# Computer Aided Design
# CAD

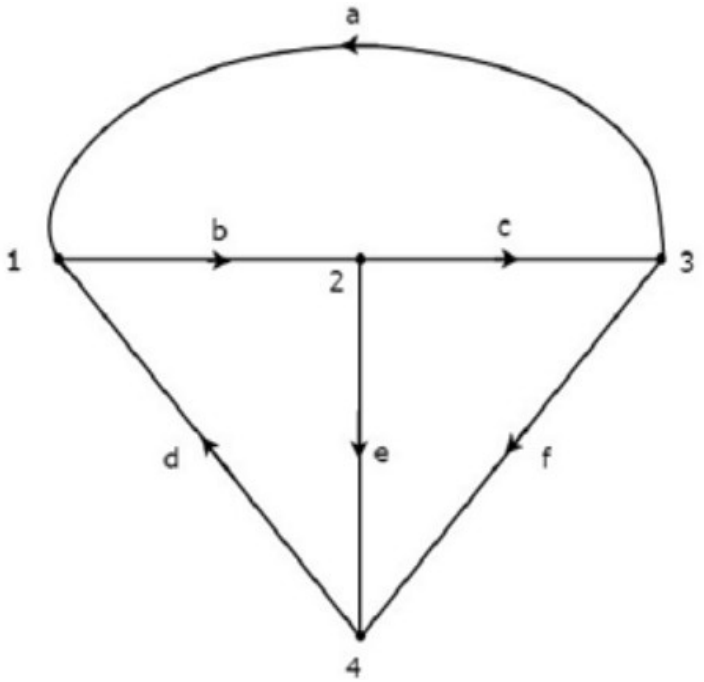
LECTURE 2

# Reduced incidence matrix

- Any node of a connected graph can be selected as a reference node.
- Then the voltages of the other nodes (referred to as buses) can be measured with respect to the assigned reference.

$$A = \begin{bmatrix} -1 & 1 & 0 & -1 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 & 0 \\ 1 & 0 & -1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & -1 & -1 \end{bmatrix}$$

$$A = \begin{bmatrix} -1 & 1 & 0 & -1 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 & 0 \\ 1 & 0 & -1 & 0 & 0 & 1 \\ & & & & & \end{bmatrix}$$



# Apply Electrical Lows

- From incidence matrix (A) we can apply KCL.

$$\mathbf{A} * \mathbf{J_B} = 0$$

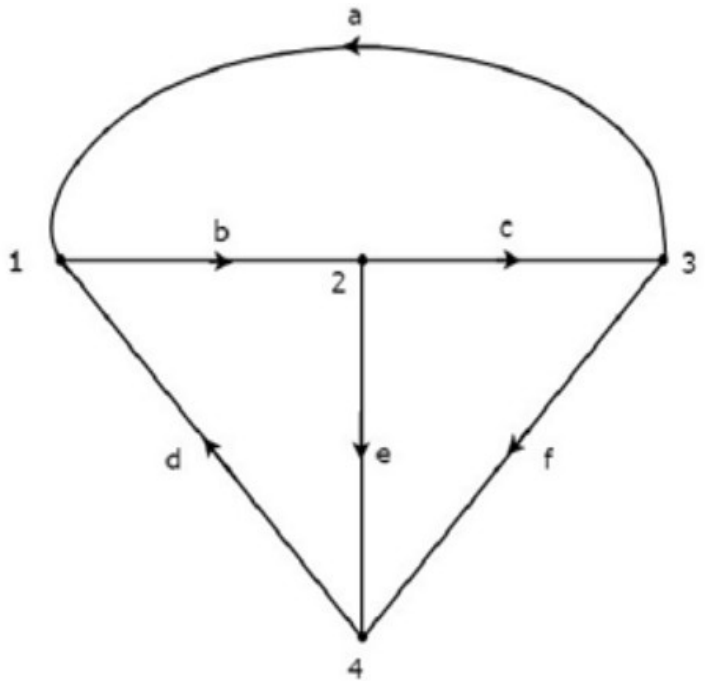
$$\begin{matrix} a & b & c & d & e & f \end{matrix}$$

$$\begin{bmatrix} -1 & 1 & 0 & -1 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 & 0 \\ 1 & 0 & -1 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} j_a \\ j_b \\ j_c \\ j_d \\ j_e \\ j_f \end{bmatrix} = 0$$

$$-j_a + j_b - j_d = 0$$

$$-j_b + j_c + j_e = 0$$

$$j_a - j_c - j_f = 0$$



# Apply Electrical Lows

- From tie set matrix (B) we can apply KVL.

$$B * V_B = 0$$

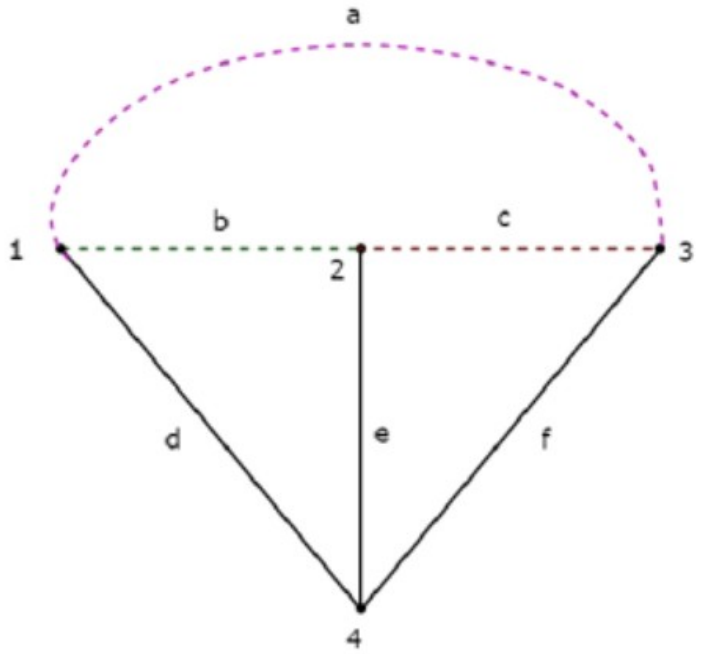
$$\begin{matrix} d & e & f & a & b & c \end{matrix}$$

$$\begin{bmatrix} -1 & 0 & -1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & -1 & 1 & 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} v_d \\ v_e \\ v_f \\ v_a \\ v_b \\ v_c \end{bmatrix} = 0$$

$$-v_d - v_f + v_a = 0$$

$$v_d + v_e + v_b = 0$$

$$-v_e + v_f + v_c = 0$$

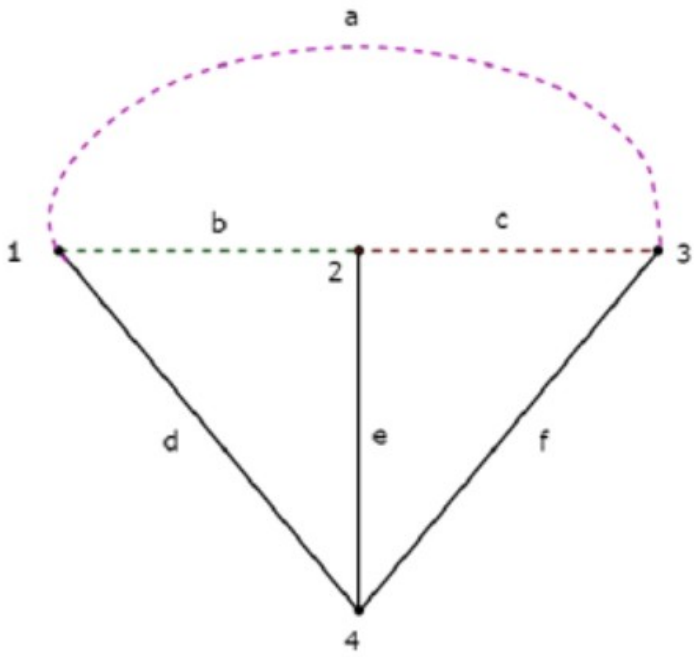


# Apply Electrical Lows

- Also, we can express branch currents in terms of loop currents.

$$J_B = B^T * I_L$$

$Where\ J_B\ are\ brances\ current$
$Where\ I_L\ are\ loop\ current$



# Relation between Network Topology Matrices

$$C_L = -B_T^t$$

$$C_L = A_T^{-1} * A_L$$

$$C = A_T^{-1} * A$$

# Example

- From A matrix calculate the B and C matrices and verify your answer by mean of obtained graph

$$A = \begin{bmatrix} -1 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 1 & -1 & 0 & 0 & -1 \end{bmatrix}$$