Note Title 8/31/2020

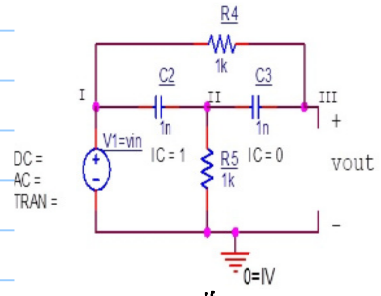
ENEE 610
09/03/20

The final report is a term paper based upon the study of your base paper topic. The electronic journal is a collection of than required things you have done for the course, such as computer runs, notes on reading of non-assigned papers, etc., to show me what you have done in the course beyond the required homework and term paper.

network = connection of circuis
circuit = connection of devices
electronic devices = R,L,C,controlled sources (E,F,G,H), gyrators, op-amps, transistors, switches, transformers, coupled coils, diodes, vacuum tubes, transmission lines, motors, etc.

Graph: points (=nodes=vertices=>n)
lines (=branches=edges=>b)
trees=>t, cotrees=links=>l forest=>f

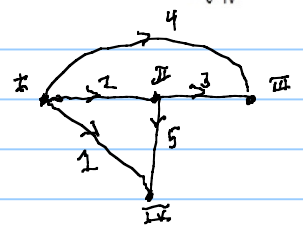
Limit to finite circuits; project on a plane
=>graphs in the plane = 2-simplex

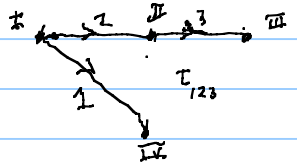


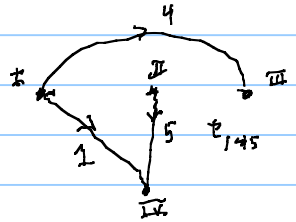
$$\text{Incident} := \begin{pmatrix} 1 & 1 & 0 & 1 & 0 \\ 0 & -1 & 1 & 0 & 1 \\ 0 & 0 & -1 & -1 & 0 \\ -1 & 0 & 0 & 0 & -1 \end{pmatrix} \qquad \text{Irdcd} := \begin{pmatrix} 1 & 1 & 0 & 1 & 0 \\ 0 & -1 & 1 & 0 & 1 \\ 0 & 0 & -1 & -1 & 0 \end{pmatrix}$$

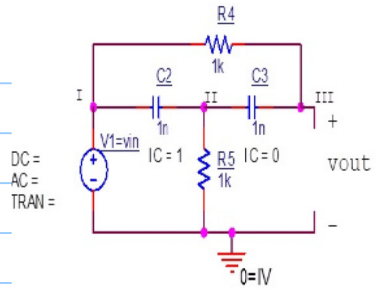
$$\text{Irdcd}^T = \begin{pmatrix} 1 & 0 & 0 \\ 1 & -1 & 0 \\ 0 & 1 & -1 \\ 1 & 0 & -1 \\ 0 & 1 & 0 \end{pmatrix} \qquad D := \text{Irdcd} \cdot \text{Irdcd}^T \qquad D = \begin{pmatrix} 3 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 2 \end{pmatrix}$$

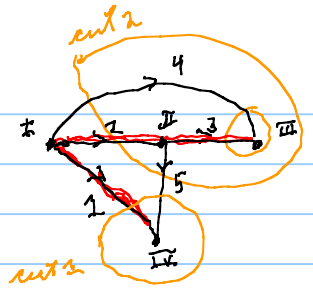
$$|D| = 8$$











KCL

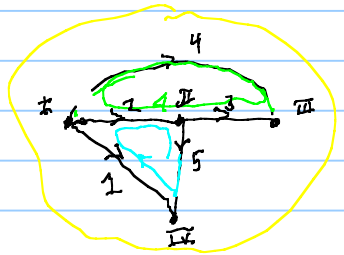
1 $0 = i_1 + 0\cdot i_2 + 0\cdot i_3 + 0\cdot i_4 + i_5$

2 $0 = 0\cdot i_1 + 1\cdot i_2 + 0\cdot i_3 + 1\cdot i_4 - i_5$

3 $0 = 0\cdot i_1 + 0\cdot i_2 + 1\cdot i_3 + 1\cdot i_4 + 0\cdot i_5$

cut set eqs., $\# = t$

$$\underline{0}_t = C\cdot \underline{i}_b, \quad C = \left[\begin{array}{ccccc} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & -1 \\ 0 & 0 & 1 & 1 & 0 \end{array}\right] = \left[\begin{array}{c|c} 1_t & K \end{array}\right] \quad t \times b$$



KVL

4 $0 = 0\cdot v_1 - 1\cdot v_2 + 1\cdot v_3 + 1\cdot v_4 + 0\cdot v_5$

5 $0 = -v_1 + v_2 + 0\cdot v_3 + 0\cdot v_4 + 1\cdot v_5$

cut set eqs. $\underline{0}_l = \left[\begin{array}{ccccc} 0 & -1 & -1 & 1 & 0 \\ -1 & 1 & 0 & 0 & 1 \end{array}\right] \underline{v}_b = \left[\begin{array}{c|c} -K^T & 1_l \end{array}\right] \underline{v}_b \quad l \times b$

$= Q_f \cdot \underline{v}_b = [-K^T 1_t + 1_l v_l]$

$v\cdot i$ = power in a branch

$\underline{v}_b^T \cdot \underline{i}_b = 0 = [v_1\ v_2\ v_3\ v_4\ v_5] \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ v_4 \\ i_5 \end{bmatrix}$ = total power in to the circuit from outside.

$b = t + l$

$= (n-1) + l$

$\underline{v}_b = \begin{bmatrix} \underline{v}_t \\ \underline{v}_l \end{bmatrix}, \quad \underline{i}_b = \begin{bmatrix} \underline{i}_t \\ \underline{i}_l \end{bmatrix}$

$0 = [1_t \ K] \begin{bmatrix} i_b \\ i_l \end{bmatrix} \Rightarrow -\underline{i}_t = K\,\underline{i}_l \Rightarrow \begin{bmatrix} \underline{i}_t \\ \underline{i}_l \end{bmatrix} = \underline{i}_b = \begin{bmatrix} 0 & -K \\ 0 & 1_l \end{bmatrix} \begin{bmatrix} i_b \\ i_l \end{bmatrix} = \begin{bmatrix} -K \\ 1_l \end{bmatrix} \underline{i}_l = Q_f^T \underline{i}_l = \underline{i}_b$

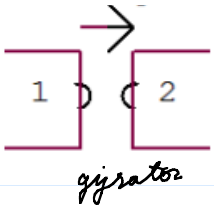
$\underline{v}_l = K^T \underline{v}_t \Rightarrow \underline{v}_b = \begin{bmatrix} \underline{v}_t \\ \underline{v}_l \end{bmatrix} = \begin{bmatrix} 1_t \\ K^T \end{bmatrix} \underline{v}_t \Rightarrow \underline{v}_b = e^T \underline{v}_t$

$\underline{v}_b^T \underline{i}_b = (e^T \underline{v}_t)^T \cdot (Q_f^T \underline{i}_l) = \underline{v}_t^T (e\, Q_f^T)\, \underline{i}_l = 0$ (a scalar)

$e\, Q_f^T$ (0_{tl} (a matrix)) true as a circuit exists to every entry since $\underline{v}_t$ & $\underline{i}_l$ can be independently chosen

$e\, Q_f^T = [1_t \ K] [-K^T \ 1_l]^T$

$= -K^T + K = -K + K = 0_{tl}$



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