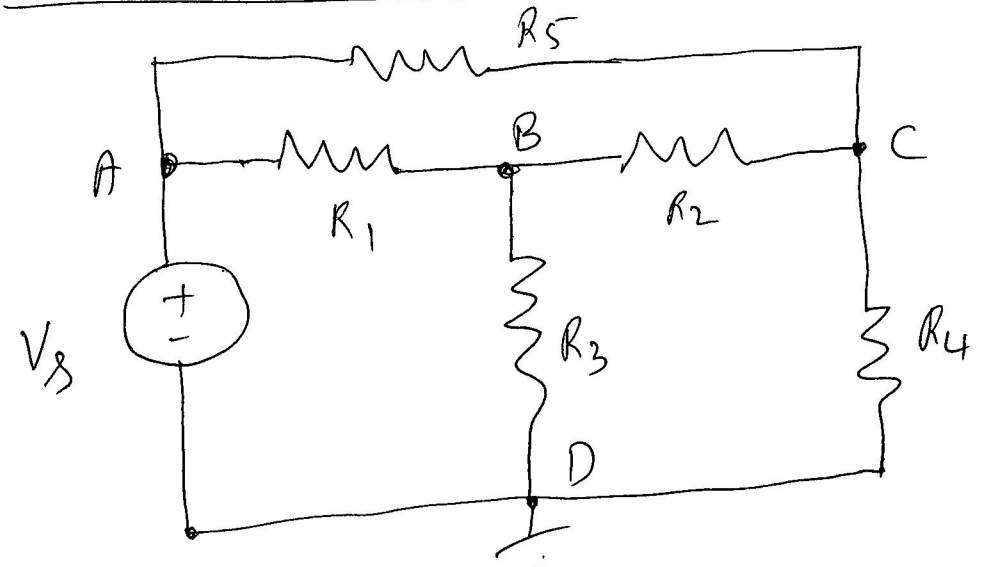
Nodal Analysis

Illustrate with an example

1)



1) Choose D as reference node
2) V_A is known. (no need for eqn at A)

Node B: $$-\frac{1}{R_1}V_A + \left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)V_B - \frac{1}{R_2}V_C = 0$$

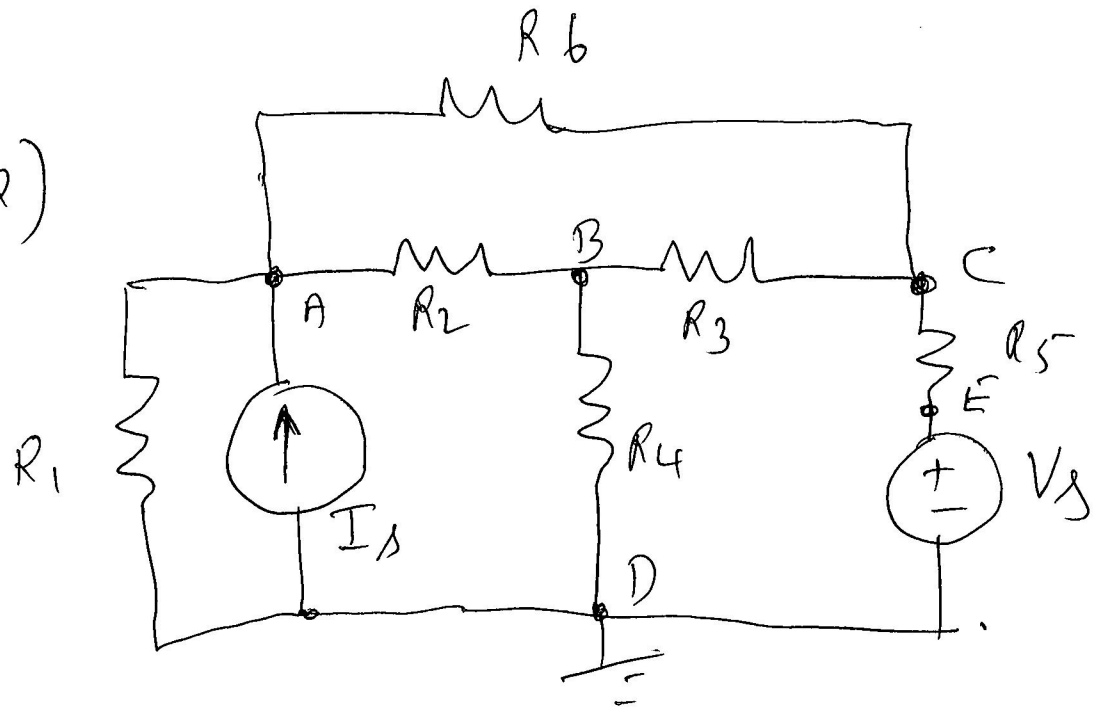
Node C: $$-\frac{1}{R_5}V_A + \left(\frac{1}{R_2}+\frac{1}{R_4}+\frac{1}{R_5}\right)V_C - \frac{1}{R_2}V_B = 0$$

Re arrange: $$\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)V_B - \frac{1}{R_2}V_C = \frac{1}{R_1}V_s$$

$$-\frac{1}{R_2}V_B + \left(\frac{1}{R_2}+\frac{1}{R_4}+\frac{1}{R_5}\right)V_C = \frac{1}{R_5}V_s$$

Solve

2)



We have two sources, a current source and a voltage source. We have five nodes. D is the ref. node. Note $V_E = V_S$ is known

Node A :

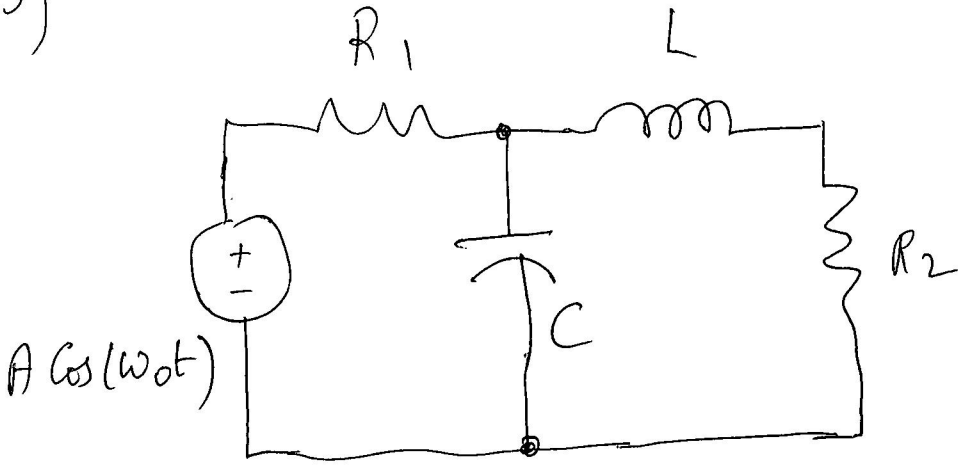
$$\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_6}\right)V_A - \frac{1}{R_2}V_B - \frac{1}{R_6}V_C = I_S$$

Node B :

$$-\frac{1}{R_2}V_A + \left(\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}\right)V_B - \frac{1}{R_3}V_C = 0$$

Node C :

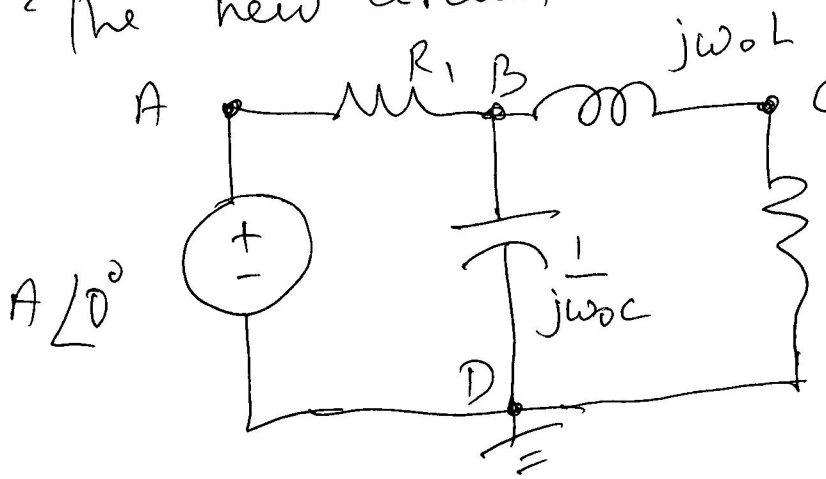
$$-\frac{1}{R_6}V_A - \frac{1}{R_3}V_B + \left(\frac{1}{R_3}+\frac{1}{R_5}+\frac{1}{R_6}\right)V_C = \frac{V_S}{R_5}$$



This is an AC circuit. Replace $A\cos(\omega_0 t)$ with $Ae^{j\omega_0 t} \longrightarrow A\angle 0^\circ$. Replace R, L, C with their impedances as below

$$R \longrightarrow R, \quad L \longrightarrow j\omega_0 L, \quad C \longrightarrow \frac{1}{j\omega_0 C}$$

The new circuit is



Node B :
$$\left(\frac{1}{R_1} + j\omega_0 C + \frac{1}{j\omega_0 L}\right) V_B - \frac{1}{j\omega_0 L} V_C = \frac{A\angle 0^\circ}{R_1}$$

Node C :
$$-\frac{1}{j\omega_0 L} V_B + \left(\frac{1}{R_L} + \frac{1}{j\omega_0 L}\right) V_C = 0$$