# Proof – Total Nodes of a Perfect Binary Tree

- Geometric Progression (finite)
  - $a, ar, ar^2, ar^3, ar^4, \ldots, ar^{n-1}$
- Sum of Geometric Progression
  - $Sn = a + ar + ar^2 + ar^3 + ar^4 + \ldots.. + ar^{n-1}$
  - $Sn = a\,[\frac{(r^n-1)}{r-1}]$ if r>1 and r!=1

Trees

- Total no. of nodes = sum of internal + external nodes
- Internal nodes = $2^h - 1$
- External nodes = $2^h$
- Total nodes = $2^h - 1 + 2^h$

$= 2^h + 2^h - 1$ ; let say; a = $2^h$

$= a + a - 1$

$= 2a + 1$

$= 2.2^{h+1} - 1$ ; replacing a with $2^h$

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