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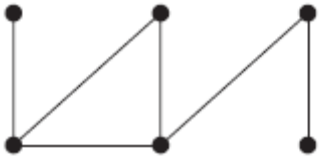
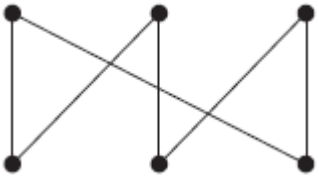
ASSIGNMENT 4 – Trees and Finite Automata

Group of 3, Due date: 27 Januari 2025

1) Which of these graphs are trees? Justify your answer.

a) 

b) 

c) 

2) Construct a complete binary tree of height 4 and a full 3-ary tree of height 3.

3) Represent the expression $((x+2)\uparrow 3)*(y-(3+x))-5$ using a binary tree.

Write this expression in pre order, in order and post order notation.

4) What is the value for the post order notation

$$521--14++*$$

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5) Given rooted tree in Figure 1

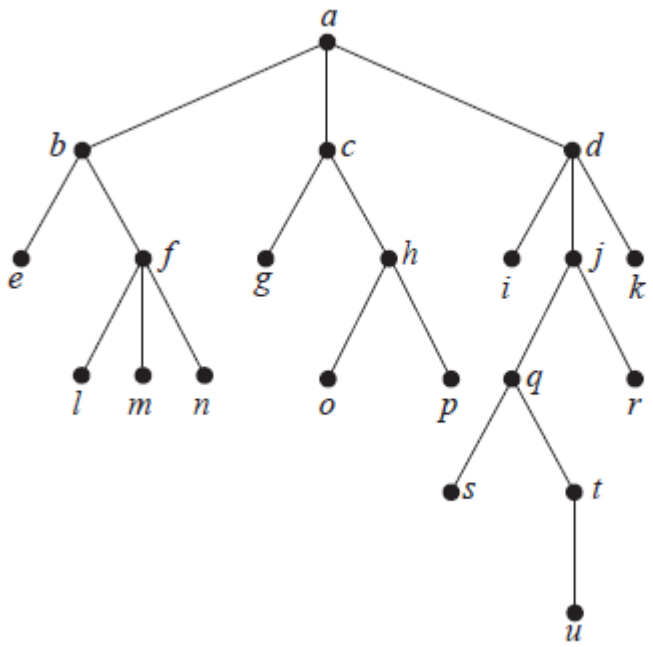

Figure 1

a) Which vertex is the root?

b) Which vertices are internal node? nodes have children

c) Which vertices are leaves? nodes don't have children

d) Which vertices are children of j?

e) Which vertex is the parent of h?

f) Which vertices are siblings of o?

g) Which vertices are ancestors of m?

h) Which vertices are descendants of b?

6) How many vertices does a full 5-ary tree with 100 internal vertices have?

7) How many leaves does a full 4-ary tree with 1000 vertices have?

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8) Use Kruskal algorithm to find the minimum spanning tree for the following graph in Figure 2

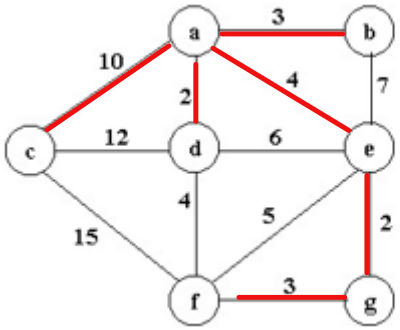

Figure 2

ab 3
ac 10
ad 2
ae 4
bc 7
cd 12
cf 15
de 6
df 4
ef 5

cg 2
bg 3

9) A chain letter starts with a person sending a letter out to 6 others. Each person is asked to send the letter out to 6 others, and each letter contains a list of the previous four people in the chain. Unless there are fewer than four names in the list, each person sends one dollar to the first person in this list, removes the name of this person from the list, moves up each of the other three names one position, and inserts his or her name at the end of this list. If no person breaks the chain and no one receives more than one letter, how much money will a person in the chain ultimately receive?

10) Construct a state transition diagram of a DFA that accepts all strings over $\{a, b, c\}$ that begin with a, contain exactly two b's, and end with c.

11) Construct a state transition diagram of a FSM that accepts the given set of strings over $\{a, b\}$:

a) contain exactly two b's.

b) at least one b.

c) odd number of a's

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12) A description of an automatic telephone answering machine is shown in Table 2. When a call arrives, the phone rings. If the phone is not picked up, then on the third ring, the machine answers. It plays a pre-recorded greeting requesting that the caller leave a message, then records the caller's message, and then automatically hangs up. If the phone is answered before the third ring, the machine does nothing.

Table 2

States		Input		Output	
q_0	idle (nothing is happening)	i_1	incoming ringing signal	0	default output when there is nothing interesting to say
q_1	one ring has arrived	i_2	a telephone is picked up	1	answer the phone and start the greeting message
q_2	two rings have arrived	i_3	greeting message is finish playing	2	start recording the incoming message
q_3	playing the greeting message	i_4	end of message detected	3	recorded an incoming message
q_4	recording the message	i_5	no input of interest		

a) Construct a state transition table by completing table below.

	f_s					f_o				
	i_1	i_2	i_3	i_4	i_5	i_1	i_2	i_3	i_4	i_5
q_0										
q_1										
q_2										
q_3										
q_4										

b) Based on answer in (a), construct a state transition diagram for the telephone answering machine.

1.a) vertices = 6

edges = 4

∴ The graph is disconnected.

Not a tree.

b) vertices = 6

edges = 6

∴ The number of edges is 6, which exceeds n - 1 = 5 for a tree, means it contains a circuit

Not a tree

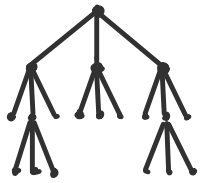
c) vertices = 6

edges = 6

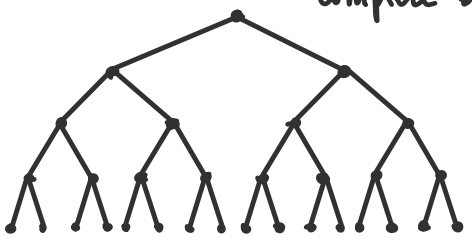
∴ The number of edges is 6, which exceeds n - 1 = 5 for a tree, means it contains a circuit

Not a tree

2. full - 3 ary trees with height 3



complete binary tree of height 4



3. Root :-

↳ Left Child : *

↳ Left subtree : ↑

↳ Left child : +

↳ Left : x , Right : 2

↳ Right Child : 3

Right Child : 5

Right subtree :-

Left : y , Right : +

↳ Left : 3 , Right : x

Pre-order (Root → Left → Right) :- * ↑ + x 2 3 - y + 3 x 5

In-order (Left → Root → Right) : (((x + 2) ↑ 3) * (y - (3 + x))) - 5

Post-order (Left → Right → Root) : x 2 + 3 ↑ y 3 x + - * 5 -

4. 521 - - 14 + + *

2 - 1 = 1 9 * 9 = 81

5 - 1 = 4

1 + 4 = 5

4 + 5 = 9

5 a) a

b) a, b, c, d, f, h, j, q, t

c) e, g, i, k, l, m, n, o, p, r, s, u

d) q, r

e) a, c

f) p

g) f, b, a

h) e, f, l, m, n

6) full-5 mary tree with 100 internal vertices

n vertices = ? $n = mi + 1$ $m = 2, i = 100, n = ?$ $n = mi + 1$

$= 2(100) + 1$

$= 201$

7) full 4-ary tree with 1000 vertices have

leaves = ? $n - \frac{(n-1)}{m} = \frac{(m-1)n+1}{m}$

$m = 4, \ n = 1000, l = ?$

$l = \frac{(m-1)n+1}{m}$

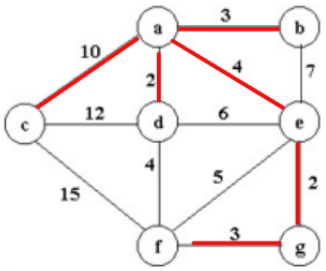
$= \frac{(4-1)1000+1}{4}$

$= 750.25$

8.

ab 3	be 7	df 4	
ac 10	cd 12	ef 5	
ad 2	cf 15	eg 2	
ae 4	de 6	fg 3	

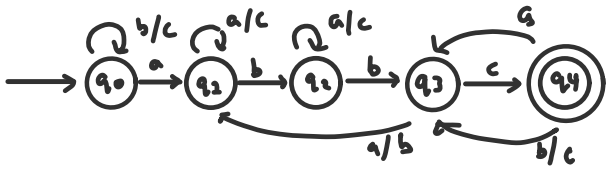
ab 3
ac 10
ad 2
ae 4
eg 2
fg 3



9.

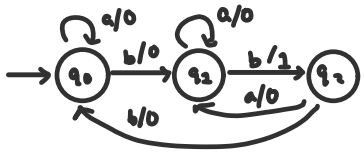
10. {a, b, c}

a b b c

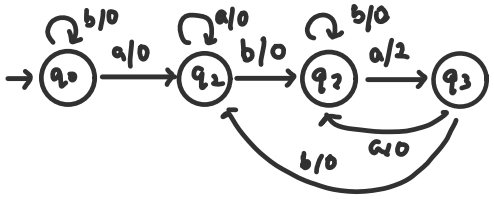


11. $\{a,b\}$

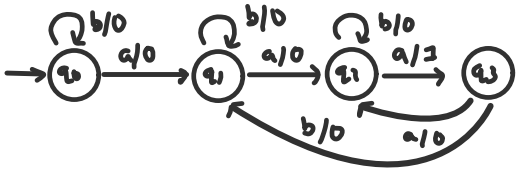
a) bb



c) at least one b



d) odd number of a's



12.a)

	f_s					f_o				
	i_1	i_2	i_3	i_4	i_5	i_1	i_2	i_3	i_4	i_5
q_0	q_2	q_0	q_0	q_0	q_0	0	0	0	0	0
q_1	q_2	q_0	q_2	q_2	q_1	0	0	0	0	0
q_2	q_2	q_0	q_3	q_2	q_2	1	1	1	1	1
q_3	q_3	q_3	q_4	q_3	q_3	2	2	2	2	2
q_4	q_4	q_4	q_4	q_0	q_4	3	3	3	3	3