# Anreays and Abstract Data Type

## · ADTs on Abstract Data Type:

Abstract data types are the ways of classifying data structur es by providing a minimal expected interface and some set of methods. It is very similar to when we make a blueprint before actually getting into doing some job

ADT -> Minimal required functionality + Operations. Poster state our

An armay ADT holds the collection of given elements (int, bit chan float etc) accessible by their index.

## 1. Minimal required functionality

LINEAR SCHOOL We have two basic functionalities of an annay, a get function to retrive the element at index i and a set function to assign an element to some index in the armay.

- · get (i) get element i
- · set (i, num) set element i to num

#### 2. Operations

to find a at-first we will go to indep a a when Some basic operations are in at a live and datan for live

- · Max ()
- · search (num)
- · Insert (i, num)
- · Append/(add)

· Min() - 2 3 4 - Index It can be dent in with sorter and

static armays: size can't be changed

Dynamic arrays: size can be changed

Annay: Armay is a collection of items of same data types stoned at contagious memory location.

Annay The about sea as a ter Onedimensional Twodimensional mutil dimensional annay linear annay annay annay annay

- · You can't resize an armay . · You can nesize an annay by coping all the elements of in a large arreay.

#### in sering ADT helds he delited for at given elements (into Operations in Arrivay

Linear searchs phoneitant bottopan leminita it Linear search is done by traversing array (going to every element) to find the fixed element and after finding the element traverise is stopped mor of management

Indp 0 1 2 3 4 5

2 7 9 8 10 13 of find 8

· To find 8 at-fins-1 we will go to inde a o when the element will not match we will go to index 1. Continuously we will go to every index. When we will go to index 3 and the element will match with 8 the treaversing will stop.

It can be done in both souted and unsonted arrays.

ie originalistic cont pechanged

named affects; size our be changed

Code (Linear Seanch): 10 to 100 to 10 # includers ldio hy int main () s int alistinitili, printl(" Number of elements: "); scant (4 /d & &n); Ind an placemine said grick preintf (" Sourching element:"); scant ("Y.d", &-U; for(1=0; izn; i++){ if (a[i] ==+)4 break. print ("Element &dwas found at index "/d", -1. return of the ewas let from the Input: Number of elements:8 Searching element: 9 Kurs apid han 23495678 Output: Friends hanizate Element 9 was found at Index 3. Binary Search: \* It can be done only in sonted armays. In binary searching the index [o] is taken as low and index[n-1] as high and then we find the midz (low thigh) After finding the mid we see that if the searching element is less than the mid then

(=+1; mai : o=i)not

Sound (and day day a little

Case: 1

bw= index[0] high= mid-1

If the seartching element is greater than the mid than [Cose: 2] high= index[n-1] low = mid +1 After doing these continuously we can find the desired elemen-1 Dennis Common Comments 2 3 4 5 6 6 9 11 19 18 1 1 1 1 18 mid low mid high mid = (low+high)/2 Searching element 14 As mid is 9 and it is less than the searching element desined element 14 so we will follow case 12 2 4 6 9 11 14 18 Case : 1 tow mid high mid
(mid-1) Number of Clemen LS 18 1 high E Harmonia Emiliano -81 65 6 B 8 2 desired element Element a was-found at tades 3 Code: CHOUNG SHOW #include Latdio.hi int main Of examin bother in place and and I the int a[15], i. n. element, low, mid, high: print (" Numbers of elements: "); Scant (" y. d", &n); scant ("1.d", &n); printf (" Searching element: "); scant (" 1 d", & element); sim sul mail est et mainso lows index[0] for(izo; izn; i++) scanf ("y.d", & a [i]); L-binn Englis

lowzo; withing everify element at one service were proved gratisty while (low c= high) { mid = (low + high)/2; if (a [mid ] = element) you eniming guitnoz not been at II print+ (" Index is : 1/d In", mid); gailaring and if (a[mid] & element) full (Nicola)-249bulaniw low z mid +1; 2/2 mines from id Letto In elsed highzmid-1: ilughuo (++i; of si toxi) not (Rigo States, +) Fuess 1574689 for izo: izio: i++) THEY HAVE OF IT return o: O and Input: in updating an element Number of elements: 8 relude 25 talia n> searching element: 9 20 mion 234 956 78 (tel. [ello 1 2 3 4 5 6 8 9 : Fugt 40 of (48 2 P 40) for Index 95 & 3 I E PESL (++1;0L1;0zi post How to find out the size of a given landay !! int a[] = {2,3,4,5,6,7,8,9} intsize z sizeof(a)/sizeof (int); (++1+01110=1 print+ (" 1.d", size); + (m.1.9 , o[i]); Output: 8

### Traversing

Visiting every element of an array once is known as travens the annay. place (low Z = higher)

It is used for sorting, printing and updating elements wide (low shipp) /2:

### For printing

#include 25-ldio. h) int main () f inta[15],i;

for (izo; iz 10; i++) scanf (u/d. & a[i]);

tor( izo; i210; i++) printf (" 1.d", a[i]); neturn 0:

### For updating an element:

#include 25tdio.n> int main () { int a [15], i,t; scanf ("1.d", &t);

fon(izo; iL10; i++)

scanf ("Y.d", & a [i]): svip a to size saft two boilt of woll ton(izo; a[5] zt;

printf ("1.d ", a[i]);

In put ! elemen : fug nT AT him & wol 1 5 7 4 6 8 9 10

grant ( Indeed a Mayor and):

Output:

15746891032

Number of Elements: 8

Mit-bimshain

Input: Frances grinomes 23495678 - 7

1 2 3 4 5 6 8 9 10 12

1234578910,12

nt d[] = {2,3,4,5,6,7,8,9}

tor(izo; izo; i++): (++); (++ i; ol size of (n+):

: (Dris , Py. n) ff-un

: fugto

```
Sonting
 sonting means armanging an annay in an orderly tastion.
 (ascending on descending)
# include (stalio h)
 int main (){
                                           fall world Melnad!
  int a[20], i, j,n, temp;
                                 Input: Knicklessbulgain
 scanf ("1.d", &n).
 ton(izo; icn; i++)
                              printed to those many stements you
  scanf ("/d", &a[i]);
                                           s(mb . bd+) knows
```

Input:

for(1=0; i 2n-1; i++)} for(jzo, jzn-i-1, j++)+ if (a[j] >a[j+1]) f temp = a []; O[j] = a[j+1];

a[j+1] = temp;

How many elements you want to sent 2345799 = [

Print+ (" 1. d = ", a [ 1]); and make the

2 3 4 15 5 7 8 9

() mion in 2 8 15 9 3 15

Output:

1 2 3 5 8 9 15 0 1 Scant (or do Latin).

Promes (+> Engen-the mack: 1): 2(4) 1/2 (4) (4 mag Emint for Enter the volue: ");

:(dx :64.4) +moss 120[2]

0[x]= by for (izo, izn; i++) ai sat the index } (++i; (+nsi; ++=i) no

nt temp = alij: afil et: -dust-st

(++1:1+1121:0=i)

mH(~1.d", a[1]).

```
An element can be insorted in an armay at a specific
   position.
                                 Carley to the red grant to
   Forward Method:
   #includesstdio.n> thugat
                                   - gratement to To to
    int main () s
                                      · (02 -64.0) pro
    inta[20], i, t, n, x, b;
                                       CHAIR CHOOKER
   printf (" How many elements you want to insert: "):
   scanf ("1.d", &n);
                                     MATERIAL CONTRACTOR
   ton(i=0;i(n;i++) = =
                                  ACT LICE - I TALL TO E () 9-
   scanf ("1.d", &a[i]);
                                     (OCT) SOCITO
   Print(" * Ententhe index! "):
                                          temp = a []]:
   scan-(u/du, 6%);
                                        IL- Dos Elo
   printf(" Enter the value: ");
                                         constantino
  scanf (47. d4, &b);
                               Input:
                            How many elements you want to ince
  tza[x];
   a[x]zb;
                            2 3 4 5 7 8 9
  for(iz x+1; icn+1; i++) {
                            Enter the index:3
  int temp = a[i];
                            Enter the Value: 15
      acij zt:
                            2 3 4 15 5 7 8 9
       tztemp;
ton (izo; izn+1; i++)
printf ("/, d", a[i]).
```

Insert-tion

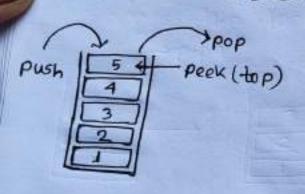
```
Backward Method:
      #include 25 Idio. h Zawa araihisag bailinga e he mamula na
      intermain () { 11 a grait-line got bout and at about tool blove
      prints (" How many elements:");
                                         their adjugent lett.
      scant ( " / d . & n);
     for(izo; icn;i++)
      scanflux du la [i];
                                           or included state in
      print+ (" Enter the index: ");
                                            Commer Ini
      scant("1.d", &n);
                                          in-1 a [30], pos. i,n;
                          Print! (* Number of elements: "):
     printf (" Enter the value: ");
     scant ("1.d", &t);
                                          scort ( " 2 a);
                                          (THI ANAL OCI) HOT
     a[n]zt:
                                        (Lila), 761. Valis);
    printy (* Deleting armog position (++i; n=ri; L-n=i) not
        a[i+]] = a[i];
                                         Scort ( . 7 7 , 8 bos);
                                         ton(i= posileni++)
   Printf 1" New value : ");
                                         a[i] zo[i+1]:
   ton (izo: i znu; i++) f
                                        G+imiliazi) ad
     print+ (" 1.d ", a [i]);
                                        printford " alist
   neturn 0:
                                                       : hugust
                                     Mumber of elements: 7
   Input:
  How many elements: 7
                                  Deleting among position: 3
                                  New Value : 2 3 4 1 2 5
 2345678
Enten the index:3
                                                 6 7 8 tug tuo
Enter the value: 12
                                       25 2 3 4 6
```

Deletion bertan bassage An element at a specified position can be deleted acreating a void that needs to be tigged by shifting all the elements HATELDONGERS +M their adjacent left. princed or How many elements: "): (11 g 2, P. J. o) places Code: #include/stdio. hi Start ( or de Da [ 170] int main () { privately (" trusten the index: ") inta[30], pos. i,n; printf ("Numbers of elements:"); printte Enten The value : Y) . I scanf ( % d , &n); 3(+2 CP4.4) tubos for(1=0,12n,1++) tala. scanf (u.l.d., &ali]); 1:42 Li 5 F-42! ) do prints ( Deleting array position: ")\_ scant ("1.d", & pas); OCITIL & OUTS ton(iz pos; izn; i++) in it is New value: 1) a[i] za[i+s]; top (izo; icn; i++) 1(++12021) (120) printf ("/d ", a[i]); (Lila . " P(x)++ wind Input: THE DE THE Number of elements: 7 2 3 4 5 6 78 8 Deleting army position: 3 Listuamala Ruom Output: 4 5 6 78 23 2 3 4 6 7 8 e the index:3

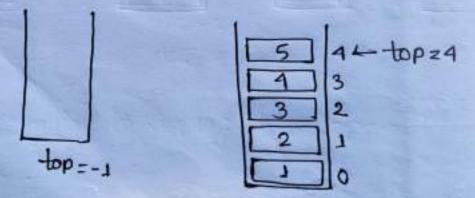
```
To detele all the odd numbers from an armay:
  # include 25-tdio.h?
   int main () }
   int a[15], i, j =0, n:
   scanf ( 1.d. 8n);
  for (izo; icn; i++) }
   ofi] = rand ()%70;
  prints ("/ d ", a[i]):
  printf (" In");
  for(i=0; izn; i++){
   if (ati]1.21=20){
   acij za [i]0;
      J++;
 tor(i=0',iL],++){
 printf("/d ", a[i]);
 meturin 0;
Input:
 43 46 37 5 43 45 66 2
Output!
46 66 2
```

Stack (Using Annay)

A stack is an abstract data structure sorving as a collection of elements that one insented anymemored according to the Last in First Out (LIFO) approach. It is a linear data structure. It pentorms some basic operations such as: push, pop, peek and traverse. Insention and deletion can happen on the same end of a stack. The top of the stack is neturned using the peek operation. It is a sequential data type unlike an array. In an array, we can access any of its elements using indexing, but we can only access the topmost element in a stack.



At stack, when the stack is full not full means when stack is empty its top is -1.



top is defined using index.

· There are two types of stack data structure: static 1. Static stock!

A static stack has a bounded capocity. It can contain a limited number of elements. If a stock is full and does not have any space remaining for another element to be pushed to it. it is then called to be in an overeflow state.

In a static stack is implemented using an annoy, as

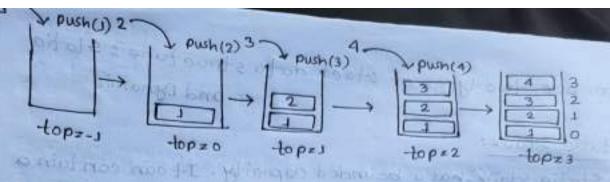
2. Ognamic Stock: tropped stanged sall-privation surted. A Dynamic stack is a stack data structure whose copacity increase on decreases in nuntime, based on the operations perdormed on it. In a adynamic stack is implemented using a Linked Listo as linked lists are dynamic data structures.

Stack operations:

- 1. push (): [scaler topics -> DSA Tutorial -> Stack in Data Struc
- · In stocks, it we try to add on insent elements it the stack is full, it nesults in a condition known as stack overflow

In pop operation first check whether the stock is full if -full print slack overflow else add data into the stack.

· The process of inserting new data in a stack is known as

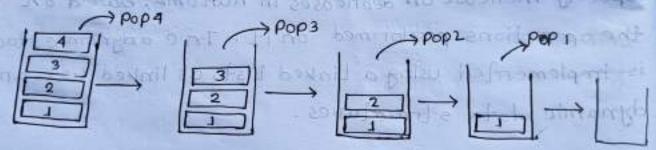


#### 2. Pop():

The process of deleting the topmost element from the stack is known as pop.

FL . 2 name of a Mapin

- · In stacks if we try to popon nemove element if the stack is empty, it results in a condition known as underthow.
- the stack is empty, if empty then print stack understow else access the topmost element.



Stack opens lions:

#### 3. Peek():

· We use the peck operation to display the topmost element of the stock.

#### 4. Is Empty ():

We use this operation to check whether the stock is emptyon to the stock is em

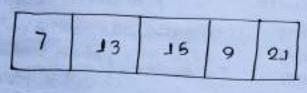
My Bolgeilo biose 5. (Isfull () 12gos = i fabriol . Hay Sand of this We use this operation to check whether the stack is full or not. Entitlement Entitlement will some the in Time complexity: Time complexity for stack operations is O(1). }(1) Water blow stack implementation using array 2 1 thing (1-1x==qof) +) #include Ls-Idio. h> #include Ls-talib. hi void peek Of i dools " Haing #define n 4 printf (" "d In", stack [top]);} int stack[n]; Case 31. Void size () { int topz-1; Deek Ca: print ( " /d In", top+ 1) ... void push () } (A) sound int croice: int value; CASC 4: (L) slide it (top==n-1) +1 print ( "PUS NIM"); printf (" stack overflowin"); mint (v2. Pep m): elso 1 205e 5 : TriAT (13. PEEKIND printf(" Enter the value:"); minelf (=4.5 ize ) Him scanf ("1.d", &value); rissiff (515 Emply In) top++; Case 6: rindf(~6.1s Fulling Stack [top] = value; y sin-H ( . 7. Displayin') void pop Of 10 Co golgails elistflongakeyour choice: ); ant ( upd ", & choice); if (top==-1) +i ton (enoise) f printf (" stack undereflow "n"); else C'altopasia fasat") Hainy :() 43 CARS

:0900

```
Void is Empty US
                                    Void display Of
     if (-top == -1)
                                    tom(intiztop; 1)-1; 1-05
     printf ("stock is emptyln");
                                     printf("/d y, stock[i])
     else
     printf ("Stack isn't empty In"):
                                     printf(* In");
     time ompleasing that compleasing for stock operation
    Void is Full () {
     if (top==n-1)
      Printf( stack is Full in ) and the many and water
                                           sindude Estation's
     else
                                           Windlade 25-la Block?
     printf ("stock is not Full In");
                                                deliver m4
    Print ( 1/2 4/41, 5 took Etob12
                                     Case 3: 120 Name 1-1
                     الماط عاء والما
                                       peek(); ==== qal- +a
    int main () from Live Hains
                                       break; (1) daug bies
     int choice;
                                     Case 4: taller fol
    while (1)}
                                      size(): ( m== 9af) Hi
    printf ("Pushin");
                                    prieak; a double williams
    print ( "2. Pop \n");
                                     case 5:
    printf ("3. Peek In"):
                                      Is Emply O; Ind Williams
    printf ("4. sizeln");
                                       break; ... LAND from
    printf ("5]s Emply In"),
                                                     1+400
                                     Case 6:
    printf (" 6. Is Full In");
                                       is Full (); N= [got-] Noot?
   printf ("7. Displayin");
                                        bneak:
                                     case 7:
   printf("Makeyour choice :");
                                        display(); breeak, on bior
  scanf("%d", & choice);
                                              1 (1===qof) +
                                     Case 8:
  switch (choice) {
                                 ( rapide 2it (1); Loute ") Him
 Case 1:
                                     default:
   push ():
                                     printf ("Insort right keyln"
   break;
Case 2:
    POPO;
    break,
```

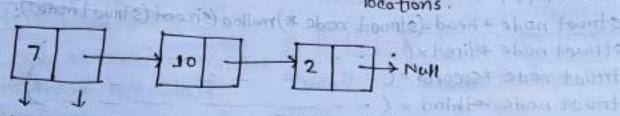
· A linked list is a linear data structure, in which the elements are not storred at contiguous memory locations. The elements in a linked list are linked using pointers. In simple wonds, a linked list consists of nodes where each node contains a data field and a neterience (address) to the next node in the list. The first node of a linked list is called the Head and it acts as an access point On the other hand. the last node is Tail and it marks the end of a linked list by pointing to a NULL value.

### Linked Lists Vs Annays:



- In array, elements are stoned in configuous memory locations.

- for any oboth - sour



Data element of a stop - bailly

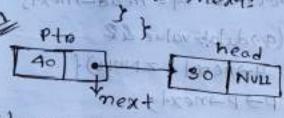
In linked lists elements one storted in the next non-configuous memory location

- Shield ou Ly · Advantage of linked list over annay!
- ferriffer and a bount . L -> Memory and capacity of an armay remain fixed while in linked lists we can keep adding and nemoving elements without any capacity constraint suled board a board

· Disadvantages of linked lists: Extra memory space for pointers is nequined (for Random acess is not allowed as elements one not sta in contagious memory location. Example: We cann't mandomly set the value of an element-such as: a[4]=30 it is not possible in linked list Basia at the last made is Tail and show the board of Basic Structure: salar July of Building Ratell Parail & to pus out · Struct Node of int data; congram A W etal boxel struct Node \*next; on I in survey a tement & Inc 100 main function: int main () f struct node \* head a struct node \*) malloc (size of (struct node)): struct node \*first= (. struct node \*second = ( = struct node thind = ( head - data = 12; 10 dinst - data = 24; of majorios head mext=first: first-next=second: Second -> next = -thind; thind -> data = 40 formals second -> data = 32; 1. head = Insertfirst (head 62). neva feil bevail to egotroub 2. head = insent alend (head, 62), to to blood on broman 3. head = insentation node (head, second, 62); at all box 1 4. head z insent between (head, 62, 2) ; 0900 pro tworld

- 1. head z deletefinst (head);
- 2. head z deletelast (head):
- 3. headedeleteatindes (head, 2);
- 4. head = dete-lebyvalue (head, 32);

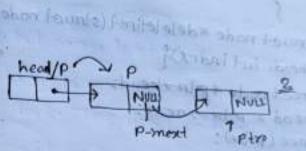
· Void travesal (strengt node + pin) ; while (ptolz NUL) printf (uyd Inu, pin-) data); Ptn = ptn >next:



· s-truetnode \* Insortfinst(struct mode thead, int data) f struct node \* plazmalloc(sizeof( )); Ptr ->data = data [ ptr is-the ptn-)next = head; head = ptp; neturn head: }

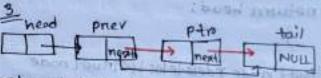
5-truct node \*insentational (struct node thead, int datas of struct node aptra = malloc struct node \*p z head; while (p->next ! = NULL) {

> P= p-mext;} Pin ->data = data; ptn-mext = NULLS p-)next=ptn; neturn head;



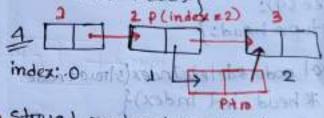
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the way who we we



· street node \* insertationnode ( struct node & head, struct node & priev, intolata)

Struct node \*ptr=malloc - pto->data zdata; == 9 = 9 ptn -> next z priev -> next; priev-) next = ptns netunn head; }



· struct node \* insertbetween ( struct node \* head, int data, int E(xobri

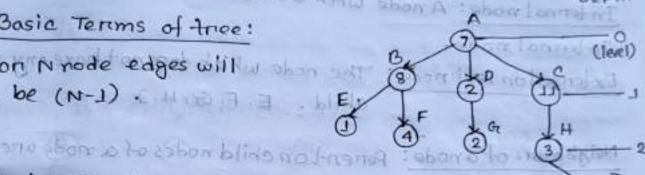
struct node \* ptr z malloc Struct node \*pzhead; forlint izo; il z indeg-1;

Pz p-mext; bush moutant

```
Ptn-)datazdata:
                                    MAGAN DERTINATION AND LINE
     ptn-)next=p-)next;
                                c - bread a deletelant (bread):
      P-Inextz pln:
                               (Chuan reabouted also about
      naturn head;
                              in the section of the second state
   -Struct node *deletefiret (struct node
   * head, intindex)
                                 ·struct node *dele-lebyvalue(
   Struct node *ptn = head;
                                   struct node * nead, int value);
    head = ptp-)next;
                                    struct node topzheod:
    free (ptp); bearing
    neturn heads
                                   struct node #g z head - ) noxt
                                  while (a->data = value &&
  Struct node *deletelast (struct node
                                        9-next! z NULL) {
       shows flower & head) & towns
                                       p → p → nex+;
   struct node * P = head; how how !
                                   9 z 9 ->next;
   Struct hode * 49 z head -> next;
                                         That her board
   while (9-mext)= NULL) &
                                   if (9 -> data = z value) 5
      Pzp-)next; lab = alab (- a) q
      9=9->next; 4 = 12=0 = 019
                                     P-next = q-)next;
   P-next z Null
                                      fnee (9);
                Though Amelon
  -free (9);
  neturn head; }
                                              TERUNA MENGER
                                    rietunn head.
struct node *deleteIndex(struct node
                                       house sinced in declarate
    * head, int index) {
                                     To pollon = a los about to un
 Struct node *p = head;
 struct node *97 head -mext;
                                           hugh mode app a hugads
for (intizo; icindex-1; i++)f
                                       (July & ! facone q) sline
    P=p-)next; q=q-)next;}
                                          1. to sace 0 =0
P-)nextz q-)next;
                                          Plu-Smext=Molly
free (9):
                                              (-) rext = p+m;
neturn head;
                                           re-luster head;
```

What is thee 2 hallon and shore fort-of- front and to whole = A-tree is a non-linear data structure because it does not stone in a sequential mammen. It is a hierarchical structure and a collection of nodes that are connected by edges and has a hierarchical nelationship between the nodes no enoteus to Atiw about a sport and

Basic Terms of tree: ton N node edges will be (N-1) . HE BE



Root: The topmost node of a tree is called noo. It doesn't have any parient node. Here node A is the most node.

child node: A node which has an edge pointing to it trom some other node. His the child of a and I is the child of 14

Parrent Node: A node which on edge pointing to some other node. C is the parent of H. . . . . . . .

Siblings: Nodes belonging to the same partents are called siblings to each other. Node B. C. Dane sibling of each other and they have same parent A.

northode.

Ancestore of a node: Any predecessor nodes on the Path of the most to that node are called Ancestors of that Node: Arc, Hone ancestons of node I.

Descendant: Any successor node on the path of the leaf node to that node. Hand I are descendants of eages and nos a blenomenical nelationshi

Internal node: A node with at leastone childiscalled Costa Terrors of Ince: Internal node.

External on leaf node: The node which does not have any Child . E. F. G. H. J. (1-17) 30

Neighbourr of a node: Poment on child nodes of a node one called neighbours of that node.

Subtree: Any node of the along with its descendant.

Depth: Depth of a node is the number of adjest from root to that node. The depth of node A.C. Hand I one 0,1,2,3 mespectively.

Height: Height of a node is the number of edges from that node to the leaf node. Height of node cisz, and A is 3. smos of of grignolog sobola segmildie

Height of a trice: Number of edges from noot to the leaf no

Degree of a node: The total count of subtness attached to that node.

The degree of moot node is 3 because it has at most 3 Children addition the med when

Degree of Tree: degree 2000 1 node as no of children. degree of tree means maximum degree of a node.

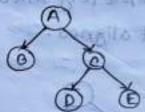
level of node: The count of edges on the path from the most node to that node.

Ginary Tree good elect the took and growing statement It is a type of thee where each node should have at most two children. (0,1,2)









SMANUS KIND ONE

Maximum no of node for heighth: (2h+1-1) = n -> node

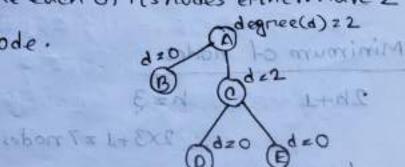
Minimum no of node for heighth!

h+1 -> n (node)

Full binary tree: (Extended binary tree)

It is a type of tree where each of its nodes either have 2

children on is a least node.



It is a type of thee when each node have exactly 2 nodesilias mening in ansister south - alacm o to son (B) about fort of short from Complete binary tree: A complete birary tree has all its levels completely filled except the last level. And if the last level is not completely-filled then the last levels keys must be lett aligned. (show) in ( + + in Binary Maximum node of a full binary tree s 2 bt addition sometite who small sout to sail a olderen on is a least node. Minimum of nodes 2h+1 2×3+1 =7 nodes

Complete Binary tree (maximum nodes): 2h+1 -1 (minimum nodes) : 2h Binary thee treavels Preorider (Root, Lett, right) postonder (lett, night, noot) Inorder (Lett. Root, night) preorder: but ashiround moultonif granid transferro the de hoor 12 9 4 of the seed of the monden: CBDAFE G. ( Lett. 8) FREORGED TIME ROOT THUST ESPERA Tronder tare most as Left of Postonden: Postonder: 4:12:10:18:24.9 Inguider : 4 do 12 , 15 . 18 . 2 2 Past andere (L, R, Root): SE Las Trionder tage Latt and right as and

Construet binary tree-trom preorder and inorder Preorder: ARABEFG (Root, Left, Right)

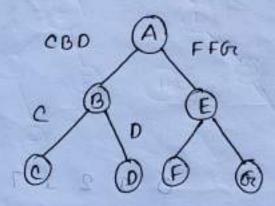
Inorder: CBDAFEG (Left, Root, Right)

Preorder Com Root Fam [2000 (2000)

Inorder Com noot of Left and right the right

(Freing Lood - Fts \_

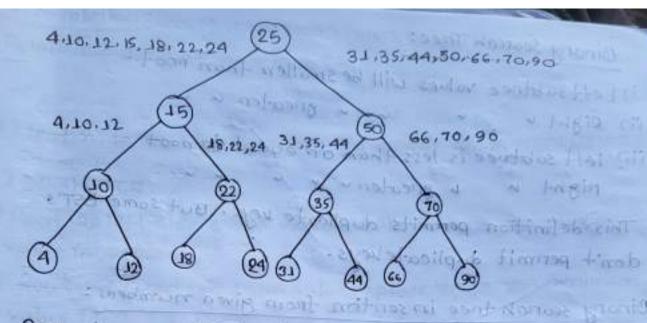
West To



.5

Postonden: 4,12,10,18,24,22,18,31,44.35,66,90,70,501
Inonden: 4,10,12,15,18,22,24,25,31,35,44,50,66,70,90
Postonden(L, R, Root): 47 Last = 2100 Root counting

Inorder take Left and right the age of



### Preorder and Postonder Text 10 181 at algueral

- i) Preorder term left side tog magar
  - > Lett side ag element gran post order cerca onas
  - ii) postorden हथात्क might side खन्न कत्रावा
    - =) right side ar element gent priconden war enter

POST: KGLMHDBECA (L. R. ROOT)

Prie az First and Post as last same ega stroot Prie cerco Left B post cerco

LES BOCKHIM GOS SEQUENTED 310

Post: KGINHOB B Q' left e lement.

PILE: DEIXHEM WAS PILE CARROCE TOBE

POST: KGLMHD Right AS element

pre: GK

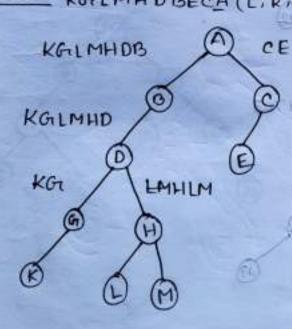
Post : K G

Prie: HLM

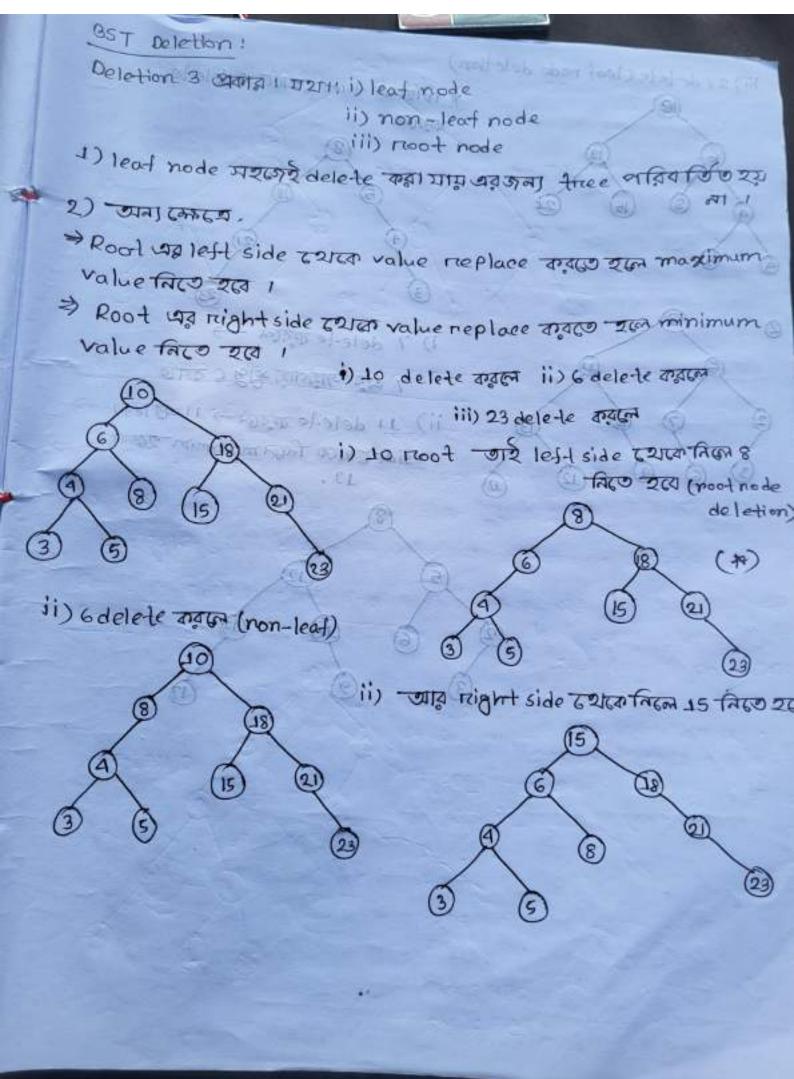
Post: LMH

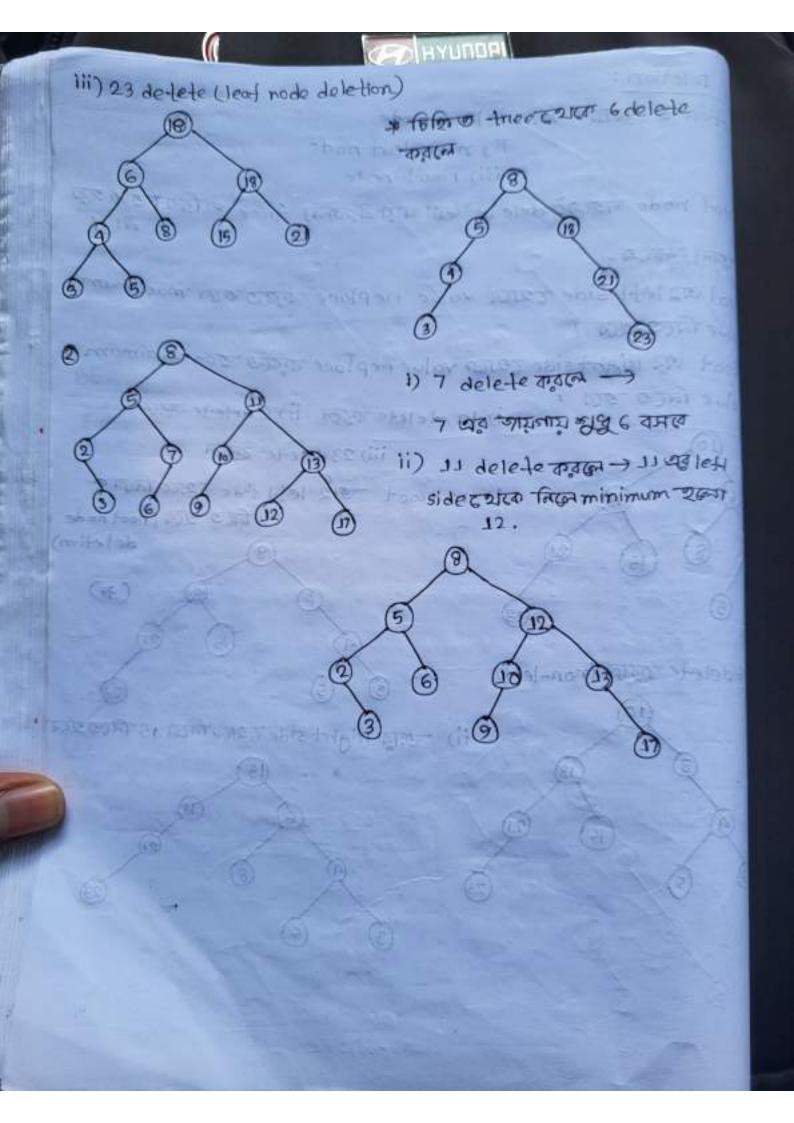
prie: OE

post: EC



#### Binary Search Tree! 1) Lett subtree values will be smallen than noot. u a grieaten u ii) Right o u iii) left subtree is less than on equal to noot night a a greater u u v This definition permits duplicate keys. But some BST's don't permit duplicate keys. Binary search tree in seriton from given numbers: 10, 18, 6, 4, 21, 8, 15, 22, 3, 1, 5 Example: + Left to night THE HALL COURT PROPERTY to the first state of the post of bis lorden caren rikan side 18) briparis. KONTHIORECH (L. COST (5) 1 4 TET 0119 39 WATER STREET, NO. KUTUMDB. (-nomala telet all all all Ex2: 8,52,7,6,11,13, 10, 9, 12, 17,3 DONN (8) STEPPE TENED E E TENE might Ty elemen Da : Heeg





#### Hulfman's coding

Hallman coding is a compression technique. It is used to neduce the size of data on message

Example: Message ! BOCABBODAECO BBAEDDOC

> Length: 20 -> Message will be send AscII codes instead of characters.

ASCII codes -> 8 by bits and cell

: Total Number of bits -> 20x8 = 160 bits.

#### Fix size of code:

Character	Count	Frequency	Code
A .	DBAE DDG	55 TA 3/20 A 5	The m 000 p
Stide Racoco and	N. Sobric	2115/5/2010AS	Thene LPO 2
- Cooks	xac6 s of per	6/203	The oto
parte the factor	4	7000000	. 011
none in	2 0 3	2/20	100
in each char	20	ond semme	The chart

#### Table:1

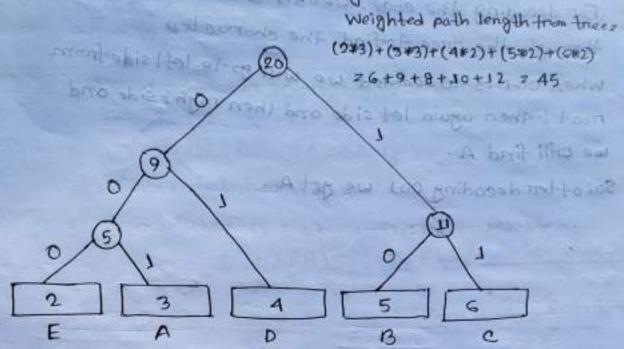
There are 5 chan. And They are used in the message as their count times (A15 used 3 times). Now we need to write code (Binary). If there were 4 charac. (22 = 4) codes will be: 00, 01, 10, 11. When there alive 5 char. (23 28) . We will use three bits code.

According to the Table !! There are 20 characters and each take 3 bits (code) = 20x3 = 60 bits = Size of the STIPLET dimessage allidor (2xx)

5 x8 = 40 bit 5 x3 = 15 bit size of characters codes (Th codes (There are 5 dodes and they are each 3 bit) .. Table on chant of codes = 40+15 DE DOS AND SE BONE DE LE BOUTE DE LE BOUTE Mesage = 60 bib Table 2 55 bits of solvering to head zone 115 bits dista 3 = 29hos [198A effect out = exces = - alie to made und teffet for Variable size code: Labor to aris mil Haffman encoding: Caretan et ler The mess: BCCABBODAECC BBAEDDOC There are 20 characters and each charactupy 8 bits-.. The total size of the string is 2 20x8 2 160 bits. Huffman coding first creates a trace using the traquencies of the chare and generates code for each chan. 1. First calculate the frequency of each char-of string. 2. Sort the characters according to the trequencies. character | count | code | Size (10) show stinus 2 9 A STISH - 03 W . 001 - 0 (3x3) 29 Him 2 9600 3 (5x2) 2 10 JJ - (6x2) =12 (C) - 10/0 bro end Darrand 224 290 s OIT - (AXZ) 28 No of grillon as A ON - E 2 2 000 -> (2x3) 26 each take 3 (5x8) 240 bils 20 bits 12 bits 45 bits

P HYUDON

3. take-two minimum trequency nodes and adda new internal node with the sum of the frequency



Take two smallest frequencies and add them to make an internal node. 2+325 here left frequencies one 5, 4,5,6. we take 5+4=9. Then left 9.5.6, two smallest are 5+6=11. Then add 11+9220. Use a for left side edges and I for right side edges. And then find the code of freq the characters.

Now the encoded message is:

DDAECCBBAEDDCC BCCABB Now count the total size after encoding:

Size = (40 +120+45) =9705 bits · : compression nation .

Now decadinger white breezeborr parisuport mumicine or For decoding the code, we can take the code and travers through the tree to-find, the characters when our is to decoded we will go to left side from 1700t, then again les side and then right side and we will find A. So, afteredecoding oos we get A To be - two - smallest - trequencies and add them to make est interinal mode. First s here left frequencies one si fire Contact one state of the most of states maller to a state of There add 1170720. Use of form left side adges and 1 for right side edges. And then tind the edge of freque CHOPEOCHETS -Now the encoded message is: SCCACCACA BAE COCAE O CCC LLLL Loro protect at LL 81 ook too to he of or or too tell of count the total size often encoding Size = (40 490+45) = 9705 bits

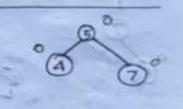
#### AVL Tree

AVI Tree is a height balanced binory searan-tree (Adelson - Velsky - Landis)

Balance-factor = height of lest subtrice - height of right

There are 4 notations: i) LL? single iv) RL )



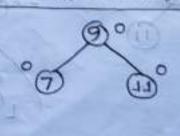


As the balancetacton in 7 is 2. so it is imbalanced. And It is imbalanced for Lett-Lett on LL type. So its notation will be LL notation. ( )

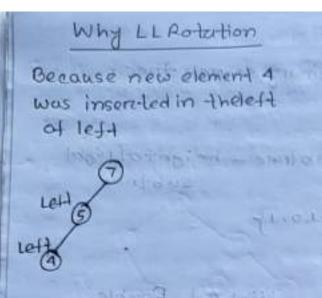
RR reotation

Insent 11

RR rectation

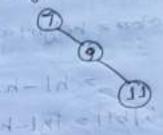


After inserting 11 the balance factor of 7 becomes (-2) that is imbalance for night to night because highet in night side is too large. so we need RR notation.



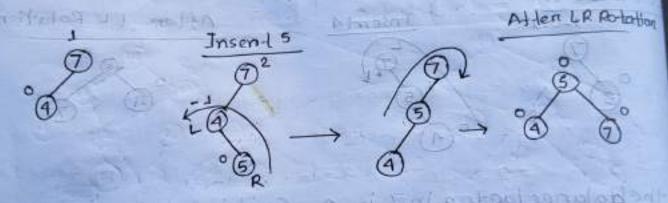
Why RR Rotation

New element 11 was insented in the night of night

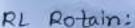


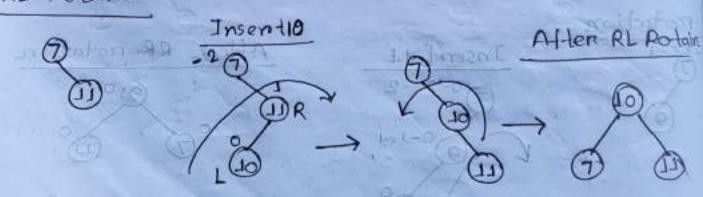
LR Rotation:

when insention will happen in (Laft 97 Right)



LR Rotain (First anticlockwise notation then clockwise motation)



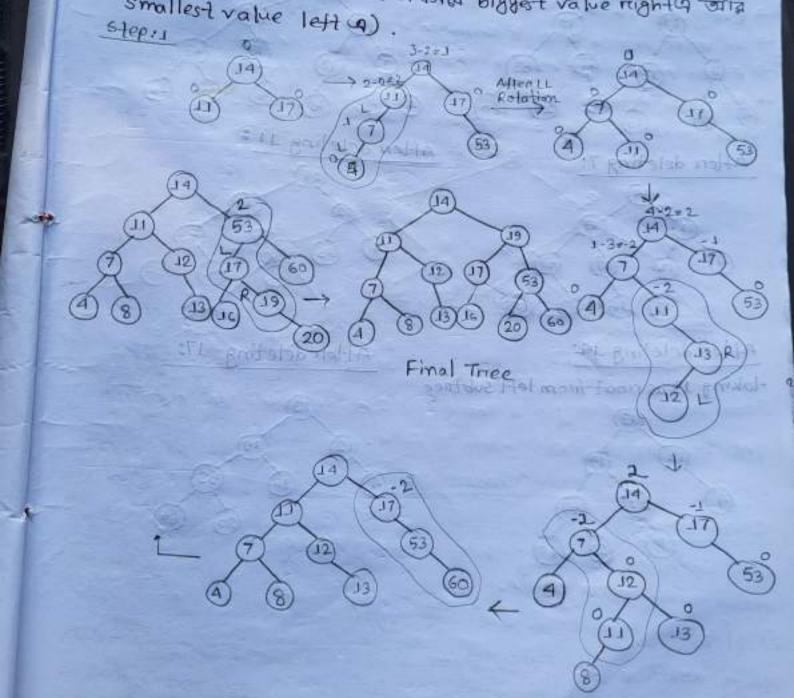


RL Rotation (First clockwise then anticlockwise).

abie tokin in tokeid removed their of light in not some

AVL Insertion 14,17,11,7,53,4,13,12,8,60,19,16,20

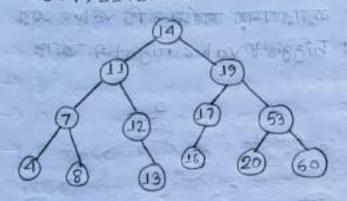
After inserting each node check the balance tocton it thetree is not balanced then rotate it according to its imbalance (Tips: imbalance थाकल balance क्वाइसमय सर्पा ३ कि value up मद्भा median value most u काल biggest value nightu आह smallest value left (a)



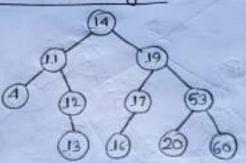
# AVL Deletion

· Its deletion is alive BST deletion but often deleting one have to check the balance factor and if the tree is imba then we have to balance it 14, 17 -> delete these de la sont basantion

After deleting 8:

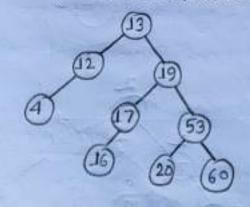


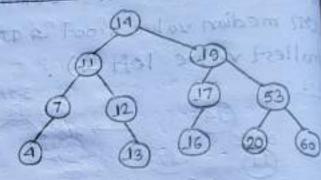
After deleting 7:



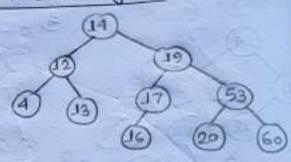
After deleting 14:

taking 13 as most from left subtree

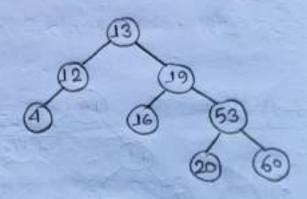




After deleting 11:



After deleting

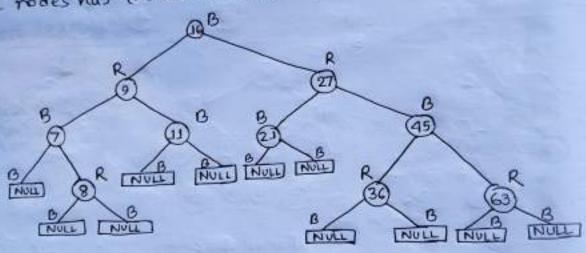


Threaded Binary Tree A threaded binary thee is a type of binary tree datastanc. where the empty left and night child pointers in a binary tree orieneplaced with threads that linu nodes directly to their in order predecessor on in order successor. - Anold examin at front t - Evell read margin is want is stock " It nede is ned been its abildoen wire sweek A red node com't have a red parented ned abild. at motion as a serie ( triched on a series of a formation of the descent of the NULL rodes has fine some mumber of block mades. From root to every null thene one I bluex nodes which justify the last good filen moletal to path. med meant Conditions! marice steer women stooms made property contract the mode with rolling of a representation of its family and the first made of the first

# Red Black Tree bake mid

Red Black-tree is a self Halancing binary sounch tree in which even node is coloned with either ned on block. It is a self-balancing

- -> Every node is either ned on black.
- -> Root is always black.
- -> Every leaf which is NULL is Black
- -) If node is ned-then its children one black.
- -> A ned node con't have a ned parent of ned child.
- -> Every path from a node (including root) to any of its descendant NULL rodes has the same number of black nodes.



From root to every null there are 2 black nodes which justify the last condition related to path

## Insertion

## Conditions:

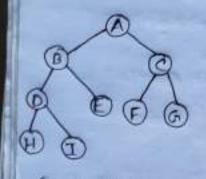
- 1) If therenee isempty then create a new node as most node with color black.
- 2) It there is not empty create new node as leaf node with color red.

НУППОВІ

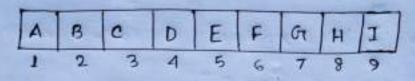
- 3) It parient of new node is black then exit.
- 4) It parient of new mode is ned then check the colon of new modes uncle.
- If uncle is black or null then dosuitable notation and recoon [ It notation LL and RR. then Grand Parent and Parent node will be recolored. it notation is RL or LR then Grand Parent and child node is recolored ]
- =2 It uncle is ned then necolon and also sheek it that if grandparent of new node is not noot then necolon it and necheck.
- # 10.18.7, 15.16.30, 25,40,60,2,1,70

# Annay Representation of Binary Trae (sequential Representation

- If node is at ith index: In this case zero index is skipped to left child at = (2\*i) index start from index 1. right child at 2 [(2\*i)+1] index parentat = | i/2 | index



omnay representation for this tree:



(left to right representation)

- · for iz5th index parent is at Li/2] = [5/2] = 2nd index
  - · Parent of Eis B .

# note how & took at the without Infig, prefix, post-lix

Operator	Priecedence	Associativity
\$ on 1 on 1	highest	Right to left
*,/	Next highest	Left to night
+ 12-	lowest	Lett to night

#### \* 8+ \* 90) + ( \* MOHO Infix

#### LOPERand > Loperta for > Lopertand>

- A+B
- · 2\*3+9/3-5
- = 6 +9/3 5
  - -6+3-5
  - = 9-5

## postfix

# Loperand > Loperand > Loperator) A FLER FRED -

- · A\*B+C/D
  - = AB \* +C/D
  - Z AB \* + CD/ in the source A A TO 65 THE SAME SAME STATE OF SAME
    - = AG \* CD/+ 12 Det / FED \* AFTITU & MPS STORE STEE CIE NE WHIE WHE WAS THE FOR COME FO

# Profix

Loperta-ton / Lopertand / Lopertand

CABER+DE/Hs.

SEN FOR

554 -6

- · A+B +C/D
- 2 \* AB + C/D AB + A
  - = \* AB +/CD

· Priendence summe teresonant and

क्षेत्र कार्य कार्य कार्य कार्य कार्य कार्य कार्य कार्य कार्य

. Postlick यह जाता हाड़ apenous के बाह्य आर्ट हो कार्या अर्थ होता अर्थ है के कार्या के कार्या के

+ \* AG/CD

# Infine to posttix (without stock)

- · a+b\*c+(d\* e+f) +8
- = 0+6\*C+(d0\*+f)\*8
  - = a + b \* c + (de \*f+) = 8
  - = a+bc \* + (de \*f+) \* 8
  - = a+(bc\*)+ (de\*++9\*)
  - = (a bc\*+)+ (de\*++g\*)
  - = (abc\*+de\*++8\*+

- · A+B\*0-0/E\*H
- = A+(BC\*)- D/E\*H
- = A + (BC\*) (DE/) \*H
- = A+(BC\*)-(DE/H\*)
- = (ABC \* +) (DE/H\*)
- \* (ABC \* + DE/H \* -
- · Breacket आकल अथका Breacket এव काउँ कावल रख
- ' Priecedence অনুসারে চিহ্নের বাবহার করতে হবে মার priecedence বাদ তার বাজ বেশি তার কান্ত আলে করতে হবে এবং মার priecedence বাদ তার বাজ
- धकर्र priedence धव किस्त्रव क्षादा Associativity tollow का ए यह।

  यथि धकरि equ () धकायिक \* धवर्। किस्त्र थाकल वामलाल स्थादा का अ
  भूतु कहरण राव यात्र किस्त्र खाला स्थापत सामला है।
- · Postfix एव जमा मूर्ति operand प्रव माला व्यविष्ठ operation का किसी
- ab\* c+de/- प्रकास भूत्र'+'operation पर काउर वालि । जारे पर उत्त

3 वह्मलालाइ अविवृह्दक openand चिट्नाव थाइ (१४+५ -> ४४+) प्रदे ग्राकादि लकान कडल इस्ट । [ab\*cde/-+

# Infix to proting (without stock)

- · pre-fix বস্তার ক্রেতে operator কে প্রথমে আনতে হরে। THE GET A PER [2+4-+24] and sa sa (1+0) and +1+
- · (A\*B)/D+C\*F

(A+B)\*(0-D) =(+AB)\*(0-D)

\* + AB-CD (Q\(BKA)) · यकि जनाधिक Bracket शास्त्र करव Left (2) con Greacket up ons 2) 2 \* + /\* ABD\*CF | AMCO 2(8 /

# postfix to Infix (Without stack)

- · Left to night scan ago on hoteling was and had a · পরপর দুটি operand এরপর operator থাকলে তারে operand प्रदेश माला काता देख । मेंद्रतीय व्यक्तिक Oberrand तथे क्षे operator थाकल डाएमदा operator क प्रवाद्य निकरेवण operand विविगाल वमारण रहा (abcd \* -> ab(c\*d))
- ABQ \* + DE/H \*-
- = A (B\*c) + DE/H\*-
- = A+ (B\*c) DE/H\*-
- = A+ (B\*C)(D/E) H\*-
- = A+(B\*C)((D/E)\*H)-
- = A+ (B\*C) ((D)E)\*H) =
- · women operation as priecedence प्रव गुवराव रख मा । १०१८

- WEBS

#### pnetix-to intix

- Right to 1ett a care zer 1
- आह वाकि डाव postting to intix पह मद्यार्ट
- + /\* ABO \*CF

# Infix to Postfix (using stack)

#### Procedure:

- i) Two operators of the same priority cannot stay together a stack. (previous operation will pop)
- ii) Highest priority operation will not stay in the stack when lowest priority operation will be inserted. (Highest priority operators will pop)
- iii) (+, \*) -> when inside parrenthesis pop all the two operation of the stack and place them in the postfix

A ( B= C) + DE AH

CADEST COAN &

A+ (Bre)- ((ONE)+

. A+	(B*C	- (D/	EAF	*6)	Selet
	The second secon	Control of the Control of the Control		71.41.7	IS PERSONAL PROPERTY.

and areal upole	and the state of t	(-) (-)
Symbol	Stock	Postfix I
Here of search	IND SHOW OF THE	A 60 + will pepin
,	+	Postlix.
B	+(	A
*	+(	HEDDI ABI-D-DADAGA
c	+(*	ALL THE REAL PROPERTY OF THE PERSON OF THE P
	+(-	a just a mode
- 1	1+(-(	7004
D	+(-(	ABC*
1	- N. W. W. W.	AGCAD
E	+(-(/	ABOND
1	+(-(1	ABC*DE
F	+(-(/^	ABC *DE
,	+(-(/n	ABC*DEF
,	+(-(/^)	
*		ABC * DEF 1/
UT	+(-*	+ABC*DEF //
7 01/13	+(-*	ABC*DEF 1/60
91139	+ (-*)	
TEN DO -		ABC*DEF // Gr.*-
11		ABC*DFF N/G*
E MOC	1.3.8.1	ABC*DEFT/G*-H
DPQ//37	+1013	
* 800M3	TA ANN	ABC *DEF // G. * - H*+
EVIDOES A	THE PARTY OF THE P	36-+ D

116-FENOGO\*AF-

Pre-fig: +- # A+ 0 00// 1F + 64

# Infix to prietix (using stack)

- 1) Highest prilority operator will notstay in the stack when law prilority operator is inserted
- ii) (+, \*) pop all the operation of the stack and place them in the prietix.
  - · A \* 0 ^ C D+E/F/(G+H)
- Reverse: (H+G)/F/E + D-C + B \*A

The second	200 Stack	# Priofix	
Symbol	4-00A (	-)#	
(	+SEC+	)=)(H	
Н	AGOLD IL	H	
+ Gi	danaa(+	- HGt	1
)	30 x 0 8 A (+)	\)-HG+	
1	10 × 00 A	HG+	
F		HG+F	40
To partie	II ABG X DEF	HGt+F	
E	WESG # DEFEAT	HG1+FE	*
+	+40000000	HGZ+FE//	
D	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	HG+FE/10	
20	-+0/19/00 10	HGT+ FE110	-
	## # - A	HGC+FE/IDC	
^	+-^	HGC+FE/IDC	H
	ABONDEE/	HGI+FE//DEB	
****	ラングラヨロボング	HG+FE//DCB ^	
A	+-*	HG+FE/1003^	A
		HG+FEIIDCB P	+-*

... pre-fig: +- \* AnBCD//EF + 67H

· Left to reight scan.

ally mane died at drain ein · operand Mem on stack and push are only operator (PITE) जा Top two element अक्र माला वर्षिया calculation कला द्या value भाउमा चात जा stack a push रात ।

symbol	· 623+-382/+ *21	3+
6	E [6]	
2	[6 [2]]	
3	Sec. 623	6
+		
	6 5 2+3 = 5	
3	1 6-5-1	-
8	C=0-8 113 1	2
	138	
2	1 3 8 2	9
/	1 3 4 9/2 24	
+	[ 1   7   3+4z7	#
*	DESCRIPTION OF STREET	2
	7 1*727	+
2	7.12	
^	49 7^2 = 49	=
3	[49]3	
+		
	52 49+3 = 52	

# Evaluation to Priefix Expression

- · Right to left scan 20
- · -+ 2 \*9 1 2 -8/+34 21 04 15 6 Julie 18 Fulls brown is

ii

\*

2

Sambol	matrolyolog is that istack I wante
1	The The state of
	V CAE - + ECA .
3	11219
*	12 43
,	1 2 2 4×3 = 2
1	116 12/2 26
8	[1]6[8]
	1 2 8-622
2	
^	122
	[] [] 2124

[49]3]

52 49+3 = 50

Smaph: A graph is an abstract data-type-thot consists of a set of objects that are connected to each other via links. These objects are called vertices and the links are called edges. A graph is represented as = G= {v, E} G=Graph space, v=set of ventices, E=set of Edges. If E is empty-the graph is known as Forcest.

Ventex: Each node of a graph is represented as a vontex.

Edge: Edge represents a path on line between two verities.

Adjacency: Two nodes are adjacent if they are connected to each other through ventices.

Edge from node A to node B [A is the initial node and B is the terminal node].

Path: Path can be defined as the sequence of nodes that one followed inorder to reach some terminal node v-from the initial node V.

Directed and Undirected Graph: A directed graph (digraph)
15 a graph in which the edges have a direction.

Undinected grouph have edges that do not have a direction.

Closed path: A path will be called closed path if the initial node is some as terminal node.

1

Graph Representation:

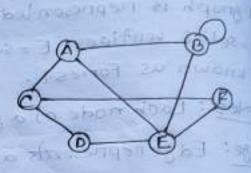
1. Adjacency matrixs

# Undirected Graph

- i) no of vertices cas argo 20 1
- ii) square matrix represent out
- iii) adj[i, J] =1 (100p / i, j odjocent 27)
- iv) adj[i,j]zo (i,j adjagenta DA)

Adjacency matrix representation:

A	B	C	D	E	F
0	- 1	1	0		0
1	١	0	0	1	0
1	0	0	1	0	3
0	0	1	0	1	0
100	1 10	0	3	0	Tr.
0	0	Jain	0	1	0
	0 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1 0 0 1 0 0 1 1 0	7 1 0 7 0 0 1 0 1 0 0 7 1 1 0 0	7 7 0 0 0 0 0 0 0 1 1 0 0 1 0 1 1 0 0 1



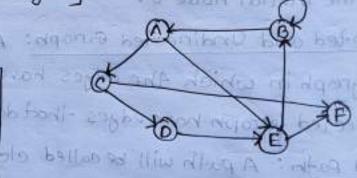
Joseph Thur Wodes of

a short of A short mett wi

יום פתפאה שלאחות אלאחום

Directed Giraph: [Rules are same but now observe the direction of edges]

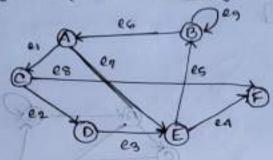
1949	A	B	c	D	E	F	6
A	10	0	3	0	1	0	
B	volis	0)	0	0	0	0	14
C	10	0	0	J ,	0.	01	2
D	0	0	0	0	1	0	1
E	0	.1	0	0	0	1	l
FL	. 0	0	0	0	0	0	



is some as farming trade

thoph peppesembelian:

- ii) Incidence Matrix:
- 1. No of vertices and edges can react ac
- 2. adj[i,j]=1 (i j outgoing)
- 3. adj. [i,j] = 0 (no connection)
- 4. adj [1, j] z 1 (i + j incoming)



tidg and extendit

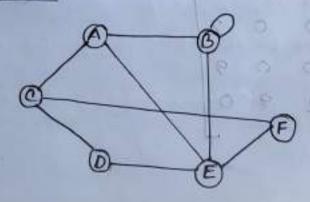
a FRED (VI

(3)	es	02	23	24	25	e6	07	e8 -	199	
A	[ O1	0	0	0	0	د-	1	0	0	1
В	0	0	0	0	-1	1	0	0 7	1	1
0	-7	J	0	0	0	c	0	1	0	
D	0	-7	1	0	٥	c	0	0	0	
E	0	0	-1	7	1	0	7+3	10	0	
L	000	0	0	7	0	0	0	0000	0	4

# iii) Adjacency List: a L- Lbiro insented appears and and leas sin

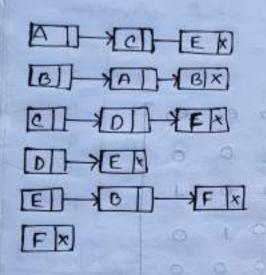
- i) Find the nodes
- ii) List down the adjacent nodes to each nodes.

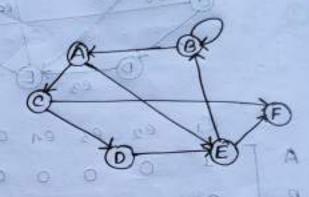
## Undinected graph!





Directed Greaph!

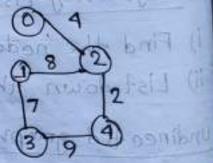




- in cost adjacency matriz:
- 1) Aij = cost-for an edge between i and j, O otherwise.
- 2) If the cost can be 0:

Aij = cost for an edge between i and 1 - 1, other wise.

	0	1	2	3	4	-
0	10	0	4	10	0	1
1	0	0	8	7	0	I
2	4	8	0	0	2	
3	0	7	0	0	9	F
4	0	0	2	9	0	
				35	-	



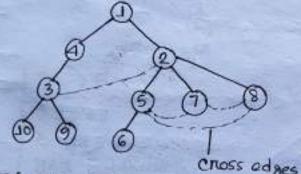
#### BFS (Breadth Firist Search)

- i) Queue alago an
- ii) तार venten निक्त काड़) कहता जान adjocent ventices queue हर insent again
- iii) Visited ventices aga aco insent ecoan i (queue co)
- My Insented vertices repeat 2017 / insent 2017

Queue: 8 8 2 8 8 8 7 16 8

Results: 1, 4, 2, 3, 5, 8, 7, 10, 9, 6

BFS spanning tree: Strating from 1



If stant from 5: 270 at ages to new orthically server

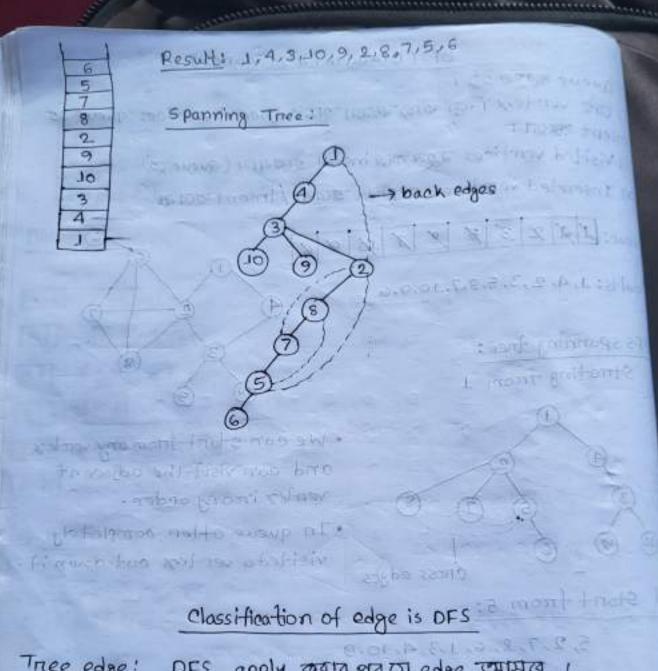
5, 2, 7, 8, 6, 1,3,4,10.9

# 6

- · We can stant from any vertex and can visit-the adjacent ventex in any orden.
- · In queue often completely visited a ventex cut down it.

# THEE EDGE OF UPPLY STEAMED STATE DFS (Deptan first search)

- i) Stack use aca ,
- ii) अथात्म ध्वादि node रथाता ब्रुव कृत्र एरवं। यदि जाव वका शिक adjacent vertex थाता जल त्य त्यातान प्रकृष्टि नित्र एत प्रयः जाइ adjacent দেখতে হবে এতাথে লোম প্রাক্তি পৌছালে আবার আহোর node এ ফে, তত জ্ঞাসতে হবে এবং ঘেসব adjacent nodes visit করা হয় নি তাএক হ টিপাত্য visi-l করতে হবে ।



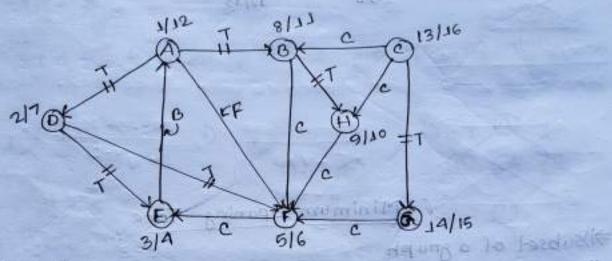
DES apply कड़ाव अड़ हा edge जामल । Triee edge:

Back edge! E(x,y)[x node to y node] war starting time year aca (2 node as time care aca) as y to a path , भागत but path जाकणाई trice edge a थाकत

Forward ege: E(xy) when soy) x (sog x to y path থাক্তব '

Cross edge: E(x,y) com path more of cross edge.

Time: First node a stant time । হবে পরবর্তীতে । করে
বাহুবে এবং যে কোন node যাদি আরু অন্য কোনো node
এ না যেতে পায়ে তারে তার end-time নিপাতে হবে ।
end time হয়ে আরু stant time এর সাহেয় । মোন করে



B = x = 8

F = y = 5

YLX but there is no (tree edge)

Ruth from F to B.

So cross edge (c).

There edge  $A \rightarrow F$ There

Gruph ( without edele)

E -> A

E = 2 x z 3

A z y z 1

and there is a tree edge

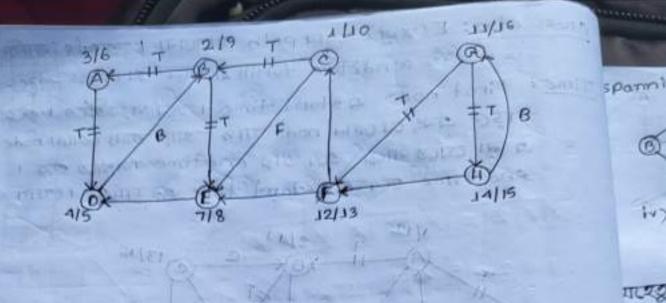
Poth-trom A -> E (A -> D -> E)

and then (E -> A)

So Backward Edge (B)

G(V) C) + Malm Set

E = IVI-1 - man of edges



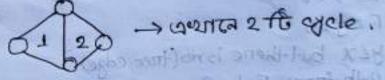
Minimum Spaning Trice

≠i)subset of a graph

ii) পুcle হলনা (অহাs edges দ্বারা graph divided হরেনা)

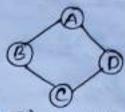
ili) ventices disconnected एएवमा

IV) प्रकृतकान edge odd/



delile হবে না অর্থাৎ spanning thee তৈরির ক্রায় আ edge

# Gerraph ( without cycle)

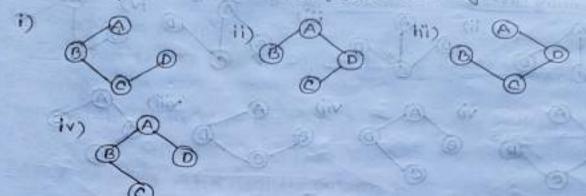


 $G(V, E) \rightarrow Mainset$   $S(V', E') \rightarrow Subset$   $V'z V \rightarrow na. of ventices$  $E' = |V| - 1 \rightarrow no of edges.$  In this graph -> v'z4
E'z4-4

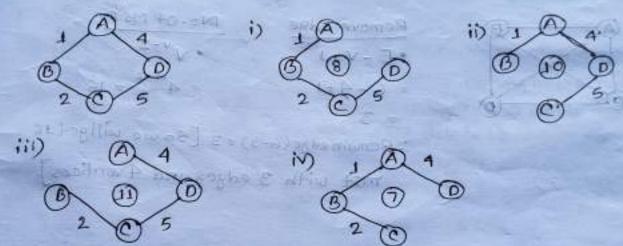
par

No of spanning tree

Ec<sub>E</sub>; ⇒ c<sub>3</sub> ⇒ 4 · 4 spanning trees with 4 verifices and 3 edges:

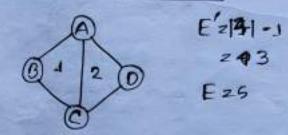


प्राट्य onaph weighted नम जाई देशद्वाय प्रविद्धार्थ मार्गालयन



In weighted graph graph with minimum cost is the minimum spanning tree.

# Graph (With cycle)

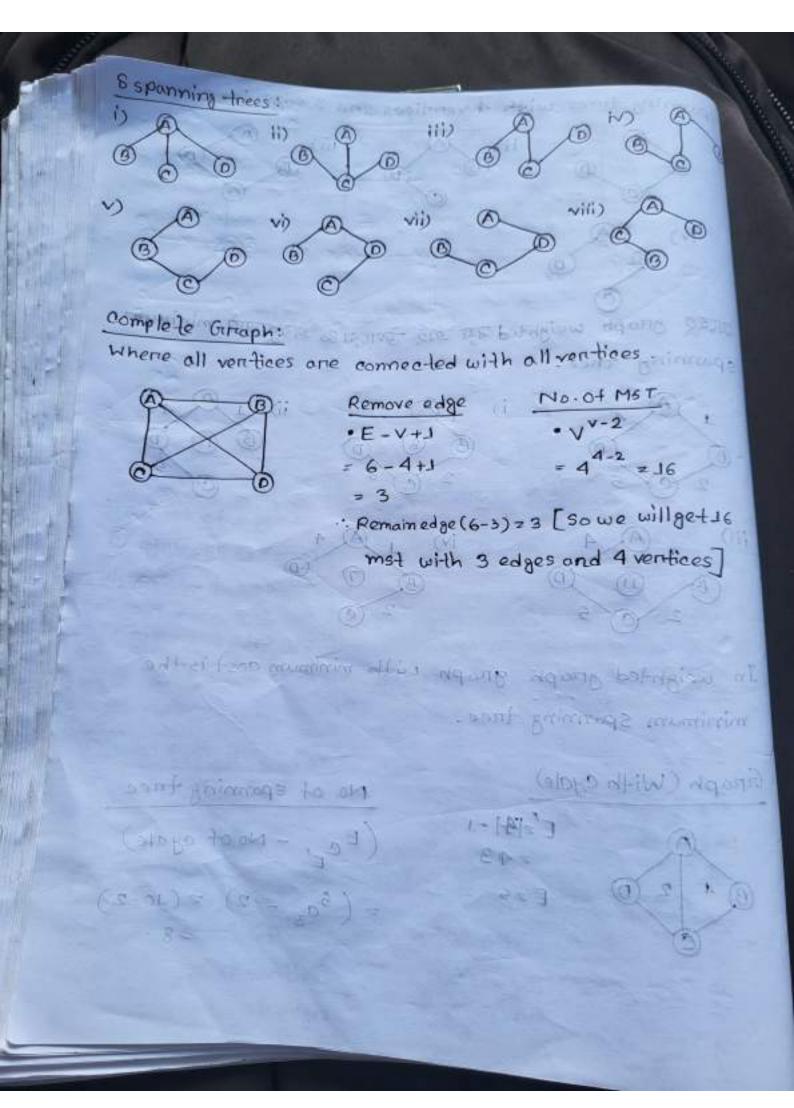


No of spanning tree

(ECE, - No of cycle)

= (5c3 - 2) = (10-2)

= 8



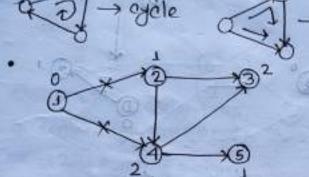
# HYLINDPI

## - Topological sorting

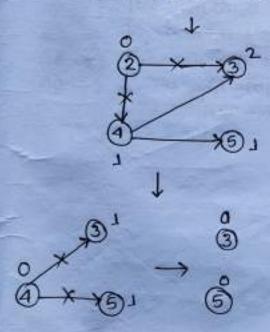
It is a linear ordering of its ventices such that for every ordered edge UV for veritex u to v, u comes before veritex v in the ordering.

- · Graph should be Directed and Acyclic (means without cycle).
- · Every DAG will have atleastone topological sonting.

  DAG & Directed And Acyblic Grouph.



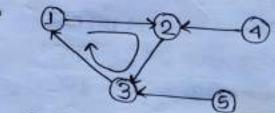
Sorting: 1 → 2 → 4 → 3 → 5 (



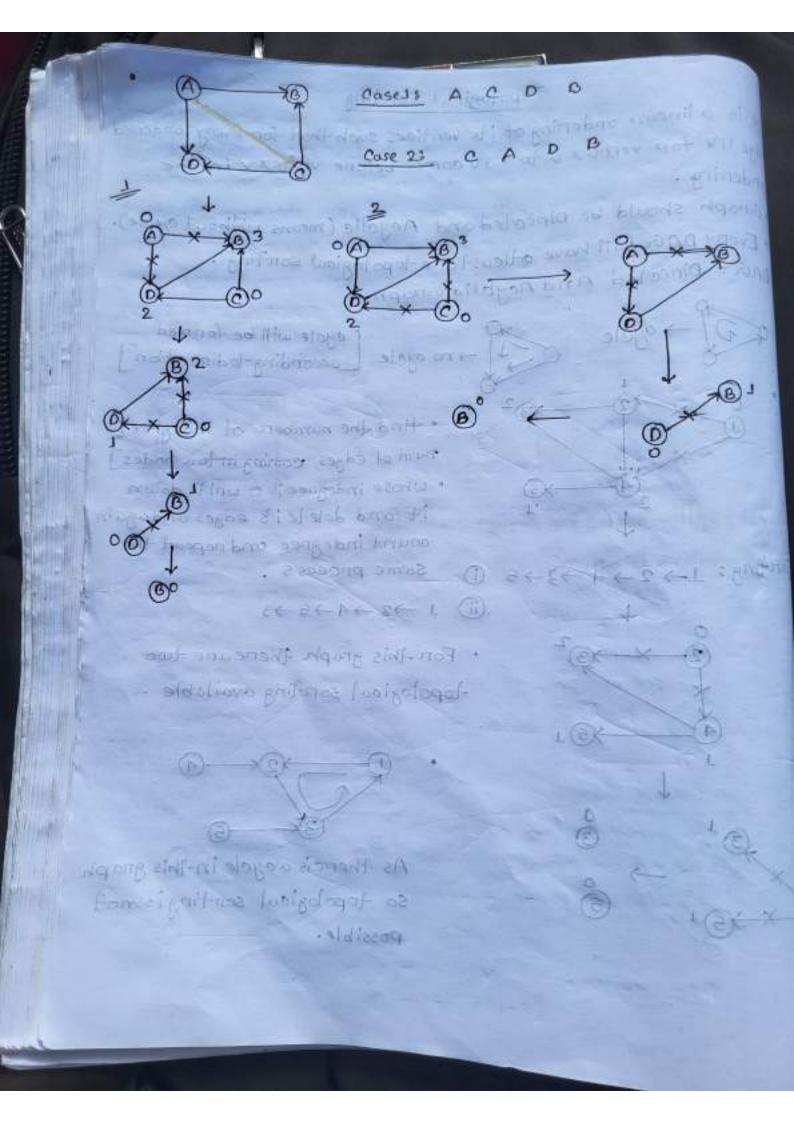
- no cycle [ cycle will be formed according to direction]

- · find the numbers of indegree [ num of edges coming into a nodes]
- · whose indegree is o write down it and delete its edges and again count indegree and repeat the same process.

· For this graph there are two topological sorting available.



As there is a cycle in this graph so topological sorting is not possible.

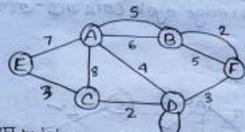




") Graph reser loop delete maso es !

Di din the sea of the partie of the sea of t

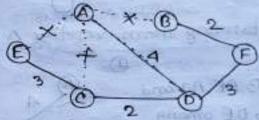
া।) নপুন MST তৈরির নামায় কোলো প্রেণে হস্ত মামারে না । ত্যেসকল ভবিষ্ঠ প্রেণে তিরির নামায় কোলো প্রেণে হবে । MST (V, E) এর সংখ্যা। (V = V, E' = IVI-1) ।



onder a edge माजार गढ़ :

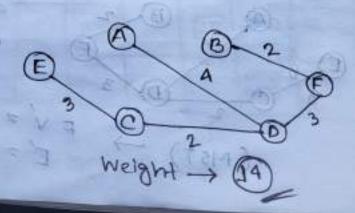
BF +2 sorting weight CD -> 2 অনুসারেএকটি DF -> 3 Graph Trailer CE->3 ट्य भावा कावा AD ->4 eyele zaan AB ->5 Grooph to gravia AE->7 তান) পুরের Groph AC -> 8 प्रविम्हणां क्रिये वामाला 260

After deletion P 3 0 2 0 3



Graph to AE, AC, AG and Toals edge TAIGHT SUITA THE ATERNATION OF THE COLD TO A COLD T

चा किया MST এর condition Fuldin कार्य । তার্থ এটি হলো MST. এর Weight minimum.



DI= Highwa

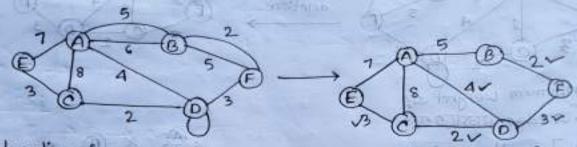
that soften that we seen I come eas

PR. A E. OR DC Break

[+-1A1] 5

## Prim's Algarithm

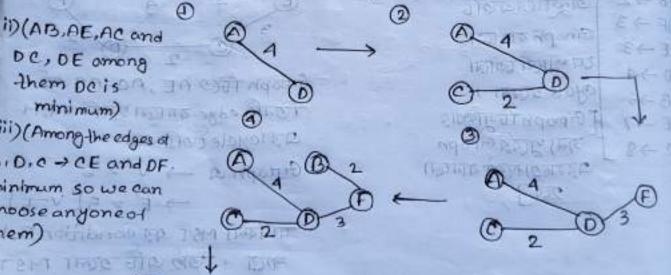
(याताता क्रांटि node ह्याता श्रुव महत्य एता । क्री node क्ष्र odjocent edge त्रुवात मार्था मात्र weight minimum तमरे edge प्रवद् वात्र मात्याद्र node print कहुए रहत । ध्वाहरिति node ह रे adjacen edge रमण्या राव पाना प्रक्रिमाला रमहित weight minimum का dream कड़िल रख । आह सिंह मुटि minimum weight लाउ सा सक তবে যে কোন একটি নাঅম কুবতে হবে , প্রত্যেকবার node হার প্রাণ मार्थ्य मार्थ जंडार्यरे हलता। यदि कात्मार्थे edge edgle कि बिकां कर তা বাদ দিতে হয়ে



Starring from ventige A (Among AB, AE, AC, AD; AD is minim

ii) (AB, AE, Ac and DC, DE among them ocison, In contago minimum) iii) (Among the edges of

A. D. C - CE and DF. minimum so we can chooseanyoneof



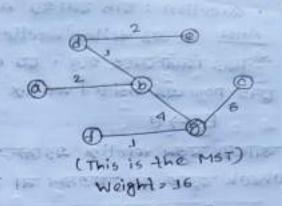
DANGER S PARISH LE But after that we can't any edge among AB, AE on Ac because each of them make excle ]

· Weight 214

Problem 1: (stant from a)

A\* C 1 7 Sx 10

7 C 1 7 C



Dijkstra's Algorithm (single source shortest

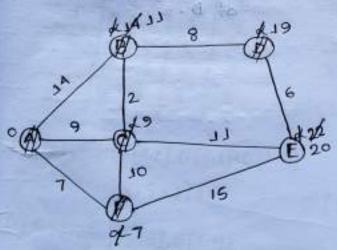
· U (node) to v (node)

· If (du) + c(u,v) 2d(v))

then d(v) = d(u) + c(u,v)

d(u) = distance of u

c(u,v) = cost of uto v



প্রথমে A এর তাব adjocent এদেখাতে

হরে এবং value chang হলে change

वार्ड एत । প্রাপ্ত value মুলোর

मध्या यात्र value অবচ্চে কম সেই

vertion on visited vention এনিতে হতে

List of ventices E D A d ol 0 d d A 14 9 d d 7 F 9 14 22 C d 11 · d B 20 19 20 D E 20

अवः जाद adjacent a क्रथर श्वा । प्रशासके क्षित्र माहि हम व

Ans! E এর visited vention एक निर्ण प्रता । प्रा तिल प्रता प्रता ।

E -> C

ত্যাবার বসুন verition এর ক্ষেত্রের ত্যানের মত্যোকরে ক্রামের ও

Ans:

-. A - 0 - B - D = 9+2+8 = 19 -> Equals to the

value of visited vention

•@	10	(A) 5		9-11	A A	idia)
	A	10	10	D	E	A
A	0	d	2	d	d	4
Ç		10	3	d	d	9
E	2.0	70		11	5	8
B	90	71		ונ		a
D	1			9		

30
P.fc
STUTE SE STE OCIOCENT SERVICE
semand and Burato and and section
FIRST Solow saves

DES ROBERT STATE OF THE PARTY OF THE

DE CHETC CHES LOL'

(V,U)D+ (0)B = (V)B = NON-

of D.

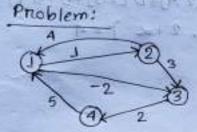
### Floyd Wanshall Algorithm (All pains shortest path)

Works with positive and negative edges (but not with negative eyele)

value of cyclez - 2 - 2+1 = -3 [so algorithm is notapplicable here

Formula: 10 Lista mine [1.2] 0

OK [i,J] = min & OK-3[i,J], O\*-1[i,K]+OK-1[K,J]



Ú	acr =	7	2	3 1	4			
	1	0	J	-2	d			
	2	4	0	3	d			
	3	8	d	0	2			
	4	5	d-	d	0			
	100			1				

01		With	1 L	the s	
-		1	12	13	14
_	T	0	1	-2	d
	2	14	10	2	d
	3	d	d	0	2
-	1	5	6	3	0
		6	LAC	CLE	C

प्पळ्ळू node () निस्म कान कड़िक कोरे 1 युव 100 पद coloumn 0° पद समुद्राश २०० । Kz1 -> for first node

01[2,3] zmin{0°[2,3],0°[2,1]+0°[1,3]}

D[4,2] zmin 10 [4,2], 0 [4,1]+0 [1,2]} =minfd,5+1)z6

= min {3,4+(-2)}

D'[4,3]zmin | 0 [4,3], 0 [4,1]+

= min {3,2} = 2 0'[2,4] = mind 0°[2,4], 0°[2,3]+0°[1,4])

0 [1,37]

= mingd, 4+d}zd

min | d, 5+(-2)

0'[3,2] = min { 0°[3,2], 0°[3,1]+0[1,2]

=min {d, d+1} = d D[3,4] = min { D'[3,4], D'[3,1] + D'[1,4]} = min{2, x+x}=2

When Kz2 for 2nd node [ row and coloumn 2 from D) 3 | 4 | 0 [1,3] = minf 0[1,3] . 0 [1,2] + 0 [2,3]} = min \ -2, 1+3 \ z -2 \_ 02[1,4] = min + 0 [1,4], 0 [1,2] + 0 [2,4]} de = minfd, 1+d7 =d 161 D3 03[2.1] = minf 02[2.1], 02[2.3]+02[3.1]) 4 0 -2= min { 4,2+2}= 4 4 03 [2A] 2 minf 02 [2 A]+ 02 [2.3] + 02 [3.4] d d 0 =min fd, 2+ = }=4 5 3. 0 04 D4[1,2] = min d3[1,2], D3[1,4]+ 03[4,2]7 2 4 0 2 4 = min { 1,0+6 } 21 3 8 0 2 09[1,3] zmin{03[1,3], 03[1]+ 3 0 D3 [4/3] } ( ( 1 ) + 1 1 1 1 2 1 2 1 1 mins [ 2 ] = min = 2, 0+3) = -2 100 + 1 . 5 nim = (the same per a language and E = TE & COME = TLE- 174 (E. 0] 0 . [0.0] 0 ham - [0.0] 10 03(1+2.6-c/m) mand of Ath 2 of Little 1. Description 0113.2] amin - 0 [3.2], 0 [3.2] + 0 [1.2] \$12-17 a 2 = 1 + 16 . 6 paint 1(2-1-3) d. 6 1-2) LELIGHTEN LASINIM-LETO The b. Sramm