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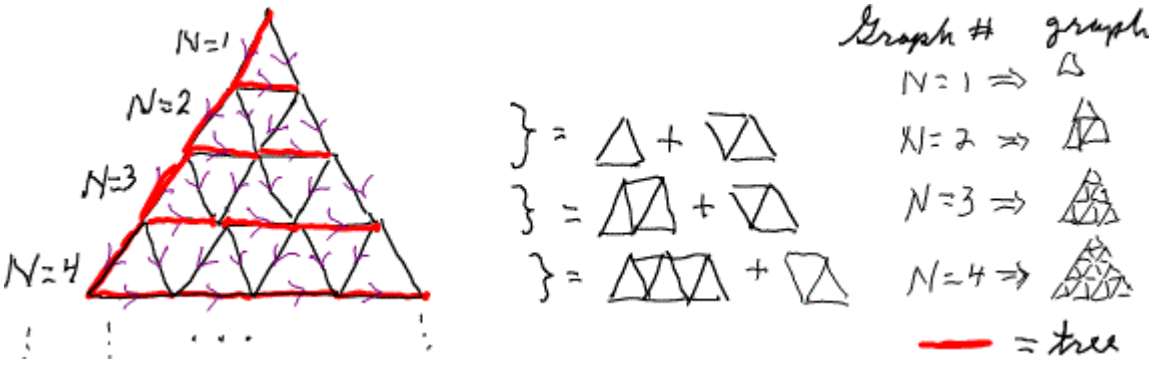
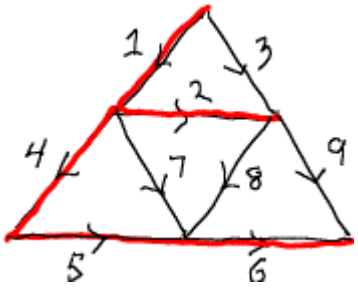
610 Fall 2016 – Homework 1 Due Tu 09/13/16

1. (40 points, Fractal Graph)

The following fractal graphs are indexed by positive integers N for which the Nth layer adds one bottom layer to the (N-1)th layer of the N-1st graph with two triangles on the right side added to the previous layers' patterns as illustrated.



a) Give the total number of nodes, $^{n}_{N}$, the total number of branches, $^{b}_{N}$, the number of tree branches, $^{t}_{N}$, and the total number of link branch, $^{l}_{N}$, for N=1,2,3 and 4.
b) Give a formula for calculating the sub-scripted-N quantities of part a) for any N.
c) For the four triangle graph of N=2, numbered as follows, give the cut set and tie set matrices.



2. (60 points, Van der Pol Oscillator)

The Van der Pol oscillator is described by the state equations:

$$dx/dt = y$$
$$dy/dt = - \omega_o^2 x + \varepsilon(r^2 - x^2)y$$

a) Set this up in Spice using two capacitors and G or GVALUE components. Normalize to r=1 and ω_o=1 but with ε as a parameter. Run transient analysis for ε = 0.01, 1 and 10 and for each plot the phase plane trajectory of y(t) versus x(t) (with x on the horizontal axis and y on the vertical; this can be set via the PLOT menu in PSpice). First use initial conditions x(0)=y(0)=0 and then investigate others including x(0)=y(0)=2.
b) Draw a graph for the resulting circuit and choose a tree which includes the two capacitors. Represent a G components by two branches (these being the input voltage sensor and the output current source).