Questions should be —
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Instructions to the candidates, if any :—

N.B. :

Johnsons !

Q. No.	Marks

Johnson's Algo. - $O(V^2 \log V + VE)$

All pair :. asymptotically better than Warshall

- uses Dijkstra's & Bellman Ford.

→ technique of reweighting.

→ if all positive edges in Graph, compute by Dijkstra's by computing for each vertex as source Vertex.

→ if negative edges, compute new set of nonnegative edges, that can allow to use Dijkstra's shortest Path method.

Johnson's - 2

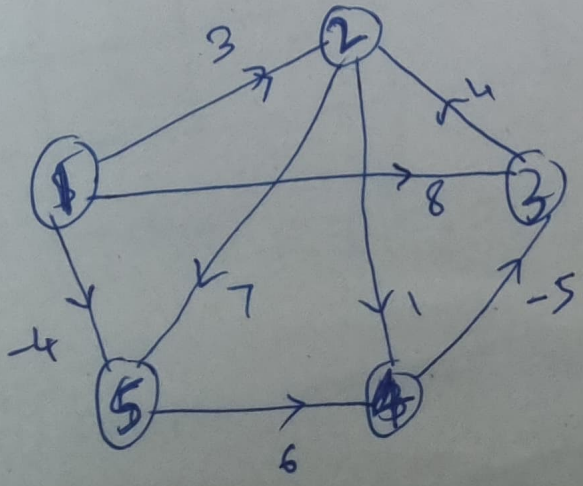
The new edges must have 2 properties.

① all vertices $u, v \in V$; shortest path from u to v using weight function w is also a shortest path from u to v using weight function $\hat{w}$.

② For all edges (u, v), the new weight $\hat{w}(u, v)$ is nonnegative.

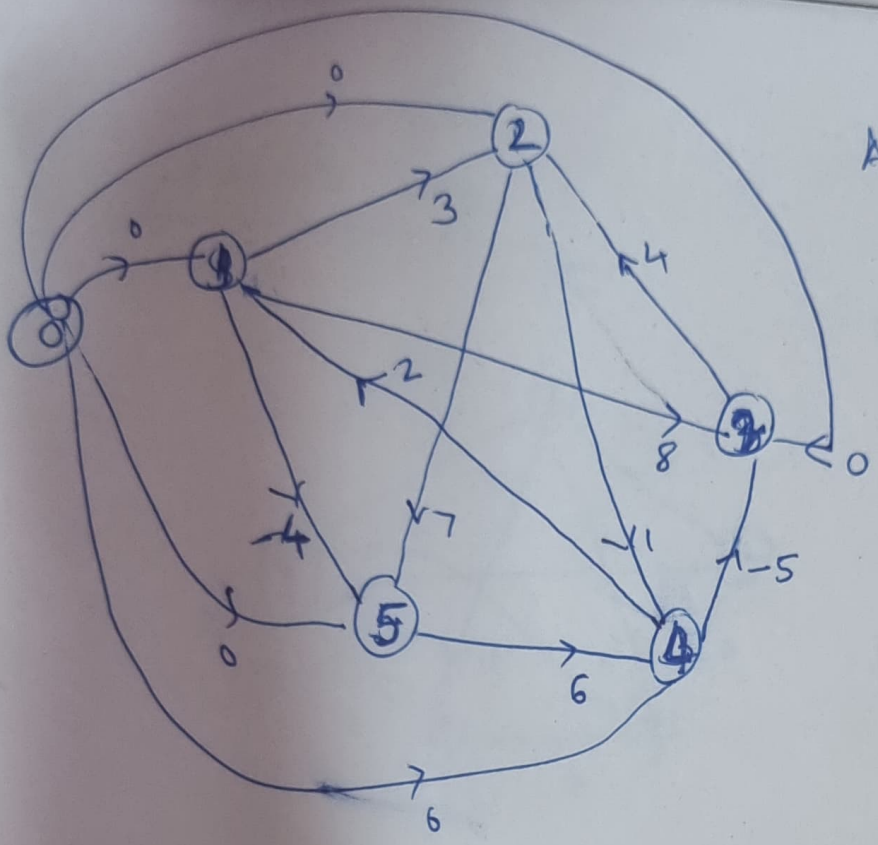
Produce nonnegative edges by reweighting.

- make a new Graph $G'(V', E')$
- Use Bellman Ford algo.
- Add a new source 0 to 'G'.



Johnson's - 3

Add new source 0



0 source	1	2	3	4	5
1 edge inbet	0	0	0	0	0
2 edge inbet	0	0	-5	0	-4
3 edge inbet	0	-1	-5	0	-4
4 edge inbet	0	-1	-5	0	-4
5	"	"	"	"	"

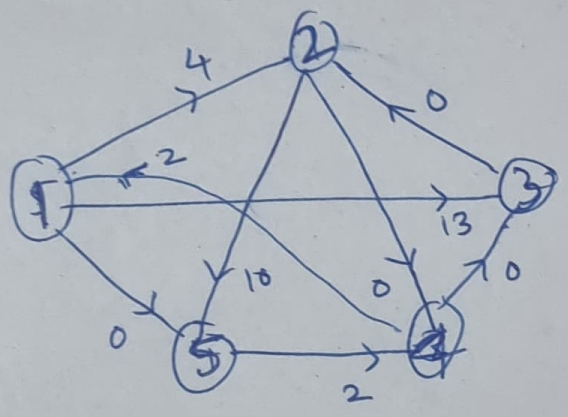
H function [ ] = [0, -1, -5, 0, -4]

→ remove source & rewrite edges as,

$$w'(u, v) = w(u, v) + h(u) - h(v)$$

Johnson-4

Rewrite edges



$w'(3,2)$

$w'(\cancel{4,1})$

$= 4 + (-5) - (-1) = 0$

$w'(1,2) =$

$3 + (0) - (-1) = 4$

$w'(1,3) =$

$8 + 0 - (-5) = 13$

Apply Dijkstra's Shortest Path Algo.

Consider Source 1

	Source	Selected	1	2	3	4	5
Initial	1	1	0	4	13	∞	0
1		5	-	4	13	2	0
	1,5	4	-	4	2	2	0
Source 1	1,5,4	3	-	2	2	2	0

similarly do for remaining vertices.

Source 2

V	1	3	4	5
	2	6	0	2

To,
The HOD

Name of
the Faculty

Page No. .....

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Johnson's-5

Q. No.	Marks

Source 3

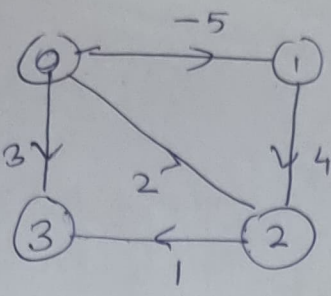
1	2	4	5
2	0	0	2

Source 4

1	2	3	5
1	0	0	2

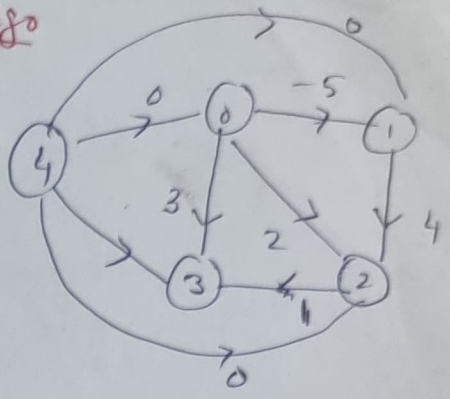
Source 5

1	2	3	4
4	2	2	2



Johnson's algo

add source



① Bellman ford

Source

K	4	0	1	2	3
	0	∞	∞	∞	∞
1	0	0	0	0	0
2		0	-5	-1	

$dist^2(0) = min(dist^1(0), min(dist^1(i) + cost(i,0)$

$= 0, ($

$dist^2(1) = min(dist^1(1), min(dist^1(i) + cost(i,1)$

$= (0, 0-5,$

$dist^2(2) = min(dist^{0-1}(2), min(dist^1(i) + cost(i,2$

$0, 0+2,$

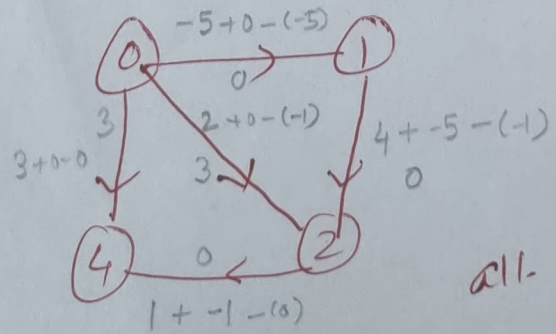
from 4 to 0, 1, 2, 3 are

(0, -5, -1, 0)

② h[] = {0, -5, -1, 0} calculation

③ remove source, rewrite edges.

by $w(u,v) = w(u,v) + h[u] - h[v]$



all costs +ve

④ run Dijkstra's for every vertex as source

Time complexity $O(V^2)\log V + VE$