ev = ev+2
   }
   printf("\n");
```

O/p:

```
0
2
4
6
8
```

★ Diff^t forms of a FOR loop

(i) Standard

(a)
```
for (i=1; i<=10; i++)
 {
  - - - -
 }.
```

(b)
```
i = 1;
for( ; i<=10; i++)
{
  - - -
}.
```

(c)
```
i = 1;
for( ; i<=10; )
{ i++;
}
```

(ii) Infinite for loop.

```
for( ; ; )
{ - - - -
}
```

(iii) Nested for

```
for(i=1; i<=10; i++)
{
    for(j=1; j<=2; j++)
    {
        printf("%d %d\n", i, j);
    }
}
```

o/p :-

```
1  1
1  2
2  1
2  2
 .
 .
 .
10 1
10 2
```

Program:- WAP to read a no. & find its factorian

```
#include<stdio.h>
main()
{
int i, n, prod = 1;
printf("\n Enter the no.\n");
scanf("%d", &n);
for(i=n; i!=0; i--)
{ prod = prod * i;
}
printf("\n The factorian is %d", prod);
return(0);
}
```

Program:- Enter a no. 'n' & find n^n.

```
#include< stdio.h>
main()
{
int i, n, prod = 1;
printf("\n Enter the no.\n");
scanf(" %d", & n);
for(i = 1 ; i <=n; i++)
 {
  prod = prod * n;
 }
  printf("\n The result is %d", prod);
return(0);
 }
```

SENTINAL
☆ ~~Setinal~~-controlled loops:-

eg: Find sum of all nos. input, till user inputs a negative number

```
# include< Stdio.h>
main()
{
int n=0, Sum=0, i;
while (n>=0)
  {
    printf("\n Enter the no. \n");
    scanf(" %d ", &n);
    sum = sum + n;
  }
    printf("\n Sum is %d" , sum);

}
```

* A FOR stmt. to implement a sentinel loop :-

```
for (scanf(" %d ", &num); num>0 ;
     scanf(" %d", & num))
   {
     s= s + num
   }
```

Program :- WAP to make the following asterisks pattern with n output lines. -

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

```
#include<stdio.h>
main()
{
int n, i, j;
printf("\n Enter the no. of lines");
scanf("%d", &n);
for (i=1; i<n; i++)
 {
     for (j=1; j<=i; j++)
      {
        printf(" * \t ");
      }
    printf("\n");
  }
}
```

* EXITING a loop with a BREAK STMT.

```
(i) while(...)
     { ....
         if (condn)
exit  ┌──── break;
      │    - - -
      │  } - ..
      └──→

(ii) do
      {
        - - -
        if (condn)
exit  ┌─ break;
      │    - - -
      │  }
      │  while (...);
      └──→

(iii) for(...)
       {
        - - -
        if (condn)
exit  ┌── break;
      │   - - -
      │  }
      └──→

(iv) for(- - -)
      {
        for(- - -)
         {
          ... if (condn)
       ┌──── break;
exit   │      - - -
from   │   }
inner  └──→ - - - -
loop  }
```

* EXITING a loop using GOTO STMT.

```
for (...)
  {
     for (...)
       {
         ....
         if (condn)
            goto aa;
            - - .
       }
  }
 aa:
   ....
```

exiting from 2 loops

* Skipping / Bypassing and continuing in loops.

* CONTINUE STMT:

(a)
```
while (test condn)
{
  - ..
  if (...)
   continue ;
  - - - -
}
```

(b)
```
do
{
  ---
  if (--)
   continue ;
  - - - -
}
while (test condn);
```

(c)
```
for (initializn; test condn; update)
{
  ---
  if (c...)
   continue ;
  - - -
}
```

Program :- WAP to print sq. root of n nos.

```
# include < stdio.h>
# include < math.h>
main ()
{
 int i, n, num;
 printf("\n Enter the no. of numbers \n");
 scanf(" %d", & n);

 for (i=1; i<=n; i++)
  {
   printf("\n Enter the number \n");
   scanf ("%d" & num);
     if (num < 0)
        continue;
  else
     printf(" The sq. root of number
     is %f \n", sqrt (num));
  }
}
```

Chapter - 3

Top down design with f^{ns} :

- C program supports modular programming also called Structural programming.
- F^{ns} : Library f^{ns} & user defined f^{ns}

↳ **Library functions**

· provides code reuse

- $\underbrace{\underbrace{y = \underset{f^n\ name}{sqrt}(x)}_{\to\ argument\ (or\ parameter)}}_{f^n\ call\ (f^n\ calling\ stmt.)}$

	F^n name	Header file	Argument type	Return Result t
1.	abs(x)	stdlib.h	int	int
2.	ceil(x)	math.h	double/ float	double/ float

ex :- ceil (45.23) = 46.0 (Round off to next value)

3.	cos(x)	math.h	double	double
4.	exp(x)	math.h	double	double
5.	fabs(x)	math.h	double	double

fabs (-8.432) = 8.432 → float abs.

6.	floor (x)	math.h	double	double

Opposite to ceil :- floor (45.23) = 45

7.	log(x)	math.h	double	double
8.	log 10(x)	"	"	"
9.	pow(x, y)	→ value of x^y		
10.	sin(x)			
11.	Sqrt (x)			
12.	tan(x)			

.... & others

User defined functions : 4 types.

1. f^{ns} without arguments
2. f^{ns} with arguments

} f^n can be called with/without giving any parameter.

3. f^{ns} without return value
4. f^{ns} with return value.

} the called f^n may/may not return a value.

1. Functions without arguments :

f^n call :

fname ( ) ;

f^n prototype / declar^n :

ftype fname (void);

→ type of f^n eg: void, int, float, etc.

f^n defin^n :

```
f^n header → ftype fname (void);
              {
                local variable declar^ns;
                executable stmts;
              }
```

Program: WAP which calls a f^n pow(x, y) power( ) to find x^y without arguments.

```
#include <stdio.h>
main()
{            ∵ not returning any value
                     ∵ no argument
  void power(void);     /* f^n declar^n */
  power() ;             /* f^n call */
```

* By default, all f^{ns} are assumed to return an integer value at their calling place. So, $declar^n$ not $reqd$ in that

```
/* f^n defin^n */
void power (void)
   {
      int x,y, v=1,i;
      printf("\n Enter values of x & y to
      find x^y.");
      scanf("%d %d", &x,&y);
      for(i=1; i<=y; i++)
        v = v*x;
      printf("The value of x^y is %d",v);
   }
```

2. Functions with input arguments

f^n call:

ACTUAL ARGUMENT

f^n name (list of input arguments);

f^n $declar^n$:

f type f^n name (data type of each actual argument);

f^n $defin^n$:

```
f type f^n name (type and name of each
                  formal argument) ;X
   {
      local declar^ns;
      executable stmt;
   }
```

Program: WAP to find x^y ~~f~~ using a f^n power( )

```
#include <stdio.h>
main ()
{
int x, y ;
void power (int x, int y) ;
printf ("\n Enter the values of x &y to
 find x^y \n") ;
 scanf (" %d %d", &x, &y) ;

 power (x, y) ;
 }
```

declare separately

```
 void power (int x1, int y1)
 {
    int x1, y1, i, prod = 1 ;
   for ( i=1, i<=y1 ; i++)
      {
      prod = prod * x1 ;
      }
     printf ("\n The value is %d", prod);
 }
```

The variables i & prod are local to this f^n called LOCAL VARIABLES.

4. Functions with a return value

```
#include <stdio.h>
main ()
{
 int  x, y, res ;
int pow (int, int) ;
printf ("\n Enter values of x &y ");
scanf("%d %d", &x, &y);

res = Power (x, y);
  printf("%d", res);
}
  int power (int x1, int y1)
{
   int v=1, i;
    for (i=1; i<=y1; i++)
        v=v*x1;
   return(v);
}
```

• Actual arguments	C	• Input arguments
• Arguments used to return a value	A	• Output arguments
• Default return value of a f^n	L	• int
• f^n returning no value	L	• void f^n
• f^n has to be declared at its calling place	E	• local f^n
• f^n declared outside main()	D	• ~~gl~~ global f^n.

Program: Using a f^n, 'swap()', WAP to exchange values to 2 variables a and b.
(with arguments)

```
# include<stdio.h>
main ()
 {
 int a, b;
void swap (int a, int b);
Printf("\nEnter the values of a & b to
swap them");
scanf("%d %d", &a, &b);
swap (a, b);
}

 void swap (int a1, int b1)
  {
   int a1, b1, temp;
   temp = a1;
    a1 = b1;
     b1 = temp;
  printf("\nThe swapped values of a
  and b are %d, %d", a1, b1);
  }
```

Program: Read 2 complex nos. & find their sum or difference or product depending on user's choice.
Use modular programming.

```
# include <stdio.h>
main ()
{
float rp1, rp2, ip1, ip2;
int  choice ;
void add(float, float, float, float);
void diff(float, float, float, float);
void prod( float, float, float, float);

printf("\n Enter the first number, i.e, its
real part and imaginary part");
scanf(" %f %f",&rp1,&ip1);
printf("\n Enter the second number, i.e, its
real part and imaginary part ");
scanf(" %f %f", &rp2,&ip2 ");
printf(" Enter the choice of operation to
be done 1. Addition, 2. Subtraction and
3. Multiplication");
scanf(" %d", &choice);
 switch (choice)
  {
     case 1 : add(rp1, ip1, rp2, ip2)
      break;
     Case 2 : diff (rp1, ip1, rp2, ip2)
      break;
     case 3 : prod (rp1, ip1, rp2, ip2)
       break;
  }
}
void add(float rp1, float ip1, float rp2,
float ip2)
 {
 float s1, s2;
  s1 = rp1 + rp2;
  s2 = ip1 + ip2;
 printf("\n The sum of the given 2
complex numbers is (%f)+i(%f)",
  s1, s2);
 }
```

```
void diff (float rp1, float ip1, float rp2,
float ip2)
{
 float d1, d2;
 d1 = rp1 - rp2;
 d2 = ip1 - ip2;
printf("\n The difference of given 2
complex numbers is (%f) + i(%f)",
d1, d2);
}
void prod(float rp1, float ip1, float rp2,
float ip2)
 {
  float p1, p2;
   p1 = (rp1 * rp2) - (ip1 * ip2);
   p2 = (rp1*ip2) + (ip1 * rp2);
printf("\n The product of 2 given complex
numbers is (%f) + i(%f)", p1, p2);
}
```

memory address

✡ Pass by value and Pass by reference

1. PASS BY VALUE :

```
main ()
{
 int a = 5, b = 10;
  void swap(int, int);
 swap (a, b);
 printf (" %d %d", a, b);
}
```

2(*(&a)
 *( )

```
swap(int a, int b)
{  int t;
   t = a;
   a = b;
   b = t;
   printf("%d %d", a b);
}
```

O/p :- 10 55 10

gives memory address

2. PASS BY REFERENCE : Using & and *

```
ex:- int a = 10;
     int *b;
     b = &a;
printf("value of a = %d", *b);
   o/p :- 10
```

→ way to declare a pointer variable

pointer variable ←

a → name

10 → value at the locⁿ

1000 → address

→ written before an address to access value of the variable 'b' within that address.

```
ex :- main()
      {
       int a=5, b=10;
       void swap(int *, int *);
       Swap(&a, &b);
       printf(" %d %d", a, b);
      }
     void swap( int *a1, int *b1)
      {
       int t;
       t = *a1;
      *a1 = *b1;
      *b1 = t; printf("%d %d", *a1, *b1); }
```

→ declarⁿ of a pointer

we are calling a fnⁿ by addresses of variables ←

→ value = &a

→ value = &b

(o/p:- 10 5)

Program :- WAP to read 3 nos. & sort them into ascending order, using a f^n.

```
#include <stdio.h>
 void order(float *small, float *large);
main()                                   Optional
 {
   float num1, num2, num3;
  printf("\n Enter the numbers : \n");
  scanf(" %f  %f  %f", &num1, &num2,
  &num3);
   order (&num1, &num2);
   order (&num1, &num3);
   order (&num2, &num3);
  printf("\n Numbers in ascending order are
  %f  %f  %f", num1, num2, num3);
 }
  void order(float *small, float* large)
  {
    double temp;
    if(*small > *large)
     {
        temp = *small;
       *small = *large;
       *large = temp;
     }
```

Trace of program :

Stmt :	num1	num2	num3
Scanf	7.5	9.6	5.5
order(& num1, & num2)		No change	
order(& num1, & num3)	5.5	9.6	7.5
order (& num2, & num3)	5.5	7.5	9.6

Program: WAP using a f^n to find n!.

```
# include <stdio.h>
main()
{
int fact(int n);
int n, v;
 printf("\n Read the value of n to
 find its factorial ");
 scanf(" %d", & n);
V=fact(n);
  printf("\n Factorial of n= %d", v);
}
int fact(int n1)
  {
     int f=1, i;
      for (i=1; i<=n1; i++)
          f = f*i;
       return(f);
  }
```

Program: ~~Red~~ Read n and r and find binomial coefficient $^nC_r \left(= \frac{n!}{r!(n-r)!}\right)$

```
# include <stdio.h>
main()
{
int n, r, num, den; float val;
printf("\n Enter the value of n and
 r to compute C(n, r) ");
scanf("\n %d   %d", &n, &r);
num = fact(n)
den = (fact(n-r))*(fact(r))
val = num/(float)den;

Printf("\n The value of C(n,r) is
  %f", val);
}
```

→ Same here.

i/p : n=2, r=1
o/p : 2.

Program: Find the trigonometric sine(x) given x and n

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - - - (-1)^{n-1}\frac{x^n}{n!}$$

Given:- x is in radians.

$180° = \pi^c$

$x° = (3.14/180) \times x$

```
# include <stdio.h>
# include <math.h>
main()
{
 int fact(int   );
 int n, sgn, i;
 float x, t, sin;
printf("\n Enter the values of x and
n for finding value of sin(x)\n");
scanf(" %f %d ", &x, &n);
* x = x*3.14/180;
 sin = x;
  sign = -1;
for (i=3; i<=n; i=i+2)
  {
        t = ((pow(x,i))/fact(i))*
                                  sign
  sin = sin + t
   sign = (-1)*sign;
  }
printf("\n Value of sin(X) is %f", sin)
}
```

define f^n fact here

Program: Read 3 nos. a, b and c and find their sum and avg. using a f^n calculate.

```
#include<stdio.h>
main()
{
                        declared
float a, b, c, sum, avg;
 void calculate (float, float, float, float*,
          float* & avg);
Printf("\n Enter the three values to
get their sum and average");
```

* value
& address.

```
scanf(" %d %d %d", &a, &b, &c);
calculate (a, b, c, &sum, &avg);
printf(" Sum = %f \n", sum);
printf("\nAverage = %f", avg);
}
 void calculate (float a1, float b1, float
  c1, float *s, float *av)
  {
     *s = a1 + b1 + c1 ;
     *av = *s / 3 ;
  }
```

f^n is called

→ garbage value gets stored in it.

Date ______
Page ______

Chapter - 8

ARRAYS

- derived data types
- collection of elements of same type.
- stores in conservative locations

ex:- marks [10]

array name → Index / subscript
integer constt / int var / int expn

→ marks [0] to marks [9] → 10 values

1D Array | 2D Array | Multi Dimensional

* 1D Arrays

- list of items - a single name
- elemts. accessed using just one subscript, so, its calle
- single subscripted variable.
- subscript begins with zero (0).

Declarⁿ:- datatype arrayname [size] ;
Keyword user defined +ve Z constt.

ex:- char name [10] : String
→ A character array.

* Storage :-

ex int a[3]

15	10	5
a[0]	a[1]	a[2]

values assigned
a[0] = 15
a[1] = 10
a[2] = 5.

- Array ~~ld~~ elements can be used like ordinary variables used in a C program.
  ex:- a[x] = a[0] + a[1] → subscript
  b = a[2] * a[2];
- Indexes of array (subscript) should be within declared limits.

Initializ^n:- datatype arrayname [size] = { list of values }

ex:- ◦ int number [3] = { 0, 0, 0 };

★ ◦ int number [3] = { 1 };

→ number [0] = 1
number [1] = 0 } automatically
number [2] = 0

~~Compile~~ Compile time Initializ^n

◦ int counter[ ] = {1, 1, 1}; → size would be taken as 3

size = 4+1 ← ◦ char name [ ] = { 'J', 'o', 'h', 'n', '\0' };

size = 4 + ① ◦ char name [ ] = " John ";

for null character

◦ char a [5] = { 'a', 'b', 'c' };

∴ a[0] = 'a', a[1] = 'b', a[2] = 'c'

★ Complete Initializ^n — int a[3] = {1, 2, 3}

Partial Initializ^n. — int a[3] = {1, 2}

★ String / character array

eg: char name[10]

value of name = " COMPUTERS ";

C	O	M	P	U	T	E	R	S	\0

'\0' : null character ; string terminator.

If char array is initialised later :

eg:

```
char name[5];            char name[5];
name = "JOHN";           strcpy (name, "JOHN");
      X                          ✓
```

- Char array is called a STRING.

* Runtime initializ^n

eg

```
int a[10];
for (i=0; i<=9; i++)
      scanf(" %d", & a[i]);
```

eg

```
float sum[100];
  for (i=0; i<=99; i++)
    {
      if (i<50)
           sum[i] = 0.0;
      else
           sum[i] = 1.0;
    }
```

elements from 0 to 49 are initialized 0.0. Resp. from 50 to 99 1.0.

Program: Read the marks ~~of 50~~ obtained by students of a class in a course & find course avg.

Static memory Alloc^n

```
#include<stdio.h>
main()
{                    → a max. size stored
int a[100]; int sum, n; char sub[15]; float
printf("\n Enter the no. of students in
the class \n");
scanf(" %d", & n);
printf("\n Enter the subject for which
marks would be entered\n");
scanf(" %s", sub);        → & not reqd for string
printf("\n Enter the marks \n");
for (i=0; i<=n-1; i++)
        scanf(" %d", &a[i]);
sum = 0;                          } can be
for (i=0; i<=n-1; i++)            } included in
        sum = sum + a[i];         } one for loop.
avg = sum/(float)n;
printf("\n The average marks of the class
in %s are %f", sub, avg);
}
```

Program:- Read marks of n students in a class & find highest marks in that course.

```
# include<stdio.h>
main()
{
int n, l;
int a [100];
printf("\n Enter the no. of students in the
class \n");
scanf(" %d", &n);
printf("\n Enter the marks \n");
     for (i=0; i<=n-1; i++)
          scanf(" %d", & a[i]);
avg;  l = a[0];  --> assume 1st value as largest.
     for (i=1; i<=n-1; i++)
        {
             if (l < a[i])
                  l = a[i];
        }
printf("\n The class highest is %d", l);
}
```

Program: Read a 1D array & reverse its elements.

```
#include<stdio.h>
main()
{
int a[50], n, t, i, j, k, l;
printf("\n Enter the no. of elements whose
order needs to be reversed \n");
scanf("%d", &n);
printf("\n Enter the elements ");
for (k=0 ; k<=n-1 ; k++)
    scanf("%d", & a[k]);
{for (i=0, j=n-1 ; i<n/2 ; i++, j--)
            t = a[i];
            a[i] = a[j];
             a[j] = t;
       }
  for (l=0 ; l<=n-1 ; l++)
     printf("\n The reversed elements are
  %d", a[l]);
}
```

Program: Read a string & check whether its a palindrome or not.

```
#include <stdio.h> #include <string.h>
main()
{
char name[20];
int i, j, n, flag=0
```

```
printf("\nEnter the string to check for
palindrome :\n");
scanf("%s", name);
n = strlen( name);
for ( i =0, j= n-1 ; i < n/2 ; i++, j--)
 {
  if (name[i] != name[j])
   {
      flag = 1;
      break;
   }
 }
if (flag == 0)
   printf("\nIts a palindrome\n");
else
   printf("\nIts not a palindrome\n");
```

Program: Read an array & count the no. of positive nos., no. of -ve nos. & zeroes.

```
#include<stdio.h>
main()
int n,num[50], i, j.

printf("\nEnter the number of elements of
 the array\n");
scanf("%d", &n);
printf("\nEnter the elements of the
 array \n");
```

```
for (i=0 ; i< n ; i++)
    scanf("%d",&num[i]);
for (j=0 ; j<n ; j++)
    {
        if
```

★ Call Arrays with functions

Calling an array : f^n name (array name, size).

f^n $defin^n$: f^n name (datatype array name [], datatype size)

Program:- Find sum of an array of n nos. using a f^n:-

```
#include <stdio.h>
main()
{
int a[5], n, i;               OR
★ void sum(int *, int);   void sum(int [], int);
printf("\n Enter the number of elements of
array \n");
scanf("%d", &n);
printf("\n Enter the elements");
for(i=0; i<=n-1; i++)
    scanf("%d", &a[i]);
sum(a,n);
}
void sum(int *b, int n)
{
                         OR void(int b[], int n)
int s=0, i;
  for(i=0; i<=n-1; i++)
  {
        s = s + *b;   OR *s=s+*(b+i);
        b++;
  }                   OR s += b[i];
   printf("%d", s);
}
```

☆ If array has 'n' nos.,
no. of iter^ns for sorting them are 'n-1'

Program :- Read a set of nos. & sort them in ascending order.

```
#include <stdio.h>
main()
{
int n, a[50], i;
int sort(int [], int);
printf("\n Enter the number of elements of array: \n");
scanf("%d", &n);
printf("\n Enter the elements of the array\n
for (i=0; i<=n-1; i++)
      scanf("%d", &a[i]);
# Print the elements before sorting in a for loop
sort(a, 50);
Print the elements after sorting in a for loop
}

int sort(int b[], int n)
{ int i, j, t;
    for (i=0, i<=n-2, i++)
    for (j=i+1, j<=n-1 ; j++)
      {
        If (b[i] > b[j])
          {
              t = b[i];
              b[i] = b[j];
              b[j] = t;
          }
      }
```

✫ 2D Arrays

a	col0	col1	col2	col3
row0	2	4	13	-12
row1	8	100	73	16
row2	68	52	49	15

a[0][0] = 2
a[1][2] = 73
a[2][3] = 15

- **Declaring a 2D array :**

Syntax: datatype arrayname [rowsize][col size];

ex:

①
```
int a[2][3];
char name [5][10]
```
array of char = STRING

②
```
# define R 2
# define C 3
main ()
{
    int a [R][C];
```

- **To access individual elemts. of 2D array :**

Syntax : arrayname [rowsubscript][col subscript]

ex:- a[0][1].

- **Reading a 2D array :**

ex:-
```
int a[2][3];
for (i=0; i<=1; i++)            <- For rows
{
    for (j=0; j<=2; j++)        <- For columns
    scanf("%d", &a[i][j]);
}
```
(Input of elemts.. is row-wise)

- **Initializing a 2D array :**

ex:-
```
int a[2][3] = {0, 0, 0, 1, 1, 1};
int a[2][3] = {{0,0,0}, {1,1,1}};
int a[2][3] = {
                    {0,0,0}
                    {1,1,1}
                };
int a[][3] = {
                    {0,0,0},
                    {1,1,1}
                };
int a[2][3] = {
                    {1,1}, {2}};
```

→ a[0][0] = 1 ; a[0][1] = 1, a[1][0] = 2

→ all of the other elements = 0 (automatically)

★ Multi Dimensional Arrays.

Syntax: type arrayname [S1][S2]....S[m];

ex - float table [5][4][3];

★ Static arrays: ex :- int a[5];

- created at compile time.
- size fixed. Cannot be modified.
- allocating memory at compile time → static memory alloc^n.

★ Dynamic arrays:

- vary in size.
- allocated memory at runtime.
- arrays created at runtime are called dynamic arrays.

- using pointer variables & memory management functions.— malloc(), calloc(), realloc() — <stdio.h>.

* Note:
when array is declared, all elemts are initialized to some garbage value.

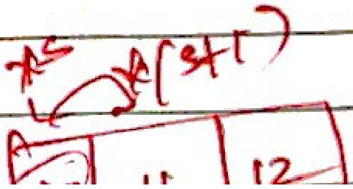
Program: WAP to read 2 matricies and find their sum

2

tally)

```
#include<stdio.h>
main()
 {
 int nra, nca, nrb, ncb, i, j, k, l;
 int a[][], b[][], c[][];
 printf("\n Enter the no. of rows & colm. of A\n");
 scanf(" %d %d", &nra, &nca);
 printf("\n Enter the rows & colms. of matrix B\n");
 scanf("%d %d", &nrb, &ncb);
 if (nra == nrb && nca == ncb)
     {
     printf("\nMatrix addition possible \n");
     printf("\n Enter elements of Matrix A\n");
     for (i=0; i<nra; i++)
         {
           for (j=0; j<nca; j++)
           scanf(" %d", &a[i][j]);
         }
printf("\n Enter the elements of Matrix B");
for (k=0 ; k<nrb ; k++)
    {
        for (l=0 ; l<ncb ; l++)
            Scanf("%d",&b[k][l]);
    }
for (i=0 ; i<nra ; i++)
    {
        for (j=0 ; j<nca ; j++)
            c[i][j]= a[i][j] + b[i][j];
    }
printf("\n The sum of matrices A &
    B is \n");
    for (i =0 ; i<nra ; i++)
      {
        for (j=0 ; j<nca ; j++)
          printf("%5d", c[i][j]);
          printf("\n");
      }
    }
else
    printf("\n Matrices cannot be
    added \n");
}
```

to give blank spaces b/w elemts. in a matrix



Chapter - 9

also called

CHARACTER ARRAYS & STRINGS.

- sequence of characters : string

⊙ Operⁿˢ on strings :

- Reading & writing strings
- Combining strings
- Copying one string to another
- Comparing strings for equality
- Extracting a portion of a string.

⊙ Declaration :

char stringname [size]

ex :- char city [10]

→ should include value of '\0'

'\0' : null character, automatically appended.

⊙ Initializⁿ :

ex: char city [9] = " NEW YORK" ;

char city [9] = { 'N', 'E', 'W', ' ', 'Y', 'O', 'R', 'K', '\0' };

char string [ ] = { 'G', 'O', 'O', 'D', '\0' } ;

* char str [3] = "GOOD"; } INVALID

* char str [5] ;
  str = "GOOD" ; } INVALID

* char str1 [4] = "abc" ;
  char str2 [4] ;
  str2 = str1 ; } INVALID

⊙ Reading strings :-

1) Using scanf()

ex:- char address[10];
scanf(" %s", address)
& not reqd

```
char address[10];
scanf(" %5s", address);
```

i/p : KRISHNA.

Store :- |K|R|I|S|H|\0| | | | |

unused locns :- assigned garbage va

- scanf() cannot read multiple words strings

To read all chars →

Syntax : char line[80];
scanf(" %[^\n]", line);
→ Reads a line of text till \n is input

2) Getchar() :-

- Reads just one char. So, use in while loop

ex:- char line[80]; char ch;

```
int c=0;
do
{
    ch = getchar();
    line[C] = ch;
    c++;
} while (ch != '\n')
```

format

3) Using gets() :- (Read multiword string)

ex :- char line [80];
gets (line);

- It accepts char. from i/p, assigns them to line, will not skip white spaces.

ex :- char line [10];

scanf ("%s", line);	gets (line);
Input :- abc efg.	
o/p :- abc	abc efg.

⑥ Writing strings :-

1. printf ("%s", name);
2. % wps → field width → actual posⁿ of string chars; no. of char to print
   ↳ (a) If w < string length : entire string is o/p
   (b) when p = 0 ⇒ no o/p.
   (c) %-wps → forced left justificⁿ.
   (d) %.ns : first n chars. of string.
   → field width not specified
3. char ch = " * " } char name [6]
   putchar (ch); } for (i = 0; i <= 4; i++)
   put char (name [i]);
4. puts (stringname);

☆ ARRAY OF STRINGS :-
2D array of char, in which each row is one string.

ex:- # define NUM-PEOPLE 30
# define NAME-LEN 25
- - -
- - .

30 rows   25 columns

char names [NUM-PEOPLE][NAME-LEN];

(each row is a string of size 25. i.e, 25 chars can be stored in each row)

ex:- char month [12][10] = {"Jan", "Feb", "Mar", "April", "May", "June", "July", "Aug", "Sept.", "Oct", "Nov", "Dec"};

* Arithmetic oper^{ns} on characters

1. char X;
   X = 'a';
   printf("%d\n", X);
   } o/p :- 97 (ASCII value of a)

2) X = 'z' - 1; ⇒ X = 122 - 1 = 121

3. if (ch >= 'A' && ch <= 'Z')
   - - - - - -
   (checks whether ch. is an uppercase alphabet)

4. ASCII values of A - 65   a - 97
   :   :
   Z - 90   z - 122

5) X = character – '0' ; (Converts a character digit to its equivalent integer value)
X = '7' – '0' ;
= 55 – 48
= 7

6. To convert a string of digits to its integer value :-

a to i (string)   stdlib.h.

ex :- char number [5] = "1998";
int year ;
year = atoi (number);
∴ year = 1998

☆ STRING HANDLING FUNCTIONS (string.h)

1. Strcat () : concatenates two strings

(a) strcat (string 1, string 2);

eg :- Part 1 :-

V	E	R	Y		\0					
0	1	2	3	4	5	6	7	8	9	10.

Part 2 :-

G	O	O	D	\0

strcat (part 1, part 2)

Part 1

V	E	R	Y		G	O	O	D	\0	

↳ Part 2 remains unchanged.
↳ Result comes in 1st string

(b) Str cat (string 1, "CONSTANT");
string constt

(c) strcat (strcat(string 1, string 2), string 3);
↳ nested strcat stmts.
↳ O/P in string 1.

2) strcmp() : compares 2 string arguments

strcmp(string 1, string 2)

↳ Value returned

↳ 0 (Strings equal)

↳ non zero (strings unequal)

-ve : String 1 is alphabetically above string 2.

returned value is diff. in ASCII values of the 2 chars compared (of strings).

eg :- strcmp(name 1, name); → +ve value returned

eg :- strcmp("ROM", "RAM"); ∵ ASCII$_O$ > ASCII$_A$

☆ if (name 1 == name)

↳ INVALID (can't compare strings like this)

3) strcpy() : Assign contents of string 2 to string 1

strcpy(string 1, string 2)

eg :- strcpy(city, "DELHI");

char city 1[6] = "DELHI";

char city2 [6];

4) strlen() :

n = strlen(string);

5) strncpy(S$_1$, S$_2$, n); → first n chars. of S$_2$ copied to S$_1$

eg :- strncpy(S$_1$, S$_2$, 5);

S$_1$[6] = '\0'; → First 5 chars. of S$_2$ copied to S$_1$

* Reqd to put null char.

6) strncmp() :-

strncmp(S$_1$, S$_2$, n);

Compares left most (first n) chars. of S$_1$ & S$_2$.

It returns : 0 : equal
-ve : S_1 substring < S_2
+ve : otherwise.

7) strncat( ) :

strncat (S_1, S_2, n);

Concatenates first n chars of S_2 to end of S_1

8) strstr( ) :

(11) A

strstr (S_1, S_2);

Searches S_2 in S_1

If S_2 found in S_1 : It returns pos^n of its first occurence.
else : null.

tring!

eg :- strstr(S1, "ABC");

strchr(S_1 , 'm'); → search for first occurence of char 'm' in S_1

strrchr(S_1 , 'm'); → Search for last occurence of char 'm' in S_1

→ search for a char in a string

search for a substring in a string.

• Strings : can be declared as pointers.
: can be passed as arguments.

★ Table of strings :

eg :- char name [10][5]
→ make an array of strings having 10 rows, each row has 5 chars.

★ substring : fragment of a longer string.

S1[0] S1[1] . . .

Jan.␢30,␢1996

```
eg :- char result[10], s1[5] = "Jan. 30, 1996";
   strncpy (result, s1, 9);
     result [9] = '\0';
o/p ;
   result :-      "Jan. 30, "

eg :- strncpy (result, & s1[5], 2);
        result [2] = '\0';
 o/p :-
   result :-      "30"
```

eg: To get final (few last) chars of source string.

```
       strcpy (result, & s1[9]);
ex :- # define STRSIZ 20
      char S1[STRSIZ] = "Jupiter ";
       char S2 [STRSIZ] = "Symphony";
  printf("%d %d\n", strlen(s1),
  strlen(strcat(s1, s2)) );
  printf ("%s\n", s1);

   o/p :-      8     16.
                 Jupiter Symphony
```

Program :- Read a string & check if its a palindrome.

```
#include<stdio.h>
# include< string.h>
main()
{
char word[30];
int  i, j;
```

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```
printf("\n Enter the string to check for
palindrome \n");
scanf(" %s ", word);
n = strlen(word);
for (i=0, j=n-1; i<j; i++, j--)
    {
        if (word[i] != word[j])
            {
                printf("\n Not a palindrome \n");
                goto a1;
            }
    }
        printf("\n Its a palindrome \n");
    a1 : ;
}
```

or, use flag.

Program: Read a set of names and sort them into alphabetical order.

```
#include<stdio.h>
#include <string.h>
main()
{
char name[10][10], temp[10];
int i, j, n;
printf("\n Enter no. of names\n");
scanf(" %d", &n);
    for (i=0; i<=n-1; i++)
        scanf(" %s", name[i]);
for (i=0 ; i<=n-2 ; i++)
    {
      for (j=i+1 ;  j<=n-1 ; j++)
       {
        if (strcmp(name[i], name[j])>0)
         {
           strcpy(temp, name[i]);
           strcpy (name[i], name[j]);
           strcpy (name[j], temp);
         }
       }
    }.
for ( i=0; i<=n-1; i++)
       printf("\n The elements/names in
       ascending order are %s \n", name[i]);
}
```

☆ CHARACTER HANDLING FN

CHARACTER HANDLING FN^{S} :-

defined in : ctype.h.

char ch;

1. is alpha (ch) → checks whether ch is alphabet
   value returned = 0 or 1.

eg : if (isalpha (ch))
        printf(" ch is a letter");

2. isdigit (ch)
3. is upper (ch)
4. is lower (ch)
5. ispunct (ch) Checks whether argument is punctuation symbol
6. isspace (ch) : Checks whether ch is a space
7. toupper (ch) ;
8. to lower (ch) ;

Program: Read a line of text & count the number of ~~alphabt~~ alphabets, digits and words in it

```
#include<stdio.h>
#include <string.h>
#include<ctype.h>
main()
{                                                   count of
                                                    punctuation
char line[100];
int count1=0, count2=0, count3=0, i, n, cp;
printf("\n Enter the line of text \n");
scanf("%[^\n]", line);   or gets(line);
n= strlen(line);
    for(i=0; i<=n; i++)
    {  if(isalpha(line[i]))
             count1++;
       else if (isdigit(line[i]))
             count2++;
       else if (isspace(line[i]))
             count3++;
       else
             cp++;
    }
     count3+=1;  > no. of words would be 1 more than no. of spaces
printf("\n The no. of alphabets are %d \n The
no. of digits are %d \n The no. of words are %d
", count1, count2, count3);
}
```

ex:
```
char str[10] = "GOOD";
int i;
for (i=0; i< strlen(str); ++i)
    if islower(str[i])
        str[i] = toupper(str[i]);
```

✯ POINTERS

- a derived data type.
- have memory addresses as values.
- can be used to access and manipulate data stored in memory.

* Uses

- used to make a f^n return multiple values to its calling place through arguments (call by reference).
- makes f^{ns} to be passed as arguments to another f^n.
- used in dynamic memory management.
- ~~rob~~ reduces the length and complexity of programs.
- used in manipulating dynamic data structures- linked list, stacks, queues, trees..

* Pointer operators :

& : address of operator. &i

* : value of address *(&i)

≡ i

ex :-
```
main()
{
    int i=3.
    printf("\nAddress of i = %d", &i);
    printf("\n Value of i = %d", i);
    printf("\nValue of i = %d", *(&i));
```
o/p :-
```
Address of i = 6485
Value of i = 3
Value of i = 3
```

* Pointer variable

```
int i=3
j = &i; /*j is a pointer to variable i*/
```

* Declaring a pointer:

datatype *pointervariablename;

ex :- int *j; float *b; char *c;

* Valid / Invalid oper^{ns} :-

1.
```
float a,b;
int x, *P;
p = &a;  }
b = *P;  } INVALID
```

2. `int x, *p = &x;` VALID

3. int *p = &x, x;   INVALID

4) int * p = NULL   VALID
   int *p = 0;

5) int *p = 350;   INVALID

6) int x, y, z, *p;
   p = &x;
   - -
   p = &y;   VALID
   - - -
   p = &z;
   - - -

7) int x;
int *p1 = &x;   → multiple pointers
int * p2 = &x;   VALID   to same variable
int *p3 = &x;

ex. Change value of variable using pointer.

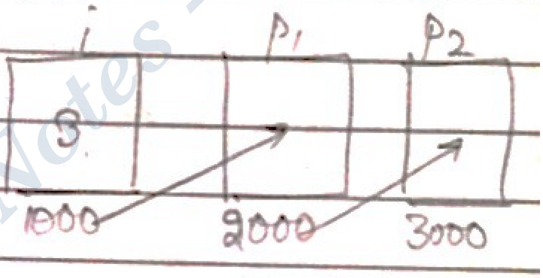
```
main ()
{
int x = 10, y;
int *ptr = &x;
 y = *ptr;
printf(" %d %d", x, &x);
printf(" %d %d", *&x, &x);
printf(" %d %d", ptr, *ptr);
printf(" %d %d", ptr, &ptr);
printf("%d %d", y, &y);
 *ptr = 25;
 printf("%d", x);
}
```

* Pointer to a pointer : CHAIN OF POINTERS.

a pointer points to another pointer ;

ex :-   → Called as Multiple indirection

```
int i = 3, *P1, **P2;
P1 = &i;
 P2 = &P1;
printf("%d", i);
prinf("%d", *P1);
printf("%d", **P2);
printf("%d", **(&P1));
```



* Pointer expressions :-

ex :- y = *P1 * *P2;   (*P1)*(*P2);

sum = sum + *P1;

Z = 5 * - *P2/*P1;

multiplicⁿ operator → unary minus

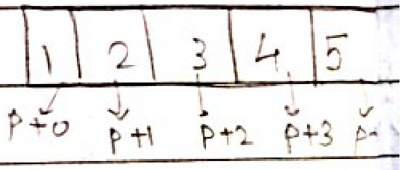
* Note : 2 pointers CANNOT be added, subtracted, multiplied, divided, ...

* pointers can be incremented. The incrementⁿ is based on their datatype (need not always be 1).

eg :- Create a pointer to an array.

```
#include <stdio.h>
main ()
{
int a[5] = {1,2,3,4,5};
int *p;
p = a;   /* Assign address of 0th element of
              a*/
for (i=1; i<=5; i++)
  {
    printf("%d\n", *p);
    p++;
  }   → p is incremented by 2 (∵ its an
           integer pointer)
}
```

p = &a[0] ≡



* SCALE FACTOR

When a pointer is incremented, it gets increased ~~on~~ depending on its type.

ex: /* make a f^n return a pointer to its calling place */

Chapter - 11

or record

STRUCTURES (Tuple Data)

- collection of dissimilar data types using a single name. (Its a derived data type)

ex: student : attributes of diff^t types

- name
- roll no.
- marks
- average
- grade

• Defining structures :

- define a structure.
- creation of structure variables.

key word

Format:
```
struct tagname  → user defined identifier
{
    datatype member1;
    datatype member2;
    . . . . .
};*
```

- a template is created to represent inform^n.

ex:
```
struct student
{
    char name[10];
    int age;
    float avg;
    char grade;
};
```

structure defin^n

struct student S_1, S_2 ;

→ structure declar^n for declaring structure variable

structure variable . member nam

→ member selection operator

eg. s1.name
S1. age

- Declaring structure variables

Format: struct tagname variable1, variable2, ...;

```
ex:- struct student
     {
       int total ;
       char  name[5] ;
       - - -
     };
  struct student  s1, s2;

ex(2):- struct student
        {
          int ID;
          char name [10];
        }s1, s2;

ex(3): struct
       {- -
        - -
       } s1, S2;
```

• no tagname.
• cannot be used for future declarations.

- Where to place structure definⁿˢ ?

• before all variable / fⁿ definⁿ.
• global definⁿ.

- Type defined structures

for renaming an existing datatype

Format : typedef struct

```
{
 . . . .
  type member1;
  type member2;
  - - - - -
} typename ;
```

just like name of structure

- To declare structure variables :

typename var1, var2, . . . ;

(in structure: struct structurename var1, var . . . . ;

- Accessing structure members :-

we don't need to use struct in typedefined structures.

Format :- structure variable name . member name

direct (member or component) selection operator

```
ex:- s1.id
     s1.name
ex:- strcpy (s1.name, "BASIC");
     scanf("%d", &s1.id);
     scanf ("%s", s1.name);
```

Program: Define a structure to store details of 2 students of a class.

- Initialising a structure
  At compile time.

ex :-
```
main()
  {
    struct record
     {
       int weight;
       float height;
     };
   struct record s1 = {60, 180.75};
   struct record s2 = {50, 160.5};
```

- Partial initializ^n is possible.

- Manipulating whole structures:
  copying and comparing structure variables:

structure copying

ex :- s1 = s2; — VALID

```
s1 == s2;  }
s1 != s2;  } INVALID
```

- No logical oper^{ns} on structure variables.
- Can be compared by comparing individual ~~members~~ members.
- Oper^{ns} can be done on members.

ex
```
if (s1.mark == 10)
        s1.mark += 10;
   sum = s1.mark + s2.mark
```

- We can apply increment/decrement operators on numeric type members.

ex Student.no ++;

- member operator (.) > rel^{nal} & logical : PRIORITY

– Arrays of Structures

ex.
```
struct marks
  {
    int maths ;
    int physics ;
  } ;
  struct marks students[50] ;
```

each element of this array is a structure.

- Initializ^n :-

ex
```
struct marks stu[3] =
  {{40,60}, {75,90},{19,20}} ;
```

stu[0].math	40
stu [0]. physics	60
stu [1]. math	75
stu [1] . physics	90
stu[2]. math	19
stu[2]. physics	20

– Structures within structure

- Nesting of structures : hierarchial structures

ex:
```
struct salary
  {
    char name;
    char dept ;
    int basic_pay;
    int da ;
    int hra ;
    int ca ;
  } employee ;
```

```
struct salary
{ char name;
  char dept;
  int basic_pay;
struct
  { int da ;
   int ca ;
    int hra ;
} allowance ;
} employee ;
```

To access innermost structure :
employee. allowance. da
employee. allowance. dra

ex

```
struct salary                           struct pay
{                                       {
char name[5];                           int da;
char dept [10];       declare outside   int dra;
int basic_pay;                          int ca ;
struct pay allowance;                   };
};
struct salary employee [50];
```

Nesting of more than one type of structures:

ex :-

```
struct salary
{                                       struct pay
char name[5];                           {- - -
char dept[10];                          };- -
struct pay allowance;                   struct d
struct d dob;                           {
};                                      };- -
struct salary emp[10];
```

Program: Define a structure to store ID no., name & 3 subject marks & total marks of each student in a class. Using this, WAP to prepare marksheet of all students in the class.

```
#include<stdio.h>
main()
{
int n, i;
struct student
{
int id;
char name[10];
int m1,m2,m3;
int total ;
};
struct student s[50];
printf("\nEnter no. of students \n");
scanf("%d", &n);
    for(i=0; i<=n-1 ;i++)
      {
        printf("\n Enter ID no.\n");
        scanf("%d", &s[i].id);
        printf("\n Enter name \n");
        scanf(" %s", &s[i].name);
        printf("\n Enter 3 subject marks");
        scanf("%d %d %d", &s[i].m1 , & s[i].m2
        , & s[i]. m3);
        s[i].total = s[i]. m1 + s[i].m2 + s[i].m3 ;
      }
printf("\nMarksheet \n\n\n");
```

①
↓

```
for (i=0; i<n; i++)
  {
    printf("\n Name \t : \t %s", S[i].name);
    printf("\n ID \t : \t %d", s[i].id);
    printf("\n Math \t : \t %d", s[i].m1);
    printf("\n Chem \t : \t %d", s[i].m2);
    printf("\n Phy \t : \t %d", s[i].m3);
    printf("\n Total \t : \t %d", s[i].total);
  }
}
```

Q. Given maruti.engine.bolts = 25;

(a) bolts $\xrightarrow{\text{member}}$ engine T

(b) engine → maruti T

(c) maruti → engine F

(d) maruti → bolts F

☆ – Passing an entire structure.

1. Each structure member can be passed as an actual argument of the f^n call.
   - inefficient when structure size is large.

2. Passing a copy of the entire structure to the called f^n.
   - all compilers don't support this.

3. Using pointers to pass structure as an argument.

ex ① Passing individual structure elements.

```
#include<stdio.h>
#include <string.h>
main()
 {
void display (char*, char*, int)
struct book
{
 char name[25];
 char auther [10];
 int call no;
 };
 struct book b1={"BASIC","YPK",101};
 display (b1.name, b1.auther, b1.callno);
 }
 void display (char*s, char*t, int n)
  {              → or: char s[10].
   printf("\n%s %s %d",*s,*t, n);
  }
```

ex ② :- Passing copy of entire structure.

structure declared outside main

```
struct book
 {
  char name[10];
  char auther[5];
  int call no;
 }
   main()
   { void display (struct book);
 struct book b1={"BASIC","YPK",101};
   display(b1);
 }
```

Passing entire structure ←

```
Void display (struct book b)
 {
   printf (" %s ", b. name);
   printf(" %s ", b. author);
   printf (" %d", b. callno);
 }
```

ex③ :- Passing structure with pointer

```
struct book
{
char name[10]
char author [5];
int callno ;
}
main()
{ struct book *p;
void display(struct book *);
Struct book b1 = {"BASIC", "YPK", 101};
p=&b1;
display(& b1);
          ↳ or p
}
void display (struct book *b)
{                                  → indirect method
printf(" %s" , b->name);             of accessing
printf(" %s" , b->author);           elements by
printf(" %d", b->callno);            pointers
}
```

* For a f^n returning a structure, datatype of f^n is struct structure-name f^n name (struct structure-name var name)

Q. Create a type defined structure to store following details of a planet :

Name
Diameter
Distance from moon
Rotation time

```
# include< stdio. h>
typedef struct
 {
   char name[10];
   double diameter;
   int moon-d ;
   double rot_time;
 } planet_t;
```

→ defined outside main()

new name given to struct

contd. Q. Using the structure datatype, declare a variable to store planet detail.

```
  main ()
  {
       * void print_planet (planet_t)
       planet_t current_planet;
       strcpy (current_planet.name, " JUPITER");
       current_planet.diameter = 142800;
       current_planet. moon-d = 10;
       current_planet. rot_time = 9.925;

       print_planet (current_planet);
  }
```

fⁿ declarⁿ

①

Name var name)

```
void print_planet(planet_t p2)
{
printf("Name = %s\n", p2.name);
printf("Diameter = %lf \n", p2.diameter);
printf("Distance from moon = %d\n", p2.moo);
printf("Time = %f \n", p2.rot_time
}
```

ex Call by REFERENCE

```
struct student
{
char name[10];
int id;
char grade;
};
typedef student s;
```

> rename structure student to s

or

```
typedef struct
{
char name[10]
int id;
char grade;
} s;
```

```
main()
{ void display(s);
  void scan_student(s*);
  s s1;
  scan_student(&s1); /* structure pointer */
  display(s1);
}
```

passing structure pointer to a fn

↓

```
));
void display (s  p2)
{ printf ("%s", p2.name);
  printf ("%d", p2.id);
  printf ("%c", p2.grade); }  → structure pointe
void scan_student (s * p2)
  {
    printf("\n Enter name \n");
    scanf(" %s", p2->name);
    printf("\n ID\n:");
    scanf("%d", P2 -> id);
    printf("\n Grade :\n");
    scanf(" %c", p2 -> grade);
```

Chapter -12.

FILE MANAGEMENT IN C.

- scanf() → to read data } When volume of
  printf() → to write data } data is small.
- when volume of data (i/p or o/p) is large, it is stored in disks — a secondary storage
- Concept of FILES is used to store data on disks
- File is a place on the disk, where a group of related data are stored.

* Oper^{ns} on FILES.

· naming a file
· opening a file
· reading from a file
· writing data to a file
· closing a file.

} done by using Std. library f^{ns} in C.

* Ways to do file oper^{ns}:

1. Low-level : uses UNIX sys. calls.
2. High-level : uses f^{ns} in C's std. ~~libr~~ library.

✲ Types of FILES

Text

- created using an editor or a word processor.
- named collection of chars stored in a disk
- no fixed size.
- eof (end of file): char to mark end of file. This is placed by the comp.
- all <enter> keys, when creating a file are replaced by \n chars.

ex This is a text file <newline> It has two lines. <newline><eof>.

Binary

It contains data in the form of 0 & 1.

✲ Defining and opening a file :

To store data in a file in secondary memory, we give following details about the file to the O.S :-

1. Filename
2. Data structure
3. Purpose.

1. FILENAME : String of chars, may have 2 parts — a primary name & extension (optional), separated by period.

ex :- Input.data
student.c
test.out .

2. DATA STRUCTURE : defined as a FILE in the std i/o f^n library.
∴ All files are declared as type FILE before used.

• General format for declaring & opening a file :-

3. PURPOSE

file pointer

```
FILE *fp;
fp = fopen("filename", "mode");
```

"r" -> read
"w" -> write
"a" -> append

f^n to open a file.
If file opens, f^n returns starting address of the file to the pointer fp.

* If fopen is failure, value of fp = NULL

Mode: r : open file for read only
w : " " " write only
a : " " " appending

* Each file should have its own pointer.
* Any no. of files can be used at a time.

Mode	File exists	File doesnt exist
w	• contents are deleted.	• a file with the specified name is created.
r	• file is opened with current contents safe.	• an error occurs. → Value of fp = NULL
a	• file is opened with current contents safe	• a file with specified name is created.

ex.
```
FILE *p1, *P2;
  P1 = fopen("data", "r");
  P2 = fopen("results", "w");
```

* Additional MODES:

r+ : existing file is opened for both reading and writing.

w+ : same as w, both reading and writing.

a+ : same as a, both reading and writing.

* CLOSING A FILE:

- when all oper^{ns} are completed, file is closed.
- all buffers - flushed out.
- all links are broken.

General format : fclose(file_pointer);

→ file pointer name (fp)

★ i/p & o/p oper^{ns} on FILES :-

1. The getc() & putc() f^{ns} :-

same as getchar() } used with std
putchar() } i/o.

• If ~~s~~ fp1 :- pointer to a file opened in write mode ("w");

c :- a character variable,

Then,

```
putc(c, fp1);
```

IIly,

getc() : reads character from a file opened in read mode.

ex

```
c = getc(fp2);
```

★ File pointer is moved by one character pos^{n}, after every getc() & putc()

getc() : returns ~~eof~~ EOF, when end of file is reached.

EOF : last char written to a file.
Press Ctrl+Z to mark end of file.

Program: Create a text file.
Write the contents of the file created onto the standard o/p device (monitor).

* EOF ⟺ ^z

Ctrl+Z

```
#include<stdio.h>
main()
 {
  FILE *fp;
  char ch;
  fp = fopen(" sample.txt ", "w");
   if (fp ==NULL)
     {
      printf("\nError");
       exit(0);
     }
     else
    ch= getchar();
   while (ch != EOF)  } or while ((ch=getchar())
     {                                   != EOF)
      putc(ch, fp);     |      putc(ch, fp);
       ch=getchar();    |
     }                  }
                        /* File now created */
 /* Now, open file in read mode, close first */
   fclose(fp);
    fp = fopen(" sample.txt", "r");
  ch = getc(fp);
  while(c !=EOF)
    {
       printf(" %c \n", c);
        c = getc(fp);
    }
       fclose(fp);
 }
```

✲ getw() & putw() functions.

- used only with integer data.

General format
putw (integer, fp); } used only for file
getw (fp); } with integer contents

ex:- Read 10 integers and write them into a file.

```
#include <stdio.h>
main()
{
 FILE *f1;
 int num, i;
 f1 = fopen(" Num.dat", "w");
   for (i=1; i<=10; i++)
     {
      printf("\n Enter a no. \n");
      scanf(" %d", &num);
      putw(num, f1);
     }
 fclose (f1);
/* Now, read contents of file & display o/p */
f1=fopen (" Num.dat", "r");
   for (i=1; i<=10; i++)
      {
       num= getw(f1);
       printf(" \n %d", num);
      }
  fclose(f1);
}
```

ogram: WAP to store 10 integers into a file NUM.DAT. Read each integer from NUM.DAT and store only odd integers in a file ODD.DAT & even integers in a file EVEN.DAT.

```
#include<stdio.h>
main()
 {
  FILE *f1, *f2,*f3;
  int num, i;
  f1 = fopen("NUM.DAT", "w");
      for (i=1; i<=10 ; i++)
         {
          printf("\n Enter no. \n");
          scanf(" %d", &num);
          putw(num, f1);
         }
      fclose(f1);
  f1 = fopen("NUM.DAT", "r");
  f2 = fopen("EVEN.DAT", "w");
  f3 = fopen("ODD.DAT", "w");
  for (i=1; i<=10; i++)
  {
  num = getw( f1)
      If ( num % 2 ==0)
         putw(num, f2);
      else
         putw(num, f3);
     }
 fclose(f1);
 fclose(f2);
 fclose(f3);
```

/* To print the file contents */

```
ex. f2 = fopen("EVEN.DAT", "r");
      while ((num = getw(f2)) != EOF)
          printf("%d\n", num);
```

write a record to a file.

* fprintf() and fscanf() :-
can handle a group of mixed data simultaneously.

General format : fprintf(fp, "controlstring", list);

to enter grp of data of diff' types simultaneously

→ file pointer of the file which is opened for writing.
→ o/p specific^ns of items in the list

constt, var, & strings.

ex. fprintf(f1, "%s %d %f", name, age, 7.5);
; name : array of char, age : int variable.

General format fscanf(fp, "control string", list);

to read a record ex. fscanf(f2, "%s %d", item, &qty);

Program: Create a file named STUDENT.DAT to store details of each student (5) in a class. Use this file to calculate & print total marks. Store: ID, name, m1, m2.

```
#include <stdio.h>
main()
{
 FILE *fp;
 float tot ;
 struct stu
{
 char name [10];
 char idno [10];
 float m1, m2 ;
 };
 struct stu s[50] ; /* Array of structures */
/* Open file */ fp = fopen(" STUDENT.DAT", "w");
  /* Now, make user enter elements */
  for (i=0; i<=4; i++)
 {
   printf("\n Enter ID no.\n");
   scanf(" %s" , s[i]. idno);
   printf("\n Enter name \n");
   scanf(" %s", s[i]. name);
   printf(" Enter mark1");
   scanf(" %f", & s[i]. m1);
   printf("\n Enter mark 2");
   scanf(" %f", & s[i].m2);

fprintf(fp," %s \t %s \t %f \t %f \n",
 s[i].idno, s[i].name, s[i].m1, s[i].m2);
 }
    /* File has been created */
```

①
↓

```
fclose (fp);
/* To calculate total & print */ /* Marksheet */
  fp = fopen (" STUDENT.DAT ", "r");
    for (i=0; i<=4 ; i++);
     {
  fscanf(fp, " %s %s %f %f", s[i].idno,
     s[i].name, &s[i].m1, &s[i].m2);
tot = s[i].m1 + s[i].m2;
 printf ("Name : %s \t", s[i].name);
printf ("ID No : %s \t", s[i].idno);
printf("\nMark1 : %f\t", s[i].m1);
printf ("\nMark2 : %f \t", s[i].m2);
printf("\nTotal : %f\t", tot);
     }
 fclose (fp);
}
```

Program: Assume "pr1.c" is an existing text file. Copy its contents character by character to another text file called "pr2.c".

```
# include <stdio.h>
main ()
{
 FILE *fp1, *fp2; char ch;
fp1 = fopen ("pr1.c", "r");
 if (fp1 == NULL)
    {
     puts ("\nCannot open source file \n");
     exit ();
```

```
fp2 = fopen("pr2.c", "w");
if (fp2 = = NULL)
{
  puts("\n Cannot open target file \n");
  exit();
}
fclose(fp1);
      do
      {
      ch= getc(fp1);
      putc((ch, fp2);
      }
      while (ch != eof);
fclose(fp1);
fclose(fp2);
}
```

or

```
while (1)   a true
{
ch= getc(fp1);
if (ch= = EOF)
  break;
else
  putc(ch, fp2);
}.
```

each file should be closed separately

→ o/p → nothing. Contents of files have to be seen by opening those files.

Program :- WAP to ~~read~~ store every character input from the keyboard into a file. The procedure should come to an end when the character "~" is entered from keyboard.

```
#include
main()
{  FILE* fp;
   char ch;
  fp = fopen("temp.dat", "w");
while (1)
 {
  getchar(ch)
  if (ch= = '~')
        break;
```

rintf (fp1;"

~~fsca (fp1,~~

FILE

= fop

```
else
    putc(ch, fp);
}
   putc(ch, fp);  → for printing the last
                    char '~'.
fclose(fp);
}
```

Program: WAP to count the no. of words in a text file - "sample.text".

```
#include<stdio.h>
main()
{
 FILE *fp;
 char ch; int count = 0;
fp = fopen("sample.text", "r");
 while(1)
  {
    ch = getc(fp);
    if (ch == ' ')      } or  if (isspace(ch))
       count += 1.      }       count += 1;

    if (ch == EOF)
        break;
  }
```

——→——

* Fns that access stdio and ~~st~~ stdin.
  - scanf(), - printf() - getchar(),
  - putchar().

* Fns that access any text file :
fscanf() , fprintf(), getc(), putc()

ex Using a string in fopen stmt.

```
char filename[50];
scanf(" %s", filename);       } where
fP = fopen(filename, "r");    } i/p:Dr1.c.
```

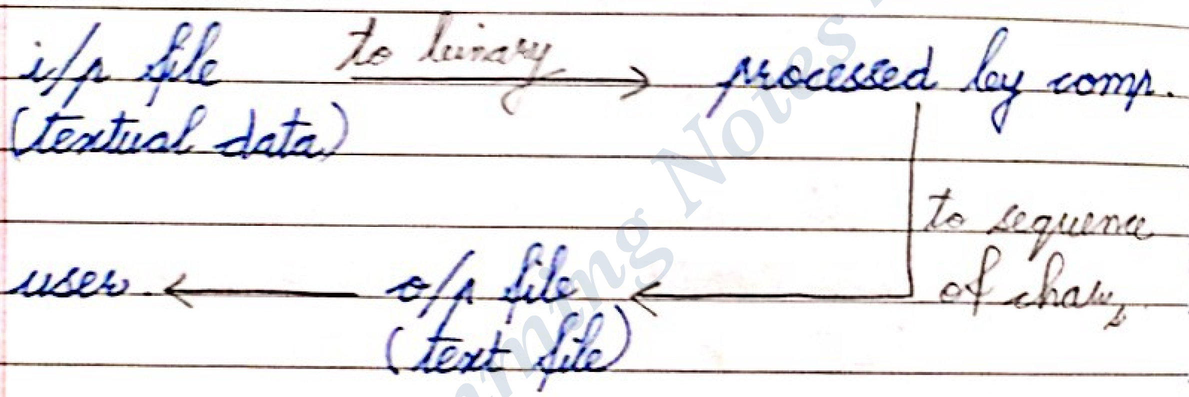
Program :- Make backup copy of a text file.

Cond'nal operator used in for stmt.

```
# include< stdio.h>
main()
{
  char in_name[80];
  char out_name[80];
  FILE *inp, *outp;

  printf(" Enter filename to be backed \n");
   for ( scanf("%s", in_name);
    (inp = fopen( in_name, "r")) == NULL;
    scanf("%s", in_name))
   {
     printf(" Cannot open file \n");
     printf(" \n Re-enter file name ");
   }
  /* get filename to store backup */
  printf(" Enter name for backup copy ");
  for (scanf("%s", out_name);(outp = fopen
  (out_name, "w"))= = NULL; scanf("%s", out_name)
   { printf(" Re-enter file name \n");
   }
/* copy chars (one at a time) */
for (ch = getc(inp); ch != EOF; ch = getc(inp))
    putc(ch, outp);
    fclose(inp);
    fclose(outp);
}
```

* Binary File :



i/p file (textual data) → to binary → processed by comp. → to sequence of chars → o/p file (text file) → user

- If o/p file of program 1 is i/p file to program 2, the transl^ne can be avoided, by using binary files, instead of text files.

- Binary file :
  file having binary nos. that are computer's internal represent^n of each file component.

ex.
```
FILE * binaryp ;
int i ;
binaryp = fopen("nums.bin", "wb");
    for (i = 2 ; i <= 500 ; i += 2)
        fwrite (&i, sizeof(int), 1, binaryp);
           → address  → size of        → no. of values
                        1 such values
    fclose (binaryp);
```

* 1 fwrite stmt. can be used to store/write array.

ex:- To write array of 10 Z_s to a binary file
fwrite(score, sizeof(int), 10, binaryp).
↳ array name

* fread, fwrite : used to read and write into a binary file

* fwrite : 4 arguments

① Address of (1st) memory cell whose contents would be copied to the file.
(& variablename, array name, & structure)
array of structures

② Size of 1 value to be written to the file

int	2 bytes
float	4 bytes
char	1 bytes

③ No. of values to be written.

④ Pointer to the file being created.

IIly for fread()
↳ returns how many values it has successfully read from the file

Disadvantages of Arrays.
ME

☆ Dynamic Memory Allocation

- Data : dynamic in nature.
- no. of data items may change during program execution.

ex : list of student names.

- Use dynamic data structures and dynamic memory management.
- Dynamic data structures : to add, delete or rearrange data items at runtime.
- Dynamic memory management : allocates add^{nal} memory space or release unwanted memory space at runtime.

Disadvantages of Arrays.

- Memory allocated at compile time :- STATIC MEMORY ALLOC^n.
- → int a[10]; → specify array size at compile time
- → wastage of space.

☆ LIBRARY FUNCTIONS

Memory Alloc^n f^{ns}:

F^n name	Task
1. malloc returns a void pointer	allocates requested size of bytes and returns a pointer to the first byte.
2. calloc	allocates memory for an array of elements, initializes them to zero returns a pointer to zero it.

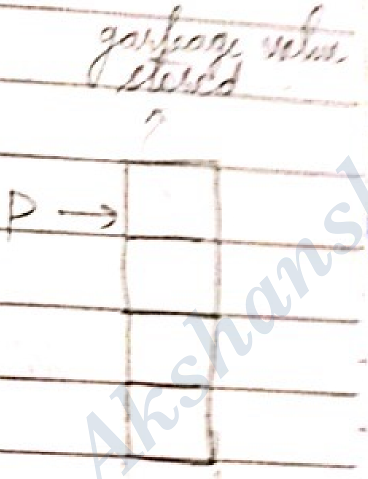
1.* malloc : returns a void pointer. So, we have to typecast it accordingly.

ex.

```
int *p ;
scanf("%d", &n);
p = (int *) malloc (n*2);
```

typecasting done

memory to be reserved for n integers.



* Fn name	Task
3. free	frees previously allocated space
4. realloc	modifies the size of previously allocated space.

* HEADER FILE : < alloc.h>.

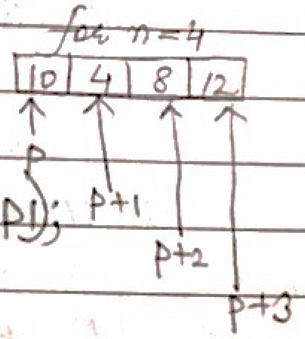
ex Read an array of n elements.
(i) find their sum
ii) Print elements in reverse order.

```
#include <stdio.h>
main()
{
int n, *p, sum=0, *p1;
printf("\n Enter size of array \n");
scanf("%d", &n);
                                        > or 2.
p = (int *) malloc(n* sizeof(int));
if (p==NULL)
  {
   printf("Insufficient space"); /*for check*/
   exit();
  }
printf("Add of 1st byte %u", p);
printf("Read array elements \n");
   for (p1=p; p1<=(p+n-1); p1++)
      {
        scanf("%d", p1);
        sum= sum + *p1;
      }
/* For reversing : */
for (p1=p+n-1; p1>=p; p1--)
  {
   printf("%d at address %u", *p1, p1);
  }
printf("%d", sum);
}
```

for unsigned Z

from 0 to n-1 : p1 points to addresses of p1

for n=4



O/P:

```
   Enter size of array   5
   Address of 1st byte   2252
   Read array elements
   1  2  3  4  5.
5 at address   2260  ← p+4
4 at address   2258  ← p+3
3 at address   2256  ← p+2
2 at address   2254  ← p+1
1 at address   2252  ← p
```

Sum, print at last

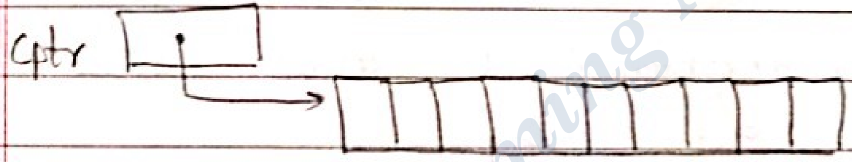
* When it is not possible to allocate enough space malloc() returns NULL.

* Allocating a block of memory : malloc()
- malloc() returns a pointer of type void.

General format : ptr = (cast_type *) malloc(byte_size);

ex :, X = (int *) malloc (100 * sizeof(int));
allocates 100x2 = 200 bytes of memory & returns a pointer to first byte.

ex: cptr = (char *) malloc(10);



10 bytes of memory.

ex : st_var = (struct store *) malloc(sizeof(struct store));
reqd to find size of Structure datatype

2. calloc()
- Allocates multiple blocks of memory. Blocks are of same memory.
- ~~Storims~~ Storing derived data types like arrays and structures.
- All blocks allocated are set to zero

General format : ptr = (cast_type *) calloc(n, elemt_size);
n : no. of elemts/blocks.
elemt_size : size of each block.

• Unsuccessful : returns NULL.

eg. store an array

int a[10];

p=(int *) malloc(10*2);   p=(int*) calloc(1, 10*2)

3. realloc():

- altering the size of a block.
- If original alloc^n is done by the stmt -

ptr = malloc(size);

realloc^n can be done by

General format: ptr = realloc(ptr, newsize);

starting address of previously allocated memory

- no guarantee that realloc^n takes place in same old region.
- If no addn^nal space, in the same old region, an entirely new ~~re~~ region of size newsize is created and contents of old block are moved to the new block.
- old data is safe.

Program: Using malloc() f^n, store the string "HYDERABAD" & then, modify the same memory block to store a larger string "SECUNDERABAD"

```
# include< stdio.h>
# include< alloc.h>
main()
{
```

```
char *buffer;
  if ((buffer = (char *) malloc (10))= = NULL)
   {
     printf("\nMalloc() failed");
     exit();
   }
strcpy (buffer, "HYDERABAD");
                  starting address of allocated memory
printf("Buffer has %S \n", buffer);
  /* Realloc^n */
if((buffer = (char *) realloc(buffer, 13))= = NULL)
   {
     printf("\nRealloc^n failed");
     exit();
   }
printf("Buffer has %s \n", buffer);
strcpy(buffer, "SECUNDERABAD");
printf("Buffer now has %S \n", buffer);
free (buffer); → returns free memory of buffer
}
```

original string was moved. So we are checking that.

Program: WAP to store the array int a[5] = {1,2,3,4,5} using dynamic memory alloc^n f^ns. Then, extend memory to store 2 more integers, 6 and 7.

```
#include<stdio.h>
#include<alloc.h>
main()
 {
```

```
int *p, *pl , i=1;
if ( p=(int *)malloc(5*2)==NULL);
   {
   printf("\nMalloc failed \n");
   exit();
   }
 for ( pl=p ; pl<=p+4 ; pl++)
   {
      *pl=i;
       i++;
   }
```

For checking

```
 printf("\n Before allocation \n");
 for (pl=p ; pl<=p+4; pl++)
     printf("%d", *pl);
```

let 5 values transferred already

```
 p=(int *) realloc(p, 7*sizeof(int));
   i=6;
 for(pl=p+5 , pl<=p+6 ; pl++)
   {
     *pl = i ;
      i++ ;
   }
 printf("\n After realloc" \n");
  for (pl=p ; pl<=p+6 , pl++)
     printf(" %d", *pl);
}
```

Program:- Using dynamic memory alloc^{n} f^{ns}, WAP to store the string BITS. & extend the memory to store the string BITS PILANI.

```
# include < stdio.h>.
main()
{
char * buffer;
if ((buffer = (char *)malloc(4)) = = NULL)
   {
    printf("\n Malloc failed\n");
    exit();
   }
strcpy(buffer, "BITS");
printf(" Buffer has %s \n", buffer);
   if ((buffer=(char *) realloc(buffer, 11))=
   = NULL)
   {
   printf(" \n Reallocation failed \n");
   exit();
   }
printf("\n Buffer has %s \n", buffer);
strcpy( buffer, " BITS, PILANI" );
printf(" \n Buffer now has %s \n", buffer);
     free(buffer);
}.
```

☆ Stacks

ex. Top → 5 ← most recently received item → gives index of topmost element
4
3
2
1 ← earliest item received.

* LIFO : Last In First Out.

Defin^n: Ordered list of zero/more elements which allows insertions and deletions at only one end called the TOP.

Implement^n: Using an array
or Using a LL (link list).

* Array implement^n of a stack.
Empty stack : top = 0
Full stack : top = array size

* Oper^ns done on a Stack:
- PUSH : adding an elemt. to top end of stack.
- POP : removing an item from top end of stack.

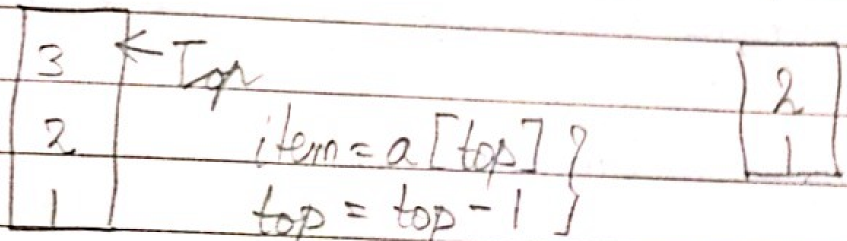
- Using arrays:

Before push.
3 ← TOP
2
1

Push item 4
top = top + 1
a[top] = item

After push
4
3
2
1

Before Pop After Pop.



item = a[top] ;
top = top - 1]

item popped is 3

* Algorithm to push an item onto the stack:

```
1. Read item to be pushed.
2. Check for stack overflow.
   If stackpointer, top, is greater than array-
   -size, ∃ stack overflow.
   So, print stackoverflow and stop else
   goto next step.
3.   top = top + 1
   a[top] = item .
4. Stop .
```

* Algorithm to pop an item from top end of the stack.

```
1. Check for empty stack (top = 0).
   If top is zero, print stack is empty and
   stop . Else goto next step
2. Pop the item on the top end of stack .
   item = a[top]
   top = top - 1
3. Stop .
```

* Applications
handling recursions, fⁿ calls & compiling.

* Implementation in C.

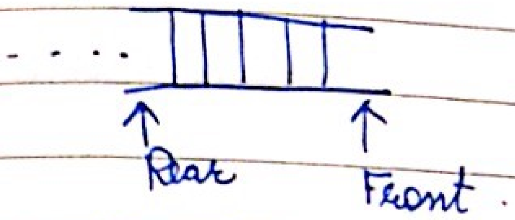
```
#include<stdio.h>
main()
{
int a[10], top, item, ch;
* top = -1;  ---> For finding empty stack (∵ array starts from 0
printf("\n1...>Creation\n");
printf("\n2...>Push\n");
printf("\n3...>Pop\n");
printf("\n4...>Display\n");
printf("\nEnter your Choice\n");
scanf("%d",&ch);
    while(ch<5)
    {
                                  a fⁿ
    switch(ch)
     {
      case 1:  top = create(a,top);
                   break;
      case 2 : top = push(a,top);
                 break;    > fⁿ
      Case 3 : top = pop(a,top);
               break;
      Case 4: display(a,top);
     }
printf("\n Enter user choice \n");
scanf(" %d", &ch);
}
} /* end of main */ /* Now f^n defin^ns */
   int create (int a1[10], int t)
      {
        int item;
   printf("\n Enter the elements (type 0 to
   terminate) \n");
   scanf (" %d", & item);
   while (item != 0)
   {
       t ++;
★      a1[t] = item;
       scanf(" %d", &item);
     }
   return (t);
} int push (int a1[10], int t)
{ int item ;
printf ("\n Enter element to be pushed");
scanf(" %d", & item);
  if (t>9)
        printf("\n Stack overflow \n");
  else
     { t++;
        a1[t] = item;
     }
       return(t);
  }
```

```
int pop (int a[10], int t)
{
  int item ;
    if (t>=0)
    {
      item = a[t] ;
       t -- ;
    printf("\n Popped item is %d\n",item)
    }
   else
    printf("\n Stack is empty \n");
    return (t);
  }
void display (int a[10], int t)
  {
    int i;
      for (i=t; i>=0; i--)
        {
          printf("\n\t%d\n", a[i]);
          printf("......\n");
        }
  }
```

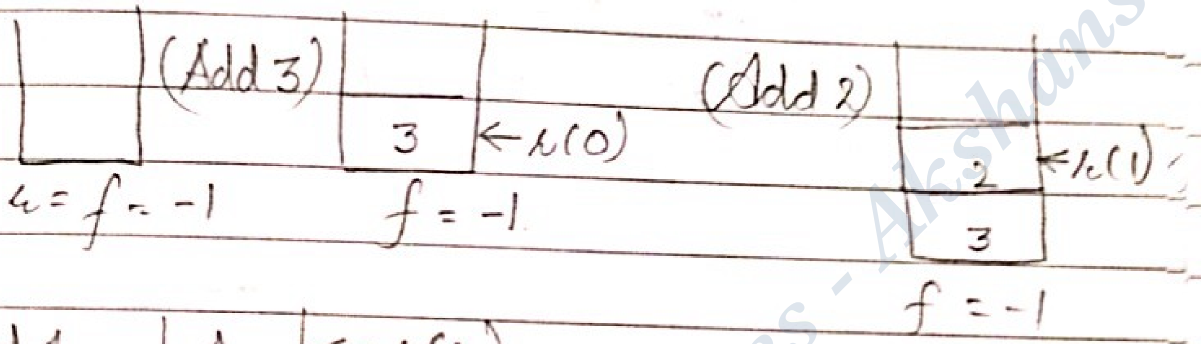
☆ QUEUE

- FIFO: first in first out.
- has 2 pointers, rear and front.
- Insertions take place at rear end.
- Deletions take place at front end.

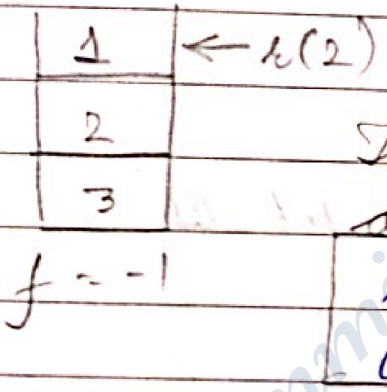
Array implementation of a queue :



Initially, front = rear = -1.



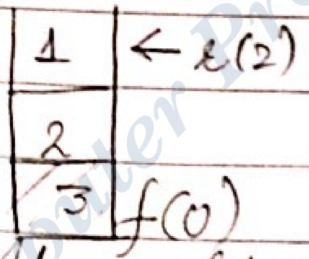
Add 1.



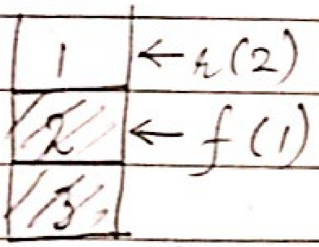
To add a data item to a

rear = rear + 1
a[rear] = item

* Delete Q



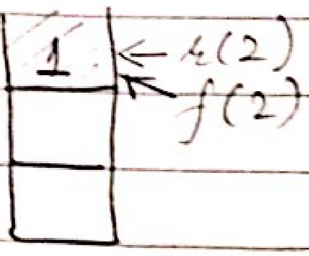
Del Q



Item deleted 3.

Item deleted = 2.

Del Q.



f = f + 1
item = a[f]

* Empty Queue — Full Queue

front == rear — rear = arraysize → some integer

eg

```
#include <stdio.h>
int front, rear;  → global variables
main()
{
int a[10];
void addq(int[], int);
int delq(int[]);
void qdisplay(int[]);
int i, j, d, ch;
front = rear = -1 /* Initialize */
system("clear"); /* Clrscr*/
while (ch != 4)
 {
 printf(" 1 --> Add ");
 printf("\n2 --> Delete \n");
 printf("\n3 --> Display \n");
 printf("\n4 --> Quit \n");
 printf("\n Enter your choice \n");
 scanf("%d", &ch);
 switch (ch)
 {
  case 1 :
            printf("Enter value to insert \n");
```

```
          scanf("%d", &d);
          addq(a, d);
          break;        → Add d to array a
    case 2:
          printf("\n Deleted item is %d",
          d= delq(a));
          break;
    case 3:
          qdisplay(a);   /* Call fn qdisplay */
          break;
case 4:
exit();
       }  /* switch close */
     }  /* while loop close */
   }  /* main fn close */
  /* Now, fns to be defined */
  void addq(int a1[10], int d1)
       {
          int r;
          if (r==9)
               printf("Full Q");    /* Check for full Q */
          else
               {
               r++;
               a1[r] = d1;      or   a1[++r]=d1;
               }
       }
```

fn is returning the deleted value at its calling place

```
  int delq(int a1[10])
     {  if(r==f)  /*Check for empty Q */
int r,f;   printf("Empty Q");
        else
             return(a1[++f]);
     }
```

```
void qdisplay(int al[10])
  {
     int i;
     if (front==rear) /* Check for empty */
     printf("Empty Queue.");
     else
       {
         for(i=front+1; i<=rear; i++)
            printf("%d\t", al[i]);
       }
  }
```

Set a counter & increment it (if size/no. of items in a queue needs to be known).

* Arguments to function main()

Two arguments to main():-

int argc ..→ an integer.

char *argv[] ..→ an array of pointers to strings.

--- command line arguments.

Program: File backup using arguments to main():-

```
/* make backup of the file whose name is the
first command line argument. Name of the
new file is second command line argument */
#include <stdio.h>
#include <stdlib.h>
int main( int argc, char *argv[])
  {
```

not necessary (optional)

no. of parameters stored in cmd line

```
FILE *inp, *outp;
                                      > source file
char ch;
inp = fopen(argv[1], "r");
if (inp == NULL)
    { printf("\n Cannot open the file \n");
      exit();
    }
                                      > Destin" file
 outp = fopen(argv[2], "w");
 if (outp == NULL)
     { printf("\n Cannot open file \n");
       exit();
     }
  for (ch=getc(inp); ch!=EOF; ch=getc(inp))
        putc(ch, outp);
  fclose (inp);
  fclose (outp);
}
/* To compile :- $ cc backup.c
   To run :- $ a.out ex1.c ex2.c
     argc = 3 <-
     argv[1] = ex1.c
     argv[2] = ex2.c                    */
```

Program: Find the sum of all nos. passed as arguments to the program from command line

```
#include<stdio.h>
#include<stdlib.h>
main (int argc, char * argv[])
```

```
{
int sum = 0, i;
  if (argc == 1)
    {
      printf("usage: %s [no1][no2] ...\n",
       argv[0]);
      exit(0);
    }
printf("argc = %d \n", argc);
  for (i=0; i<argc; i++)
      printf("argv[%d]= %s \n", i, argv[i]);
sum = 0;
  for (i=1; i<argc, i++)
      sum = sum + atoi (argv[i]);
printf("sum = %d \n", sum);
}
```

to print each argument in command line.

Run time: | $ cc sum.c
          | $ a.out 1 2 3 } or

```
sum      10   11   12   13
argc = 5
argv[0]=sum     argv[3]=12
argv[1]=10      arg[4]=13
argv[2]=11
$ cc sum.c -o sum
$ ✓sum 1 2 3
```

use the filename directly, instead of a.out argv[0] argv[1] argv[2]

i.e., a.out abcdefabc123 b → will be declared as a string

o/p :- aBcdefaBc123

Program: WAP to input a string & a character as command line parameters & convert the occurences of the character in the string to its upper case.

```
#include <stdio.h>
#include <stdlib.h>
#include <alloc.h> /* check this {?} */
main (int argc, char *argv [])
 {
   char str[15], ch; int n, i;
   if (argc != 3)
    { printf("\n Error in i/p");
      system ("exit");      → or exit(0);
    }
   strcpy(str, argv[1]);
   ch = argv[2][0];   → 0th char. stored in argv[2]
   n = strlen(str);
    for (i=0; i<n; i++)
     {
        if (str[i]==ch)
         str[i] = toupper(str[i]);
     }
   printf("%s", str);
 }
```

Program: WAP which takes 2 nos. & an operator from the cmd line & gives the result of applying the operator on the 2 nos.

eg: $a.out 10 12 + → argv[3] = "+".

→ everything stored as a string

o/p: 22

```
#include<stdio.h>
# include<stdlib.h>
#include <alloc.h>      > for atoi , toupper, - - -
main(int argc, char *argv[])
  {
 char op, str[15], ch; int i, a, c
     if(argc != 4)
        { printf("Error in i/p \n");
          system("exit ");
        }
   a= atoi(argv[1]);   > string => requires
                         typeconversion
   b = atoi(argv[2]);
   op= argv[3][0];
  Switch(op )
      {
         case '+' :
            printf(" %d", a+b);
              break;
         case '-' :
           printf(" %d", a-b);
           break;
         case '*' :
           printf(" %d", a*b);
           break;
         case '\' :
           printf("\n %d", a/b);
            break;
         }
 }
```

Chapter : LINKED LIST.

•

- used to store and organise similar data items in memory.

* Difference b/w LL and an array:

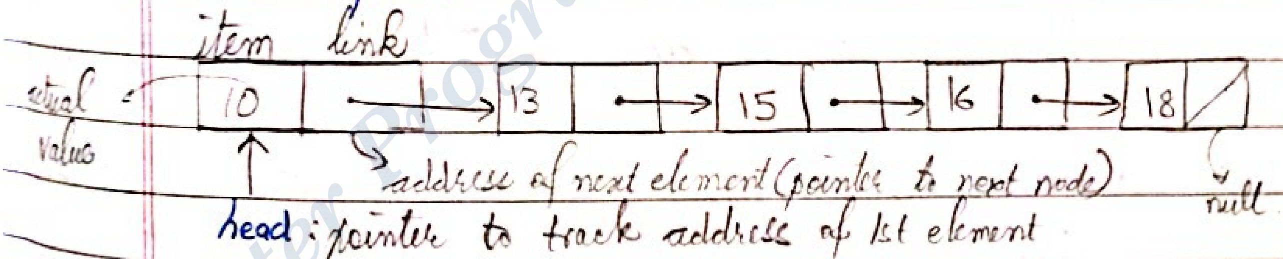
1 Elements of an array are stored in consecutive memory loc^ns.

Elements of a LL are dispersed.

2. In an ordered list of data items, maintained by a LL, insertions and deletions are easier, with no physical data movt.

* Structure of a node in a LL:

Node: an element in a LL. It has 2 parts.


item
link
actual value
10
13
15
16
18
address of next element (pointer to next node)
head: pointer to track address of 1st element
null

* Represent node in a LL as a structure data type:

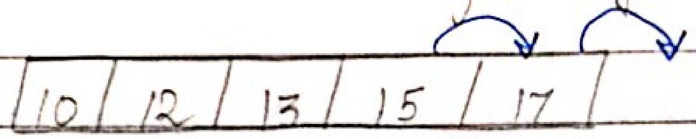
```
struct node
{
    int item;
    struct node * link;
};
```

link field of next node is given by struct node.

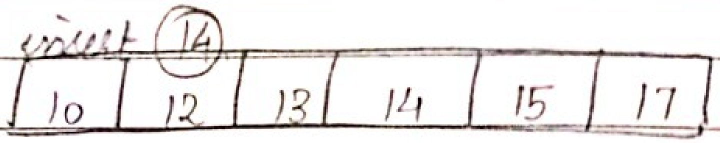
⇓

SELF REFERENCING structures

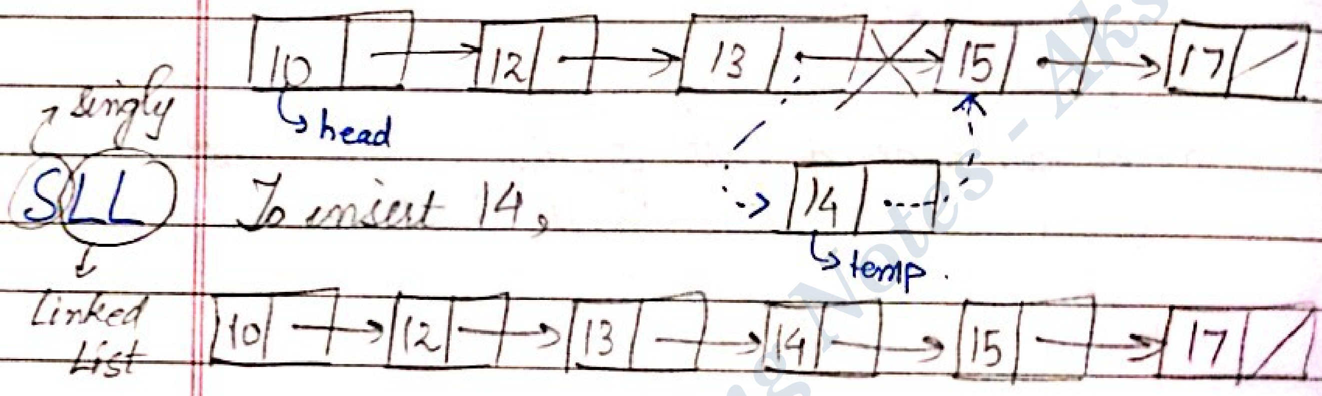
ex An ordered list using arrays.



Now to insert (14)



An ordered list using LL.



To insert 14,

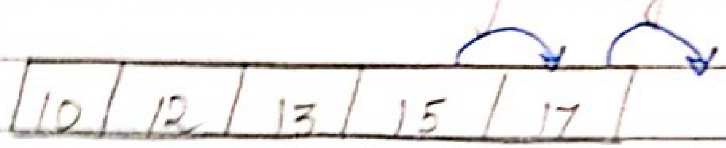
☆ Note:

- Nodes of a LL are created at run time, using malloc()
- head is a pointer to the first node of a LL.
- link field of the last node is NULL.
- if head is known, the LL can be traversed till the end.

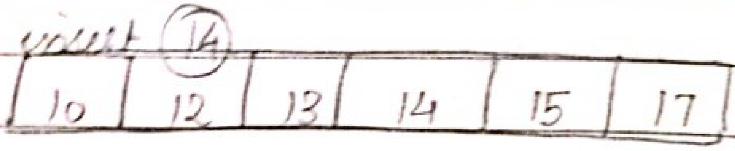
☆ Operations on a LL:

- creating, traversing, displaying a LL.
- Add (insert) a node to the beginning, end or middle of a LL.
- Delete a node from a LL.

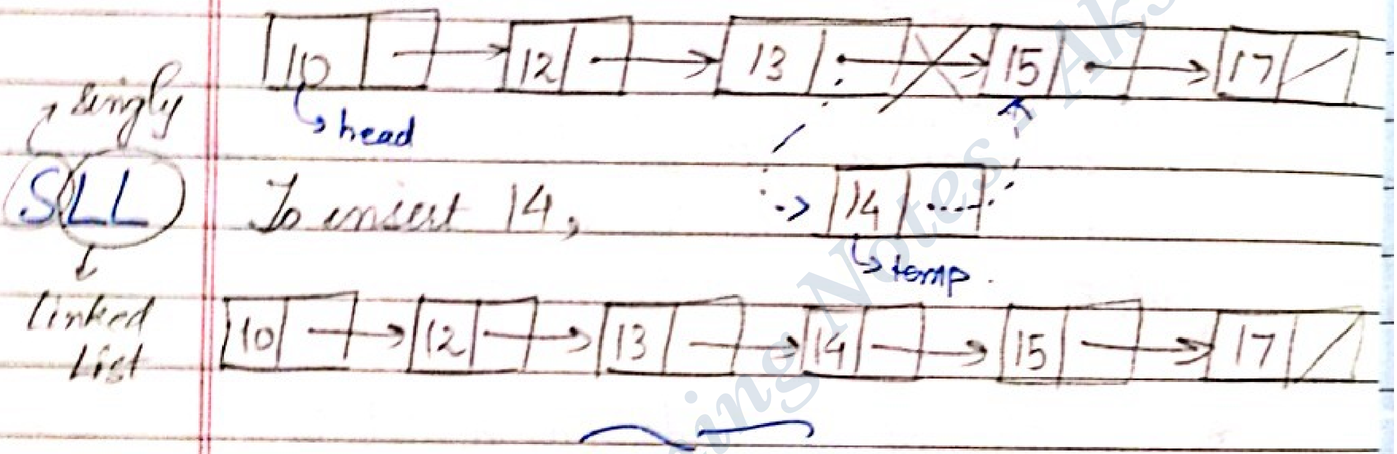
ex. An ordered list using arrays.



Now to insert (14)



An ordered list using LL.



To insert 14,

Note:

- Nodes of a LL are created at run time, using malloc()
- head is a pointer to the first node of a LL.
- link field of the last node is NULL.
- if head is known, the LL can be traversed till the end.

Operations on a LL:

- creating, traversing, displaying a LL.
- Add (insert) a node to the beginning, end or middle of a LL.
- Delete a node from a LL.

* how to check for a list to be empty : Check : head is NULL or not

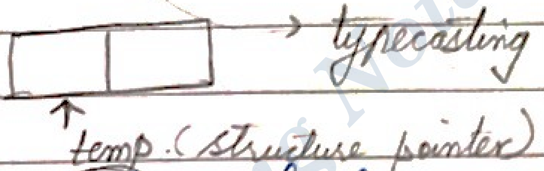
* Other types of LL :
DLL : Doubly Linked List
CLL : Circular Linked List.

* Creating a LL (by appending nodes to a LL

1. Create a new node, temp, using malloc().

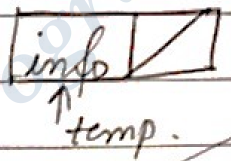
```
temp=(struct node *)malloc(sizeof(struct node))
```

→ typecasting .



2. Read data, info, of the new node.

3. Set the 2 fields of the new node, temp.



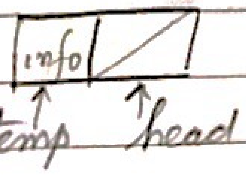
→ accessing each element using arrow operator.

```
temp -> item = info
temp -> link = NULL.
```

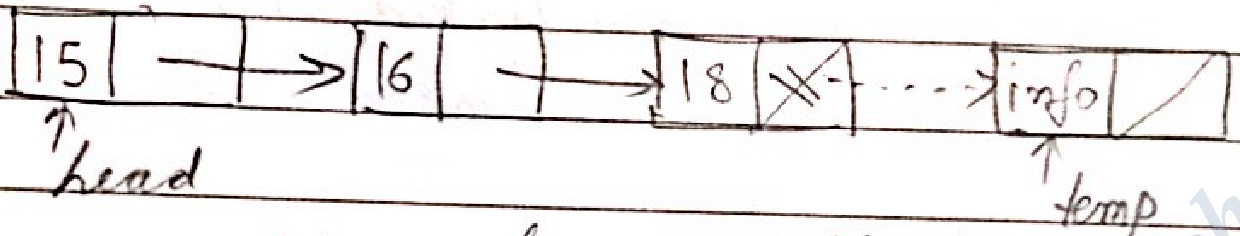
* To append a LL.

4. Check for empty list :- head = NULL.

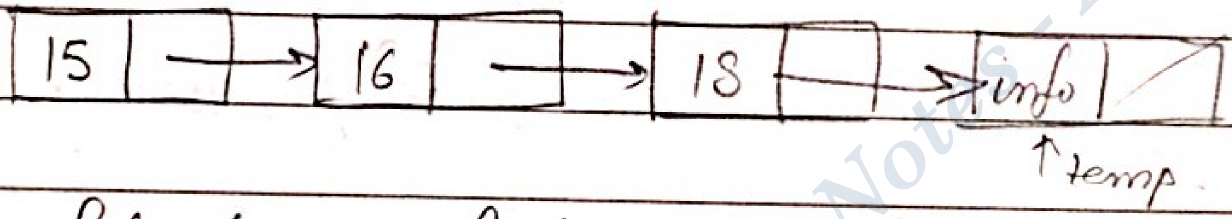
empty list :



non empty list :



Now, traverse till the end



```
while (t -> link != NULL)
        t = t -> link ; /* Move to next no*/
    t -> link = temp;
```

1/

```
* /* creating and displaying an SLL */
#include<stdio.h>
#include<alloc.h>
struct list
 {
  int item;                          { /* structure defin^n */ }
  struct list * link;
  };           - Renaming
  typedef   struct list node;
  main()
   {
   node * head;   /* Pointer to 1st node should be declared*/
   node * create (node *), Pass address of 1st node of LL
   void  display (node *);
    head = NULL;  /* For empty list */
    head = create (head);
    puts ("\n Created list \n");
    display (head);
 }
 /* creating a SLL */
 node * create (node * head)
  {
   node * temp, *t;
   int info;
   printf ("\n Enter data item");
   scanf (" %d", & info);
    while (info != 999)
     {
```

typecasting   allocating space

```
temp = (node *) malloc (sizeof (node));
temp -> item = info ;
temp -> link = NULL ;
  if (head = = NULL)  /* Check for empty list */
      head = temp ;
  else
     {
      t = head ;  /* For traversing a LL, t points to nodes */
      while (t -> link  ! = NULL)
              t = t -> link ;
              t -> link = temp ;
     }
     printf (" \n Enter a data item ");
     scanf (" %d", &info);
    }
 return (head); /* needed for fn display */
}

void display (node * head)
 {
  node * t ;
  t = head ; /* Make t (temp var) point to first node */
  while (t -> link ! = NULL)  or while (t ! = NULL)
   {
    printf ("%d -> ", t -> item);
    t = t -> link ;
   }
  printf (" %d \n", t -> item);   -> Reqd to print the
}                                    last item
```

not required if the above while cond^n is changed.

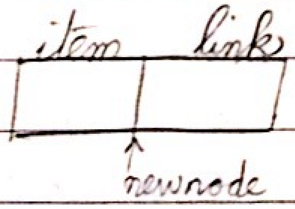
Program: Define a f^n to take address of 1st node & returns the no. of nodes in the LL.

```
/*
 use the main f^n (with some changes)
 from the previous program
*/

int count (node * head)
 { node *t ;
  int c=0 ;
  t = head ;
 while (t != NULL)
    {
        c++
        t = t -> link ;
    }
 return (c) ;
 }
```

☆ INSERTION

1. Create a new node to be inserted.



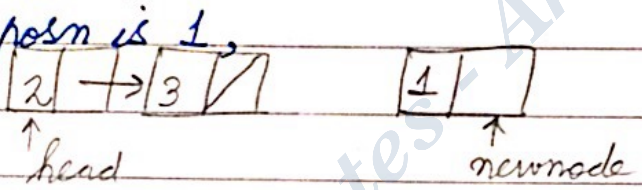
(a) Use malloc() to create newnode
(b) Read data field, data of type new node.
(c) Set the data field of new node
newnode -> item = data

2. Read pos^n of insertion, pos^n
3. Check for empty list.

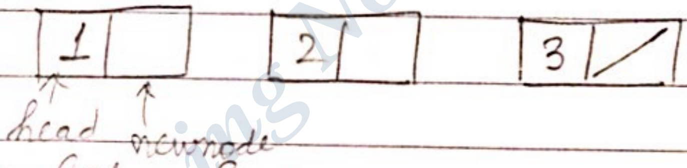
3.1. If list is empty ;
    3.1.1 : Set link field of newnode as NULL.
        newnode -> link = NULL.
    3.1.2 : Make newnode as head
        head = newnode

3.2 If list is not empty,
    3.2.1 : If posn is 1,

Before insertion : (B.I.)



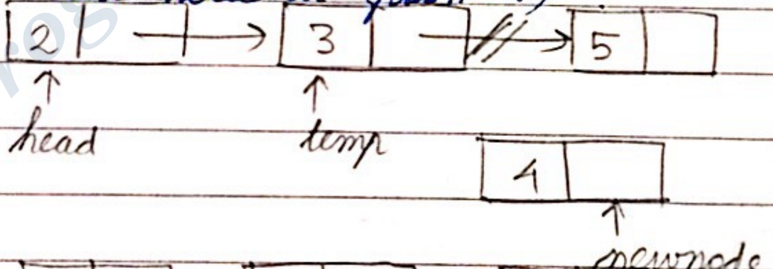
After insertion : (A.I)



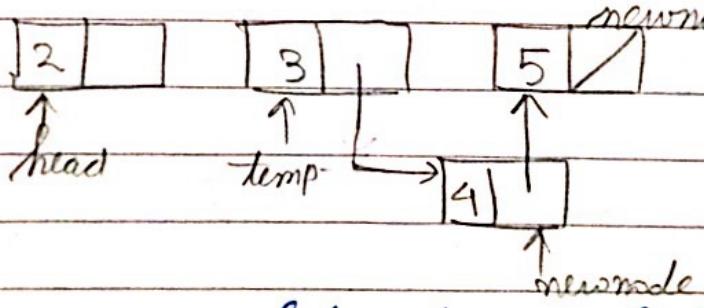
newnode -> link = head ;
head = newnode ;

    3.2.2 : If posn is not 1, traverse and reach the node at (posn-1)

B.I.



A.I.



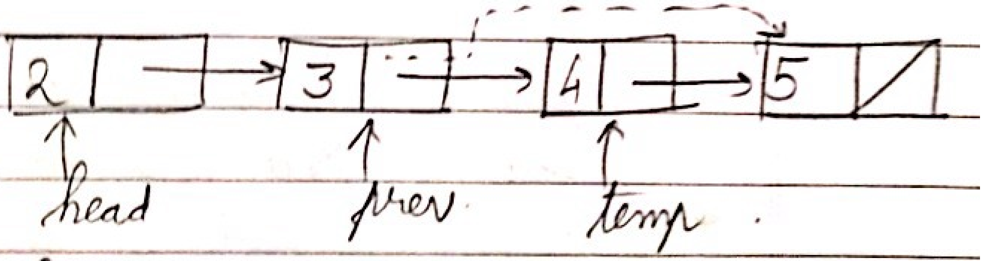
newnode -> link = temp -> link ;
temp -> link = newnode ;

```
node * insert (node * head)
{
  node * newnode, * temp;
  int newitem, i, posn;
  printf("\nEnter item to be inserted\n");
  scanf("%d", & newitem);
  printf("\nEnter position of insertion \n");
  scanf("%d", & posn);
  newnode = (node *) malloc( size of node));
  newnode -> item = newitem;
    if (head == NULL) /*Empty list */
   {
      newnode -> link = NULL;
      head = newnode;
   }
   else /* non empty list */                 not reqd
   {
    if ((posn == 1) && (head != NULL))
    {
      newnode -> link = head;
      head = newnode;
    }
    else
&& temp->link!=NULL     i = 1;
for(i=1; i<posn; i++)   temp = head;
temp = temp         while ((i <= posn-1) && (temp->link != NUL
  ->link;      {
                 temp = temp -> link;
                 i++;
               }
newnode -> link = temp -> link;
temp -> link = newnode;
    }
                    /* Pointer reassignment */
 }
return(head);
}
```

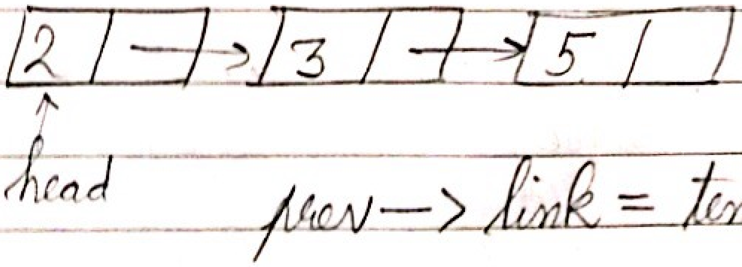
✯ Deletion

1. Read item to be deleted, item
2. If list is empty, print empty list.
3. If list is not empty,
    3.1 : Traverse and reach the node to be deleted (whose item field = item), temp.
    32 : Get the address of previous node, prev.

Before deletion.



After deletion:

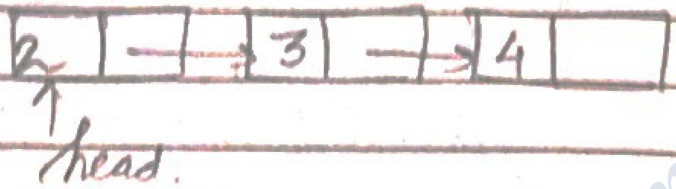


NULL))

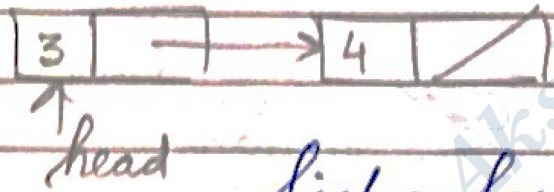
prev -> link = temp -> link

If node to be deleted is the first node

Before deletion item = 2



After deletion



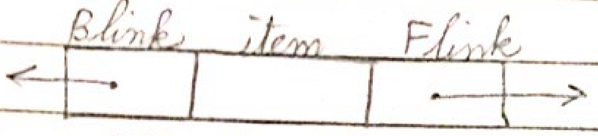
~~first = first~~
head = head->link

—x—

```
node * delete (node * head)
{
node * temp, * prev;
int target;
  if (head == NULL)
          printf("\n Empty list ");
  else
     {
       printf("Enter item to be deleted \n");
       Scanf(" %d", & target);
/* Check whether node to be deleted is
  first node */
   if (head -> item == target)
          head = head -> link;
  else
     {
      temp = head;
        prev = NULL;
while (temp != NULL) && (temp -> item !=
target)).
{
 prev = temp;
 temp = temp -> link;
}
  if (temp = = NULL)
     printf ("\n Element is not found\n");
 else
    {
      prev -> link = temp -> link;
    }
   }
 }
return (head);
}
```

* Doubly Linked Lists (DLL)

- Node:

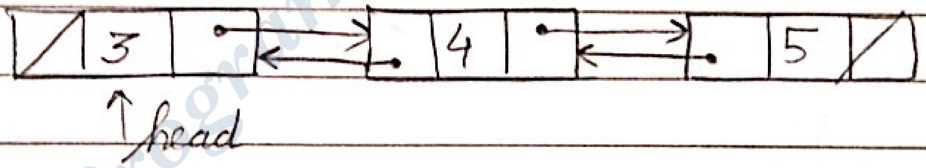


Blink : pointer to the previous node.
Flink : " " " next node
item : actual data.

- To represent node of a DLL:

```
struct list
 {
  struct list *blink;
  & int item;
  struct list *flink;
  };
```

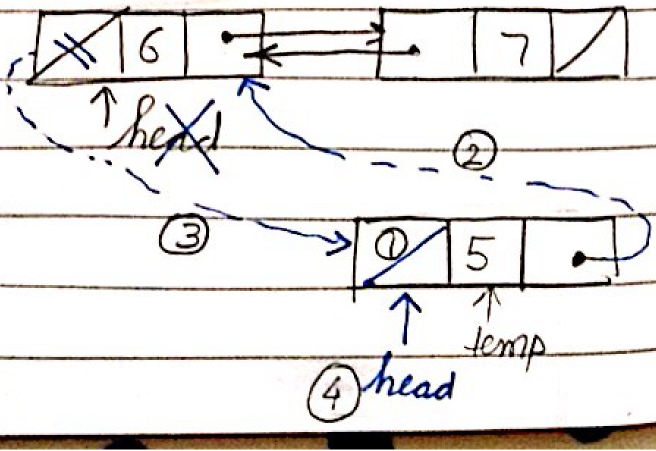
self referencing structure



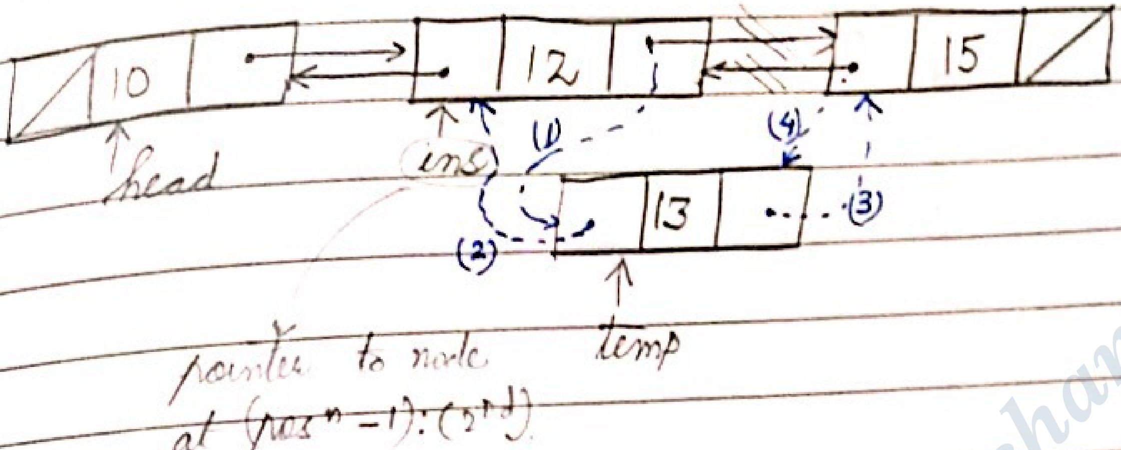
- Insertion :

1. At beginning of a DLL:

Before insertion

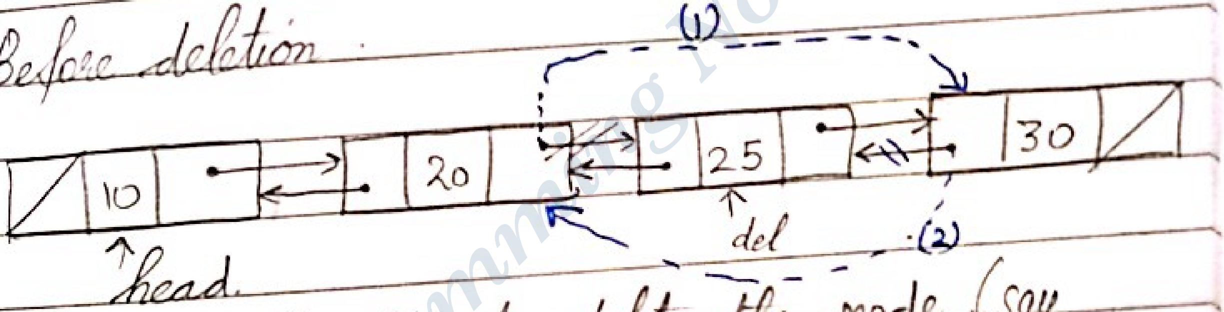


2. At any posn : (say 3rd position).



- Deletion

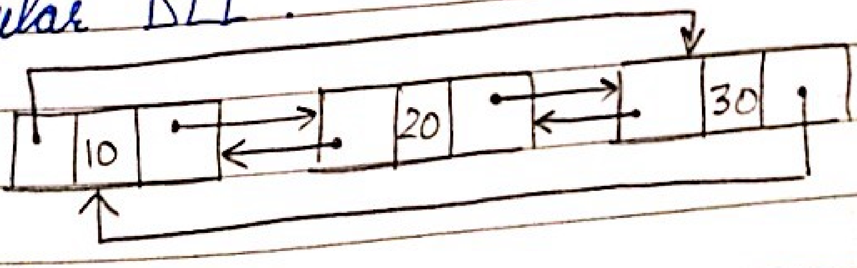
Before deletion :



Traverse the list to delete the node (say node 25)

Circular Linked List :

* Circular DLL.



* Circular SLL