Supplementary Material for Lecture 5

One cannot write node voltage equations in the format studied in Lecture 4

$$(V_A - V_B) \cdot G_1 + (V_A - V_C) \cdot G_2 + (V_A - V_D) \cdot G_3 = 0$$

if a voltage source V_S connects nodes. This is because the current that flows through a voltage source is unknown and Ohm's law does not help.

As such, label the unknown current, I_X, and explicitly include into equation

$$I_X + (V_A - V_C) \cdot G_2 + (V_A - V_D) \cdot G_3 = 0$$

and keep writing equations for all other nodes. Notice that equation for node B will include the same unknown current with the opposite sign $-I_X$. Add the equations for node A and for node B and observe that the unknown currents $(I_X - I_X)$ cancel.

Nodes A and B can be considered as a supernode; the remaining equation maintains that electric charges are neither created nor destroyed in the supernode. Relate V_A to V_B and V_S using KVL to obtain single equation for nodes A and B. Some supernodes embrace more than 2 nodes of the circuit.

Obtaining all node voltage equations in a similar manner. The unknown currents I_X, can be found, if needed, from KCL equations with known node voltages and resistances.