Q1

Process	Queue/Stack	visited

1.1.

The strategy is, we try to follow the statements to traverse. If we get a different result, the statement traversal is not valid.

a. False. Starting from A,	A	
Pop A and push B, C	B, C	A
Pop B and push D, E	C, D, E	A, B
Pop C	D, E	A, B, C
Pop D and push G	E, G	A, B, C, D
Pop E and push F	G, F	A, B, C, D, E
Pop G and push H	F, H	A, B, C, D, E, G
Pop F	H	A, B, C, D, E, G, F
Pop H	empty list	A, B, C, D, E, G, F, H
Done. Cannot get a		

b. False. Starting from B,	B	
Pop B and push A, C, E, D	A, C, E, D	B
Pop A	C, E, D	B, A
Pop C	E, D	B, A, C
Pop E and push H, F	D, H, F	B, A, C, E
Pop D and push G	H, F, G	B, A, C, E, D
Pop H	F, G	B, A, C, E, D, H
Pop F	G	B, A, C, E, D, H, F
Pop G	empty list	B, A, C, E, D, H, F, G
Done. Cannot get b		

c. Starting from B,	B	
Pop B and push A, C, E, D	A, C, E, D	B
Pop A	C, E, D	B, A
Pop C	E, D	B, A, C
Pop E and push H, F	H, F, D	B, A, C, E
Pop H and push G	G, F, D	B, A, C, E, H
Pop G	F, D	B, A, C, E, H, G
Pop F	D	B, A, C, E, H, G, F
Pop D	empty list	B, A, C, E, H, G, F, D
Done. Cannot get c		

d. Starting from E,	E	
Pop E and push C, B, D, F, H	C, B, D, F, H	E
Pop C and push A	A, B, D, F, H	E, C
Pop A	B, D, F, H	E, C, A
Pop B	D, F, H	E, C, A, B
Pop D and push G	G, F, H	E, C, A, B, D

Pop G	F, H	E, C, A, B, D, G
Pop F	H	E, C, A, B, D, G, F
Pop H	empty list	E, C, A, B, D, G, F, H

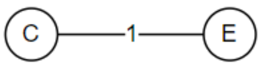
Done. Cannot get d

1.2.

Using Kruskal's algorithm:

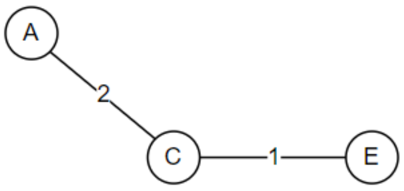
The shortest path has length 1

Add edge (C, E)

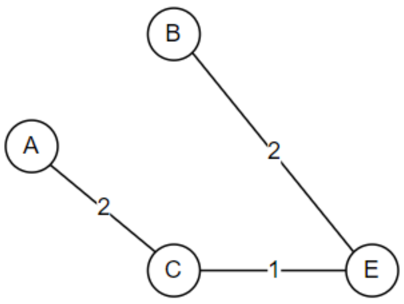


No edge with length 1 remains. We look at path with length 2.

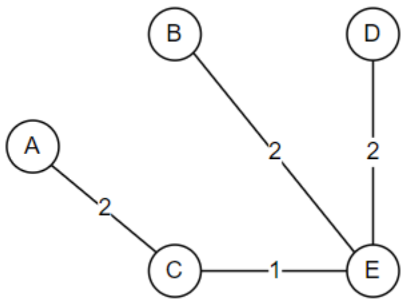
Add edge (A, C).



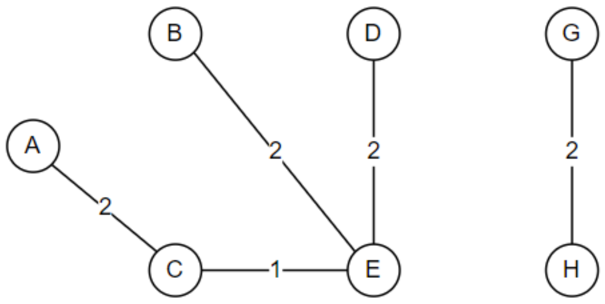
Add edge (B, E).



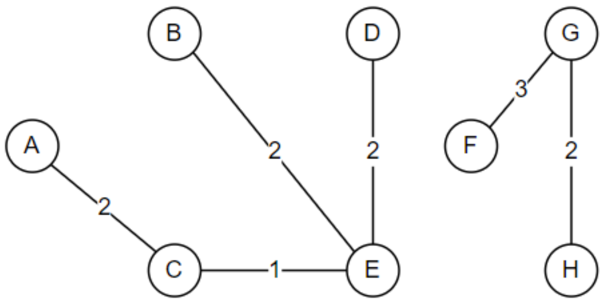
Add edge (D, E).



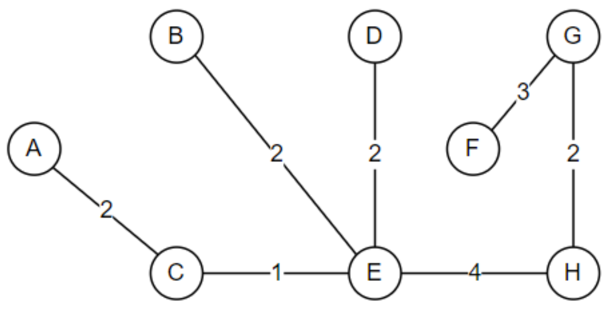
Add edge (G, H).



No edge with length 2 remains. We look at edge with length 3.
Add edge (F, G).



Though edge (B, C) and edge (A, B) have length 3, adding them would form cycles. So ignore them. No edge with length 3. We look at edge with length 4.
Add edge (E, H).



Now every node is reachable. We find the minimum spanning tree.

1.3.

We visit D.

Vertex	Visited	Distance	Previous
A	F	Inf	None
B	F	Inf	None
C	F	Inf	None
D	T	0	None
E	F	Inf	None
F	F	Inf	None
G	F	Inf	None
H	F	Inf	None

D has three neighbors: B, E, G.

Vertex	Visited	Distance	Previous
A	F	Inf	None
B	F	5	D
C	F	Inf	None
D	T	0	None
E	F	2	D
F	F	Inf	None
G	F	8	D
H	F	Inf	None

The shortest path is (D, E) of length 2. We visit E. E has four unvisited neighbors: B, C, F, H.

Vertex	Visited	Distance	Previous
A	F	Inf	None
B	F	4	E
C	F	3	E
D	T	0	None

E	T	2	D
F	F	7	E
G	F	8	D
H	F	6	E

The shortest path is (E, C) of length 3. We visit C. C has two unvisited neighbors: A, B.

Vertex	Visited	Distance	Previous
A	F	5	C
B	F	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	F	7	E
G	F	8	D
H	F	6	E

The shortest path is (B, E) of length 4. We visit B. B has one unvisited neighbor: A.

Vertex	Visited	Distance	Previous
A	F	5	C
B	T	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	F	7	E
G	F	8	D
H	F	6	E

The shortest path is (C, A) of length 5. We visit A. A has no unvisited neighbors.

Vertex	Visited	Distance	Previous
A	T	5	C
B	T	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	F	7	E
G	F	8	D
H	F	6	E

The shortest path is (C, A) of length 5. We visit A. A has no unvisited neighbors.

Vertex	Visited	Distance	Previous
A	T	5	C
B	T	4	E

C	T	3	E
D	T	0	None
E	T	2	D
F	F	7	E
G	F	8	D
H	F	6	E

The shortest path is (E, H) of length 6. We visit H. H has one unvisited neighbor: G.

Vertex	Visited	Distance	Previous
A	T	5	C
B	T	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	F	7	E
G	F	8	D
H	T	6	E

The shortest path is (E, F) of length 7. We visit F. F has one unvisited neighbor: G.

Vertex	Visited	Distance	Previous
A	T	5	C
B	T	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	T	7	E
G	F	8	D
H	T	6	E

The shortest path is (D, G) of length 8. We visit G. G has no unvisited neighbor.

Vertex	Visited	Distance	Previous
A	T	5	C
B	T	4	E
C	T	3	E
D	T	0	None
E	T	2	D
F	T	7	E
G	T	8	D
H	T	6	E

No node hasn't been visited. Done.

Q2

a. Transitive closure:

	A	B	C	D	E	F	G	H	I
A	1	1	1	1	1	1	1	1	1
B	0	1	1	1	1	1	1	1	1
C	0	0	1	1	1	1	1	1	1
D	0	0	0	1	1	1	1	1	1
E	0	0	0	0	1	0	1	1	1
F	0	0	0	0	0	1	1	1	1
G	0	0	0	0	0	0	1	1	1
H	0	0	0	0	0	0	0	1	0
I	0	0	0	0	0	0	0	0	1

(A, F) = 1, true. (C, G) = 1, true. (E, F) = 0, false.

b.

(1). H: 1, I: 2, G: 3, E: 4, F: 5, D: 6, C: 7, B: 8, A: 9

(2). H: [1, 1], I: [2, 2], G: [1, 3], E: [1, 4], F: [5, 5], D: [1, 6], C: [1, 7], B: [1, 8], A: [1, 9]

c.

(1). C: 1, E: 2, I: 3, H: 4, G: 5, F: 6, D: 7, B: 8, A: 9

(2). C: [1, 1], E: [2, 2], I: [3, 3], H: [4, 4], G: [4, 5], F: [3, 6], D: [3, 7], B: [1, 8], A: [1, 9]

d. The optimal spanning tree is the better index. When querying reachability for (C, G), the optimal spanning tree returns true since 1 <= 3 <= 7. However, the random spanning tree would return false since 1 < 4. Thus, the random spanning tree don't contain this information.

e.

Starting from node D, we add in(D), in(E), in(F), in(G), out(B), out(C), out(D).

	A	B	C	D	E	F	G	H	I
in				{D}	{D}	{D}			
out		{D}	{D}	{D}					
Processed	F	F	F	T	F	F	F	F	F

Then we choose node G, we add in(G), in(H), in(I), out(D), out(E), out(F), out(G).

	A	B	C	D	E	F	G	H	I
in				{D}	{D}	{D}	{G}	{G}	{G}
out		{D}	{D}	{D, G}	{G}	{G}	{G}		
Processed	F	F	F	T	F	F	T	F	F

Then we choose node C, we add in(C), in(D), in(E), out(A), out(B), out(C). (C, D) is covered by D. (C, E) is covered by D.

	A	B	C	D	E	F	G	H	I
in			{C}	{D}	{D}	{D}	{G}	{G}	{G}

out	{C}	{C, D}	{C, D}	{D, G}	{G}	{G}	{G}		
Processed	F	F	T	T	F	F	T	F	F

Then we choose node B, we add in(B), in(C), in(D), out(A), out(B). (B, C) is covered by C. (B, D) is covered by D.

	A	B	C	D	E	F	G	H	I
in		{B}	{C}	{D}	{D}	{D}	{G}	{G}	{G}
out	{B, C}	{B, C, D}	{C, D}	{D, G}	{G}	{G}	{G}		
Processed	F	T	T	T	F	F	T	F	F

Then we choose node E, we add in(E), in(G), out(C), out(D), out(E). (E, G) is covered by G. (C, E) is covered by D. (D, E) is covered by D.

	A	B	C	D	E	F	G	H	I
in		{B}	{C}	{D}	{E, D}	{D}	{G}	{G}	{G}
out	{B, C}	{B, C, D}	{C, D}	{D, G}	{E, G}	{G}	{G}		
Processed	F	T	T	T	T	F	T	F	F

Then we choose node F, we add in(F), in(G), in(I), out(D), out(F). (E, G) is covered by G. (F, G) is covered by G. (F, I) is covered by G. (D, F) is covered by D.

	A	B	C	D	E	F	G	H	I
in		{B}	{C}	{D}	{E, D}	{D, F}	{G}	{G}	{G}
out	{B, C}	{B, C, D}	{C, D}	{D, G}	{E, G}	{G, F}	{G}		
Processed	F	T	T	T	T	T	T	F	F

Then we choose node A, we add in(A), in(B), in(C), out(A). (A, B) is covered by B. (A, C) is covered by C.

	A	B	C	D	E	F	G	H	I
in	{A}	{B}	{C}	{D}	{E, D}	{D, F}	{G}	{G}	{G}
out	{A, B, C}	{B, C, D}	{C, D}	{D, G}	{E, G}	{G, F}	{G}		
Processed	T	T	T	T	T	T	T	F	F

Then we choose node I, we add in(I), out(F), out(G), out(I). (A, B) is covered by B. (F, I) is covered by G. (G, I) is covered by G.

	A	B	C	D	E	F	G	H	I
in	{A}	{B}	{C}	{D}	{E, D}	{D, F}	{G}	{G}	{G, I}
out	{A, B, C}	{B, C, D}	{C, D}	{D, G}	{E, G}	{G, F}	{G}		{I}

Processed	T	T	T	T	T	T	T	F	T

Then we choose node H, we add in(H), out(G), out(H). (G, H) is covered by G.

	A	B	C	D	E	F	G	H	I
in	{A}	{B}	{C}	{D}	{E, D}	{D, F}	{G}	{H, G}	{G, I}
out	{A, B, C}	{B, C, D}	{C, D}	{D, G}	{E, G}	{G, F}	{G}	{H}	{I}
Processed	T	T	T	T	T	T	T	T	T

All nodes are processed. Done.