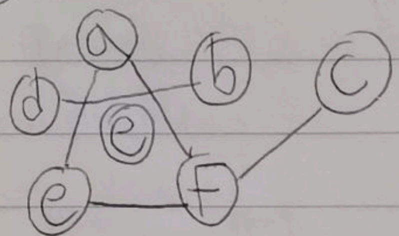
$2\cdot(n-1)$

2.1.



connected components:

d - b

a - e - f - c

e

2.2 a) $h = 9$

leaves $= 2^{h-1} = 2^8 = 256$

b) $h = 9$

$$\text{nodes} = \sum_{i=0}^{h-1} 2^i = \frac{1-2^h}{1-2} = 2^h - 1 = 2^9 - 1 = 511$$

c) nodes = 100

minimum height = 6 because

$2^6 - 1 = 63 \Rightarrow$ not enough

$2^7 - 1 = 127 \Rightarrow$ enough

d) "Every complete binary tree has more internal nodes than leaves".

N_i - internal nodes

N_L - leaves

N - all nodes

$$N = N_i + N_L$$

$$2^h - 1 = N_i + 2^{h-1}$$

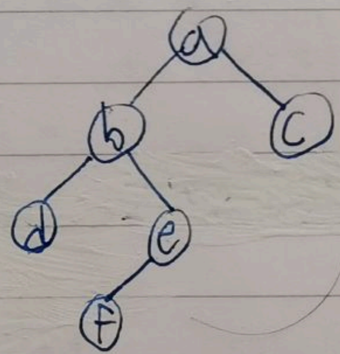
$$N_i = 2\cdot 2^{h-1} - 2^{h-1} - 1$$

$$N_i = 2^{h-1}(2-1) - 1$$

$$\boxed{N_i = 2^{h-1} - 1 = N_L - 1}$$

there is always less internal nodes!

2.3



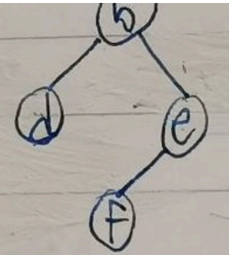
a)

pre-order: a-b-d-e-f-c

in-order: d-b-f-e-a-c

post-order: d-f-e-b-c-a

b) pre-odrer: 3-2-1-4-5-6-7



a)

pre-order: a - b - d - e - f - c

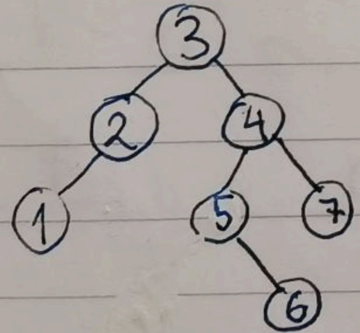
in-order: d - b - f - e - a - c

post-order: d - f - e - b - c - a

b) pre-odrer: 3 - 2 - 1 - 4 - 5 - 6 - 7

in-order: 1 - 2 - 3 - 5 - 6 - 4 - 7

post-order: 1 - 2 - 6 - 5 - 7 - 4 - 3



N_L - leaves

N - all nodes

$N = N_i + N_L$

$2^h - 1 = N_i + 2^{h-1}$

$N_i = 2 \cdot 2^{h-1} - 2^{h-1} - 1$

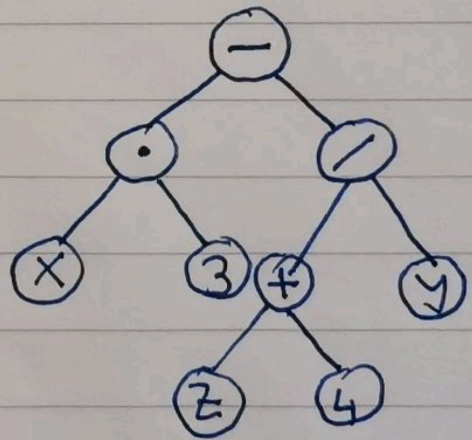
$N_i = 2^{h-1}(2-1) - 1$

$\boxed{N_i = 2^{h-1} - 1 = N_L - 1}$

there is always less internal nodes!

2.4

a) $x \cdot 3 - (z+4)/y$



2.4 $x \cdot 3 - (z+4) / y$

b) stack-machine code:

load x
const 3
mult
load z
const 4
sub
load y
div
sub

2.6

$u_1 = ab$

$u_2 = bbb$

$\Sigma = \{a, b\}$

$u_2 u_1 = bbbab$

$u_1 u_1 = abab$

$u_1^0 = \varepsilon = ""$

$|u_1 \cdot \varepsilon \cdot u_2| = |abbbb| = 5$

$|u_2^5| = 5 \cdot |u_2| = 5 \cdot 3 = 15$