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ECE 552
Fall 2017
HW #7, Solutions

Prob. 7.1: $v_1 = V_2 - V_4 = 5-1 = 4V$, $v_2 = V_3 - V_4 = 4-1 = 3V$, $i_1 = 1A$

Linearization: $v_1 = 2(1)^3 + 3(3) + 6i_1^k(i_1 - i_1^k) + 3(v_2 - v_2^k)$

$$v_1 = 6i_1 + 3v_2 - 4$$

$$i_2 = v_2^k i_2^k + 2i_1^k + (v_2^k+2)(i_1 - i_1^k) + i_1^k(v_2 - v_2^k)$$

$$= 5i_1 + v_2 - 3$$

$$\left[\begin{array}{cccc:cc} +g_1 & -g_1 & 0 & 0 & 0 & +1 \\ -g_1 & +g_1 & 0 & 0 & +1 & 0 \\ 0 & 0 & g_3+1 & -1 & +5 & 0 \\ 0 & 0 & -1 & g_2+1 & -5+1 & 0 \\ \hdashline 0 & +1 & -3 & +3-1 & -6 & 0 \\ +1 & 0 & 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} v_{n1} \\ v_{n2} \\ v_{n3} \\ v_{n4} \\ i_1 \\ i_V \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 3 \\ -3 \\ 4 \\ 10 \end{bmatrix}$$

- Note singular submatrix because of cutset of current variables

- You cannot find the values of g_1, g_2 and g_3 from the iteration point. $i_3 = g_3 V_3$, where $i_3 = -i_1$ is satisfied at the solution!

Prob. 7.2

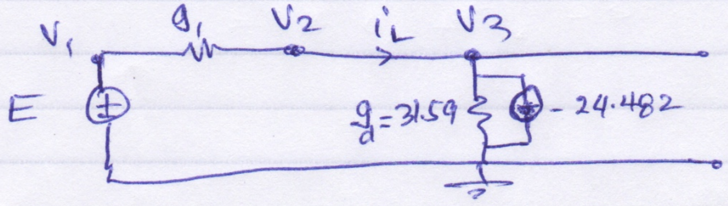
Linearization of diode equations:

$$i_d = I_s\left(e^{40 v_d} - 1\right), \quad v_d = 0.8V, \; I_s = 10^{-14} A$$

$$i_d = 40 I_s \, e^{40\times 0.8}\left(v_d - v_d^k\right) + 10^{-14}\left(e^{40\times 0.8} - 1\right)$$

$$= 31.59\, v_d - 24.482$$

Equivalent circuit at iteration point:



At DC, inductor is short-circuited, capacitor open.

$$\begin{bmatrix} +g_1 & -g_1 & 0 & +1 & 0 \\ -g_1 & +g_1 & 0 & 0 & +1 \\ 0 & 0 & 31.59 & 0 & -1 \\ +1 & 0 & 0 & 0 & 0 \\ 0 & +1 & -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} v_{n1} \\ v_{n2} \\ v_{n3} \\ i_E \\ i_L \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ -24.482 \\ E \\ 0 \end{bmatrix}$$

Cannot use $j\omega C$ & $j\omega L$. $I_C = (j\omega C)V_c$ and $V_L = (j\omega L) I_L$ can only be used to find the sinusoidal steady-state solution of linear circuits (and systems), provided the system is absolutely stable when the input is sinusoidal. Steady-state solution means all transients have become zero.