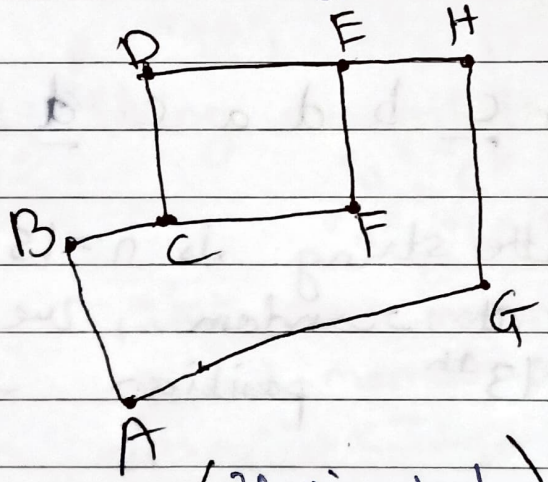
* SNA * *Unit 2 *

* Centrality :- (importance of node)

1. Degree of centrality
2. Betweeness
3. Closeness

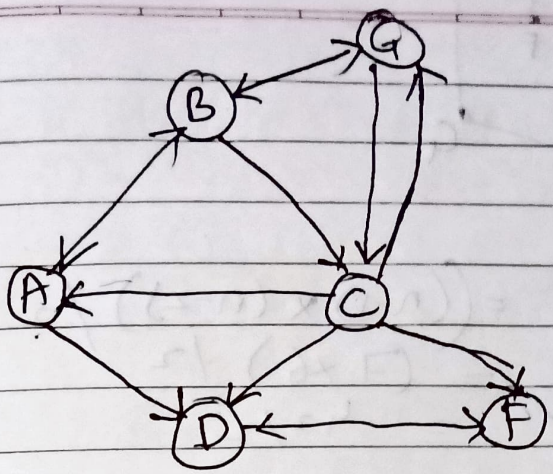
1. Degree of centrality :- $\frac{\text{indegree}}{n-1}$

where n = no. of nodes



(Undirected)

nodes	indegree	DOC
A	2	$\frac{2}{7} = 0.28$
B	2	$\frac{2}{7} = 0.28$
C	3	$\frac{3}{7} = 0.42$
D	2	$\frac{2}{7} = 0.28$
E	3	$\frac{3}{7} = 0.42$
F	2	$\frac{2}{7} = 0.28$
G	2	$\frac{2}{7} = 0.28$
H	2	$\frac{2}{7} = 0.28$

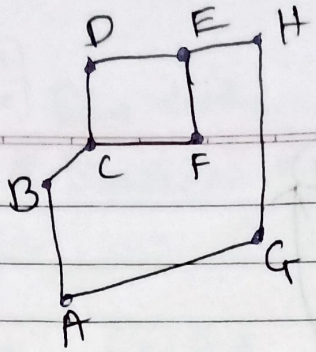


(Directed)

nodes	indegree	DOC
A	2	2/5 2/6 = 0.33 = 0.4
B	2	2/5 2/6 = 0.33 = 0.4
C	2	2/5 2/6 = 0.33 = 0.4
D	3	3/5 3/6 = 0.5 = 0.6
F	2	2/5 2/6 = 0.33 = 0.4
G	2	2/5 2/6 = 0.33 = 0.4

✱ Betweeness centrality -

Betweeness of node n = $\frac{\text{no. of shortest path passing through node n}}{\text{Total no. of shortest path between pair of node.}}$



no. of pairs $= ((n-1) \times (n-2))/2$

$= (7 \times 6)/2$

$= 42/2$

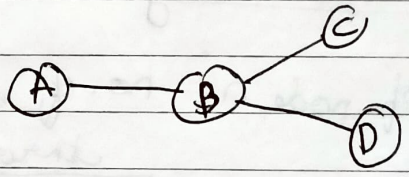
$= 21$

(A,B), (A,C), (A,D), (A,E), (A,F), (A,G), (A,H),
(B,C), (B,D), (B,E), (B,F), (B,G), (B,H),
(C,D), (C,E), (C,F), (C,G), (C,H),
(D,E), (D,F), (D,G), (D,H),
(E,F), (E,G), (E,H),
(F,G), (F,H),
(G,H)

21 pairs

Betweeness of C

Eg:-



no. of pairs $= (4-1) \times (4-2)/2$

$= 3 \times 2/2$

$= 3$

(A,B), (A,C), (A,D),
(B,C), (B,D),
(C,D).

Betweeness of B = (A,C), (A,D), (C,D).

$= \frac{1}{1} + \frac{1}{1} + \frac{1}{1}$

$= 3$

(passing through B to check shortest)

$(A,C) = \frac{1}{1}$, $(A,D) = \frac{1}{1}$, $(C,D) = \frac{1}{1}$

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Betweeness of C = $(A,B) + (A,D) + (B,D)$

$= \frac{0}{1} + \frac{0}{1} + \frac{0}{1}$

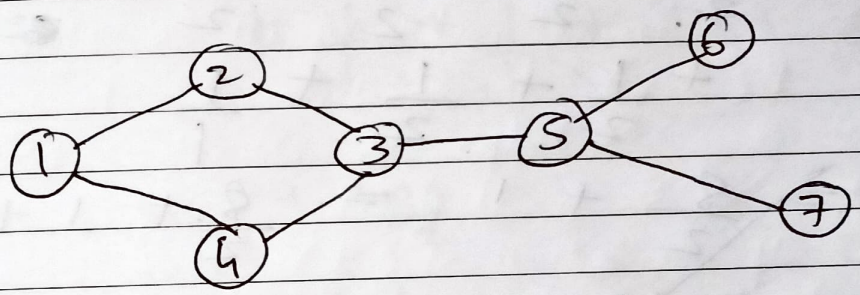
$= 0$

Betweeness of D = $(A,B) + (A,C) + (B,C)$

$= \frac{0}{1} + \frac{0}{1} + \frac{0}{1}$

$= 0$

HW



node of 5

Betweeness of 5

no. of pairs = $(7-1) \times (7-2) / 2$

$= 3(6) \times (5) / 2$

$= 15$

(1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7),
(2, 3), (2, 4), (2, 5), (2, 6), (2, 7),
(3, 4), (3, 5), (3, 6), (3, 7),
(4, 5), (4, 6), (4, 7),
(5, 6), (5, 7),
(6, 7)

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SNA

Total 15

Betweenness of S = (1,2), (1,3), (1,4), (1,6), (1,7),
(2,3), (2,4), (2,6), (2,7),
(3,4), (3,6), (3,7),
(4,6), (4,7),
(6,7)

Direct path then have only shortest path

$= \frac{0}{1} + \frac{0}{2} + \frac{0}{2} + \frac{2}{2} + \frac{2}{2} + \frac{0}{2} +$

$\frac{0}{2} + \frac{1}{2} + \frac{1}{2} + \frac{0}{2} + \frac{1}{1} + \frac{1}{1}$

$+ \frac{1}{2} + \frac{1}{2} + \frac{1}{1}$

$= \frac{8}{2} + 1 = \frac{8}{2} + 1 + 1 + 1$

$= \frac{10}{2} = \frac{8}{2} + 3$

$= 5 = \frac{8+6}{2}$

$= \frac{14}{2}$

$= 7$

$= \frac{0}{1} + \frac{0}{2} + \frac{0}{1} + \frac{2}{2} + \frac{2}{2} + \frac{0}{1} + \frac{0}{2}$

$+ \frac{1}{1} + \frac{1}{1} + \frac{0}{1} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1}$

$= 9$

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Between of 3 = (1,2), (1,4), (1,5), (1,6), (1,7),
(2,4), (2,5), (2,6), (2,7),
(4,5), (4,6), (4,7),
(5,6), (5,7),
(6,7)

$$= \frac{0}{1} + \frac{0}{1} + \frac{2}{2} + \frac{2}{2} + \frac{2}{2}$$

$$+ \frac{1}{2} + \frac{1}{1} + \frac{1}{1} + \frac{1}{1}$$

$$+ \frac{1}{1} + \frac{1}{1} + \frac{1}{1} + \frac{0}{1} + \frac{0}{1} + \frac{0}{1}$$

direct path

$$= 9 + \frac{1}{2}$$

$$= \frac{18+1}{2}$$

$$= \frac{19}{2} = 9.5 = 9.5$$

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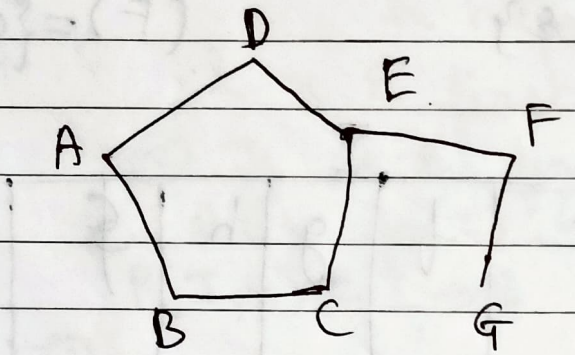
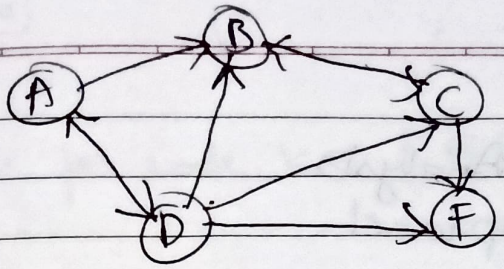
* SNA *

* Closeness Centrality = $\frac{1}{\sum_{j=1, j \neq i} d(x_i, x_j)}$

where $d(x_i, x_j)$ = geodesic distance between x_i to x_j



Nodes	Geodesic distance (length of shortest path)	Closeness Centrality
A	1+2+1+2+3+4 = 13	$\frac{1}{13} = 0.07$
B	1+1+2+2+3+4 = 13	$\frac{1}{13} = 0.07$
C	2+1+2+1+2+3 = 11	$\frac{1}{11} = 0.09$
D	1+2+2+1+2+3 = 11	$\frac{1}{11} = 0.09$
E	2+2+1+1+1+2 = 9	$\frac{1}{9} = 0.11$ (Highest)
F	3+3+2+2+1+1 = 12	$\frac{1}{12} = 0.083$
G	4+4+3+3+2+1 = 17	$\frac{1}{17} = 0.058$



		CC
A	$1+2+1+2=6$	$\frac{1}{6}=0.16$
B	(B,A) (B,C), (B,D) (B,F) $0+1+0+2=3$	$\frac{1}{3}=0.33$
C	$0+1+0+1=2$	$\frac{1}{2}=0.5$
D	$1+1+1+1=4$	$\frac{1}{4}=0.25$
F	$0+0+0+0=0$	$\frac{1}{0}=$ undefined

* NCliques (friend of friend) :- ① N cliques includes the relation which are at a distance of 2

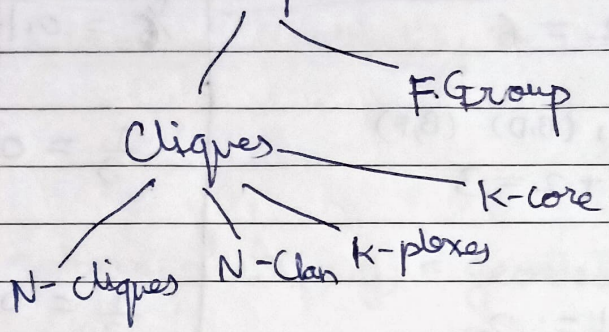
for eg :- N_i (N clique for node N_i) will be set of all nodes which are at a distance of 2 from node N_i

② N cliques is used to study friend of friend relation in a social network.

Network Structure Analysis

(1) Top Down Approach

(2) Bottom - up —"— —



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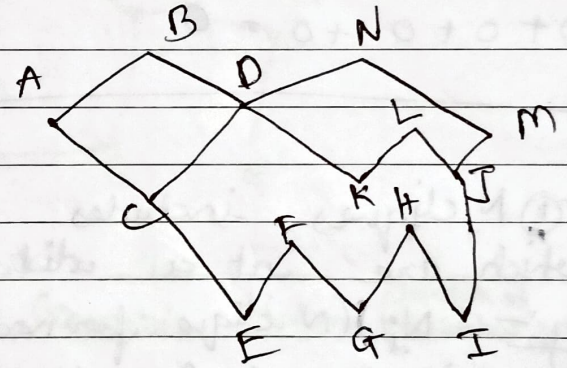
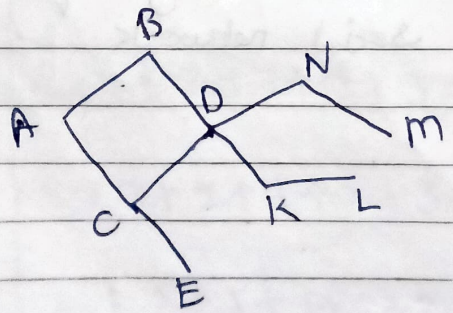
* N-cliques

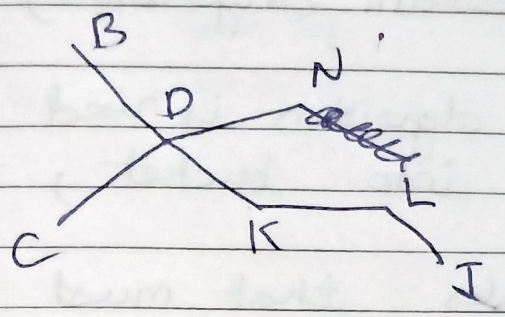
Eg (1)



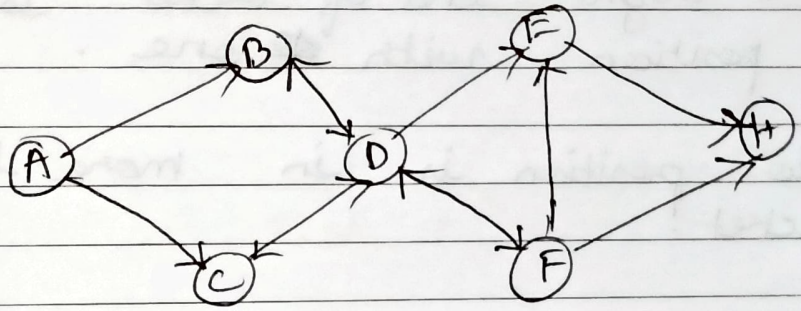
N-Clique for node D = {B, A, C, E, K, L, N, M}



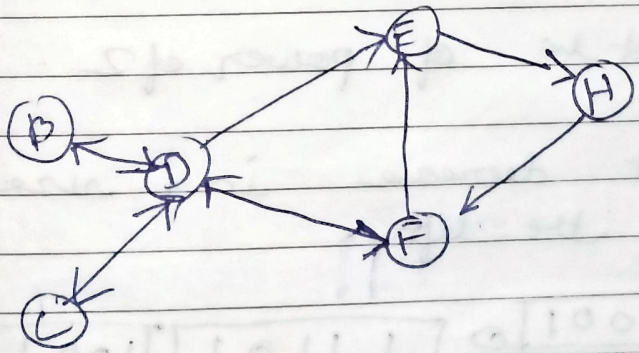
N-clique for node K = {D, C, B, N, L, J}



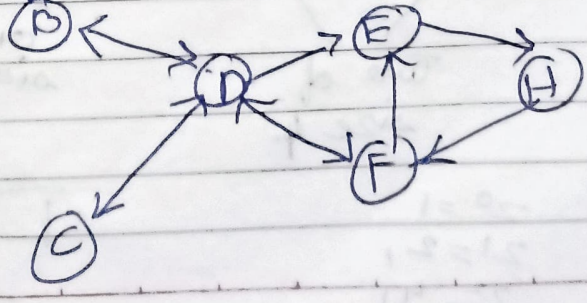
eg 2



N clique for node F = {E, H, D, C, B}



N-clique for node D = {E, H, F, B, C}



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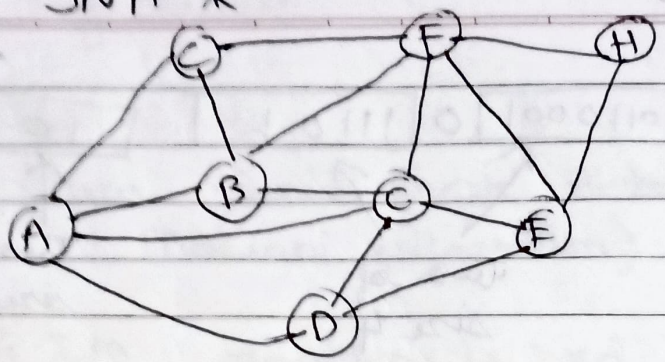
* SNA *

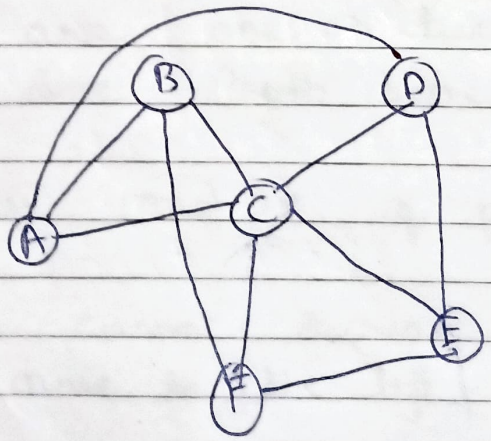
* N-Clan:-

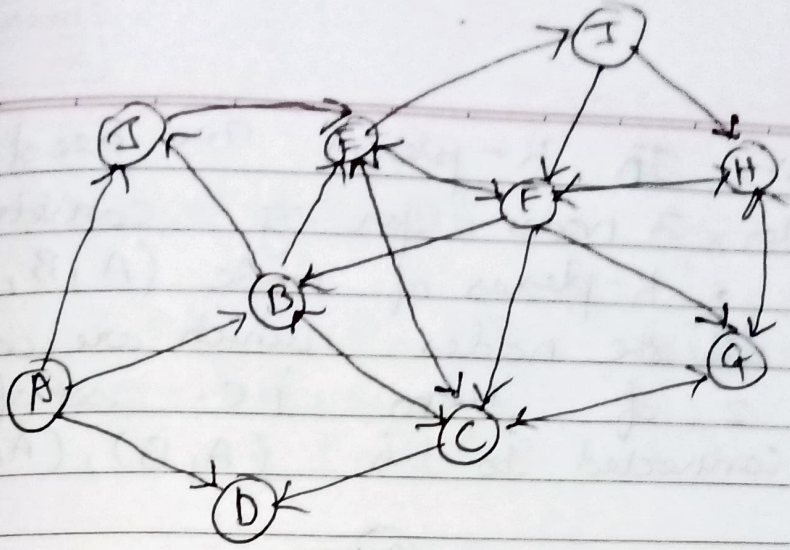


⇒ N-clan is similar to N-clique, it just put a restriction that the node should belong to same group

Eg ① $G = \{A, B, C, D, E, F\}$

N-Clan of node C $= \{A, B, D, E, F, G, H\}$ → not in so cancel.





$G_1 = \{A, B, D, J, G, F\}$

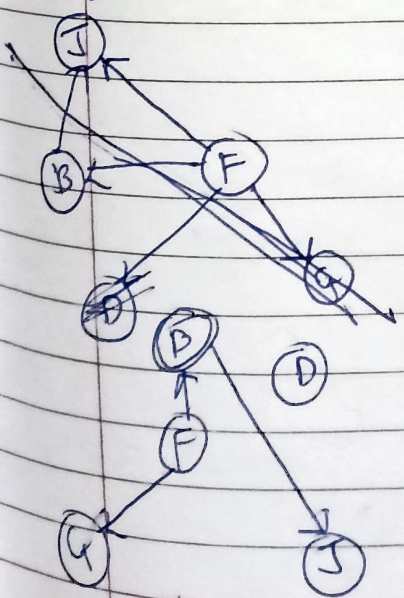
$G_2 = \{C, E, F, H, I\}$

N-Clan for node F =
$\{B, C, G, E, H, J, D, I\}$

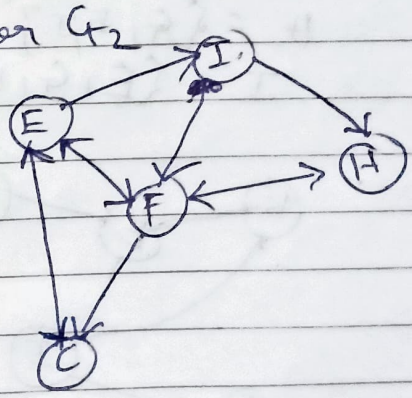
for $G_1 = \{B, G, J, D, \}$

$G_2 = \{C, E, H, I\}$

for G_1

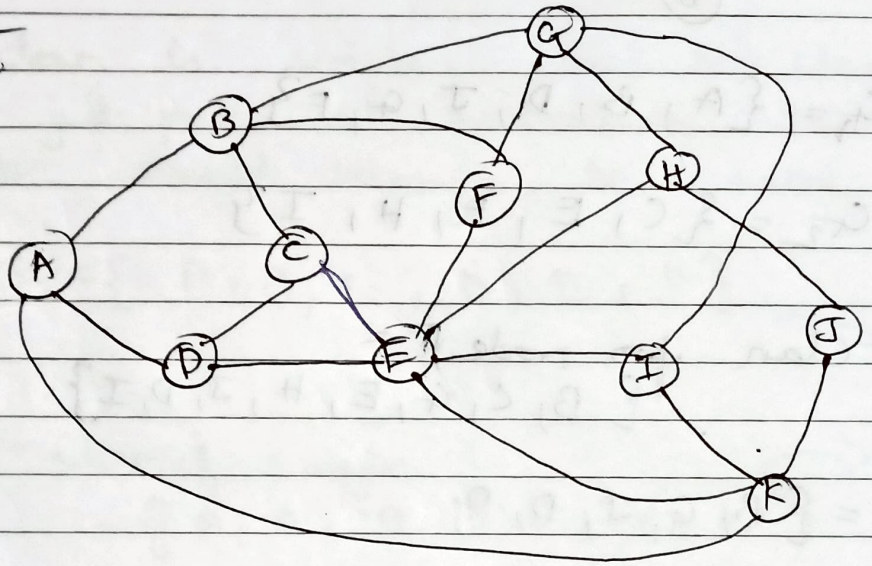


for G_2



* **K-plexes:-** In K-plexes we need to consider 3 nodes for eg consider node A, B, C, K-plexes of node (A, B, C) is set of all the nodes which are connected to any 2 of them i.e. set of all node connected to this (A, B), (A, C), (B, C),

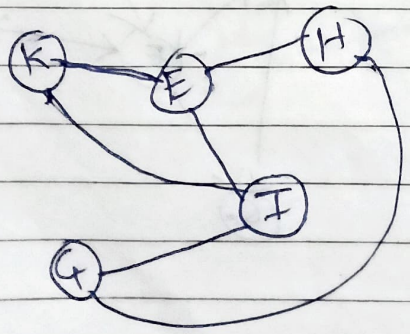
Eg:-



(1) K-plexes of (E, H, I) = {E, G, K}

E = {F, C, D, H, I, K}
H = {G, E, J}
I = {E, G, K}

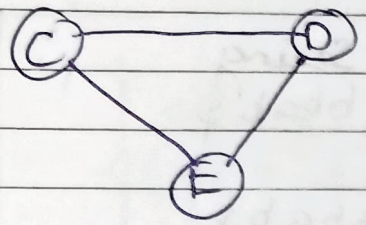
Common



(2) K-plexes of {C, D, E}

C = { B, D, E }
D = {A, C, E}
E = { F, C, D, H, I, K }

= {E, C, D}



* K-Core:- In this, it is similar to K-plexes but we resides the value more than 3 or equal to 3 & do the operation as per K-value nodes.

Eg:- {C, D, E, F}

K = 2.	K = 3
CD, CE, CF	C, D, E, CEF
DE, D, F,	DEF
EF	

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* SNA *

* F-Group :- ① F-Group is a bottom-up approach for network structure analysis where it analysis transitive relation in a given ~~dat~~ network.

② Transitive relation is define as if a is related to b, b is related to c then a is related to c.

③ It analyse transitive relation in terms of strong & weak relation

for eg:- in given network, if

$AB + BC \geq AC$ → strong relation

if $AB + BC < AC$ → weak.

* Top-down approach :- ① Top-down approach is based on component analysis where component is define as set of disjoint network i.e. networks are divided into isolated sub-network.

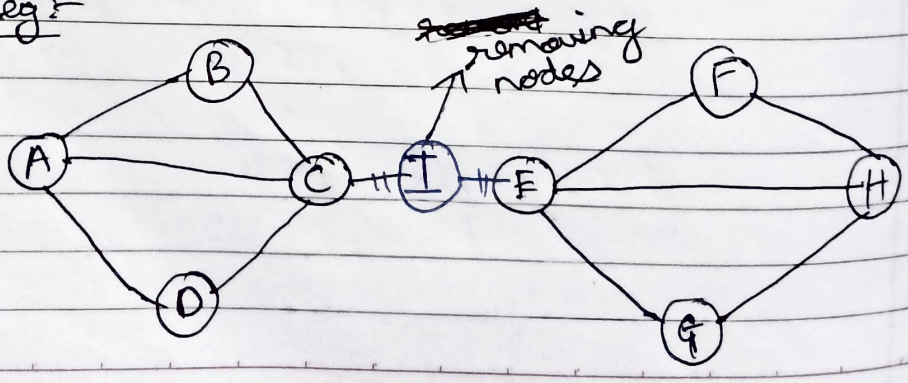
② to perform the top-down approach analysis following 2 methods are used

:- ① Block and Cut point (nodes)

② Lambda Set & bridges (edges)

① Block and cut point :-

for eg:-



Cutpoint = {I}

$B_1 = \{A, B, C, D\}$
$B_2 = \{E, F, G, H\}$

(1) When we remove the node, that node becomes cutpoint
(2) The rest circuit becomes divided into the blocks.

(2) Lambda set & bridges :- (1) When we remove the edges that is called bridge.
(2) The rest circuit becomes lambda set.

bridge {CI, IE}

$L_1 = \{A, B, C, D\}$
$L_2 = \{E, F, G, H\}$