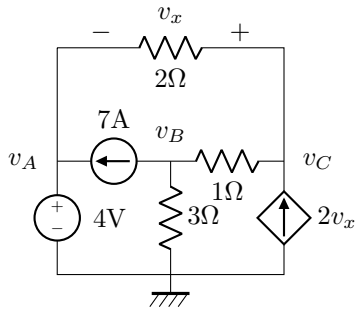
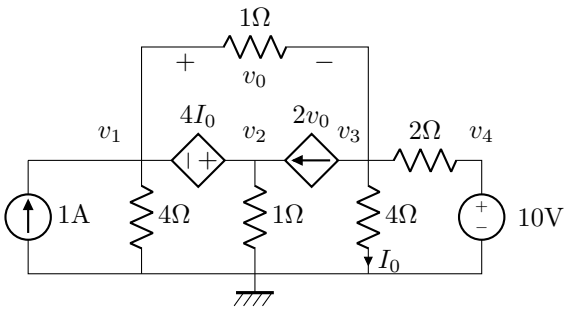
# Lecture 13, Feb 9, 2022

## Nodal Analysis With Voltage Sources

- When there is a dependent source, express the parameter that the source depends on in terms of nodal voltages
- When there is an ungrounded voltage source, instead of writing KCL for the two nodes separately, write KCL for the "supernode" that combines the two nodes connected by the source
  - This reduces the number of equations by 1, but we can get this equation back by relating the voltages of the two nodes using the voltage source; inside the supernode one node is kept at a higher voltage than the other by the source
  - This extra equation is called the *supplementary equation* for the supernode
- Example circuit 1:




  - $v_A = 4\text{V}$
  - In this case, $v_x = v_C - v_A$
  - At node B: $7 + \frac{v_B}{3} + \frac{v_B - v_C}{1} = 0$
  - At node C: $\frac{v_C - v_A}{2} + \frac{v_C - v_B}{1} - 2(v_C - v_A) = 0$
- Example circuit 2:




  - $v_4 = 10\text{V}$
  - $I_0 = \frac{v_3}{4}, v_0 = v_1 - v_3$
  - Combine nodes 1 and 2 into a supernode: $-1 + \frac{v_1}{4} + \frac{v_1 - v_3}{1} + \frac{v_2}{1} - 2(v_1 - v_3) = 0$
  - At node 3: $2(v_1 - v_3) + \frac{v_3 - v_1}{1} + \frac{v_3}{4} + \frac{v_3 - v_4}{2} = 0$
  - 2 equations, 3 unknowns $(v_1, v_2, v_3)$; the last equation comes from the voltage source between nodes 1 and 2, producing $v_2 - v_1 = 4\frac{v_3}{4}$