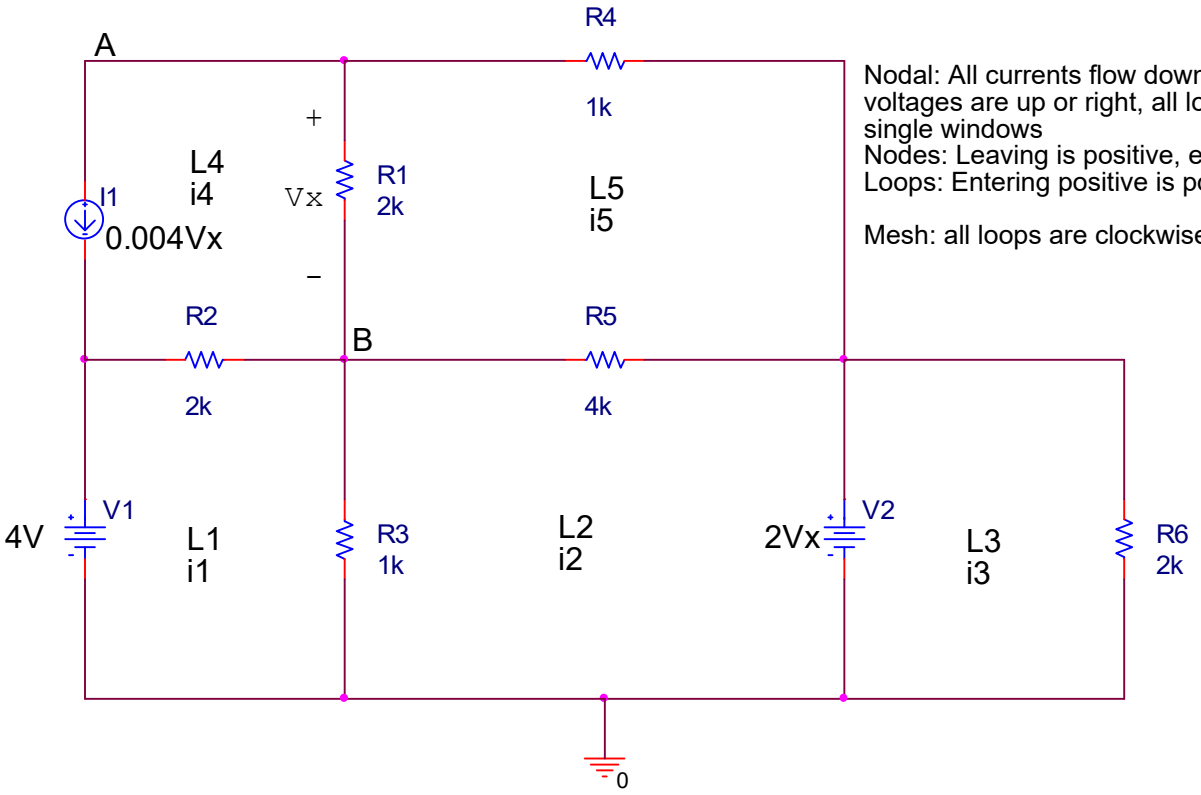
Hayden Fuller

Electric Circuits Prof. Shayla Sawyer

1) Dependent Voltage Sources



Nodal: All currents flow down or left, all positive voltages are up or right, all loops are clockwise single windows
Nodes: Leaving is positive, entering is negative.
Loops: Entering positive is positive

Mesh: all loops are clockwise

In the circuit above, set up the linear system to analyze the circuit using both mesh and node analysis. You only need to solve for Vx using one of the methods. Be sure to include the following:

a) Label the nodes you would use to perform node analysis.
b) Clearly write linear system of equations for nodal analysis.
c) Clearly write linear system of equation for mesh analysis.
d) Find Vx using either method.

b) nodal
A: 0.004*V(R1)+I(R1)-I(R4)=0
B: -I(R1)+I(R2)+I(R3)-I(R5)=0
L1: -4-V(R2)+V(R3)=0
L2: -V(R3)-V(R5)+2*V(R1)=0
L3: -2*V(R1)+V(R6)=0
L5: -V(R1)-V(R4)+V(R5)=0

A: 0.004*2000*I(R1)+I(R1)-I(R4)=0
B: -I(R1)+I(R2)+I(R3)-I(R5)=0
L1: -2000*I(R2)+1000*I(R3)=4
L2: -1000*I(R3)-4000*I(R5)+2*2000*I(R1)=0
L3: -2*2000*I(R1)+2000*I(R6)=0
L5: -2000*I(R1)-1000*I(R4)+4000*I(R5)=0

NODAL SYSTEM:
A: 9*I(R1)-I(R4)=0
B: -I(R1)+I(R2)+I(R3)-I(R5)=0
L1: -2000*I(R2)+1000*I(R3)=4
L2: 4000*I(R1)-1000*I(R3)-4000*I(R5)=0
L3: -4000*I(R1)+2000*I(R6)=0
L5: -2000*I(R1)-1000*I(R4)+4000*I(R5)=0

c) mesh
i1: -4-V(R2)+V(R3)=0
i2: -V(R3)-V(R5)+2*V(R1)=0
i3: -2*V(R1)+V(R6)=0
i4: i4=-0.004*V(R1)
i5: -V(R1)-V(R4)+V(R5)=0

i1: -4-2000*I(R2)+1000*I(R3)=0
i2: -1000*I(R3)-4000*I(R5)+2*2000*I(R1)=0
i3: -2*2000*I(R1)+2000*I(R6)=0
i4: i4=-0.004*2000*I(R1)
i5: -2000*I(R1)-1000*I(R4)+4000*I(R5)=0

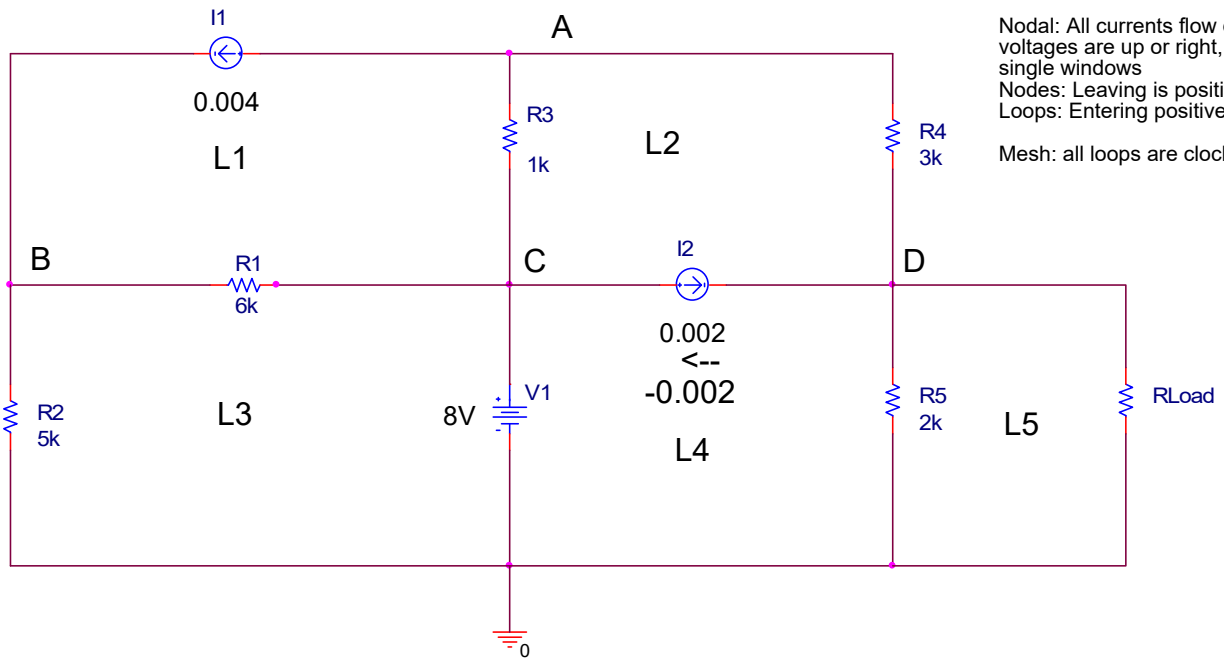
i1: -4-2000*I(-i1+i4)+1000*I(i1-i2)=0
i2: -1000*I(i1-i2)-4000*I(-i2+i5)+4000*I(i4-i5)=0
i3: -4000*I(i4-i5)+2000*I(i3)=0
i4: i4=-8*I(i4-i5)
i5: -2000*I(i4-i5)-1000*I(-i5)+4000*I(-i2+i5)=0

MESH SYSTEM:
i1: 3000*i1-1000*i2-2000*i4=4
i2: -1000*i1+5000*i2+4000*i4-8000*i5=0
i3: 2000*i3-4000*i4+4000*i5=0
i4: -9*i4+8*i5=0
i5: -4000*i2-2000*i4+7000*i5=0

I(R1)=i4-i5=0.14mA

Vx=0.29V

2) Thevenin/Norton Voltage



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On the above circuit, using any method, find the a) thevenin voltage, b) thevenin resistance, and c) norton current. Draw the schematics of the norton and thevenin circuits for full credit. Confirm your values by any method.

a) voltage
A: .004+I(R3)+I(R4)=0
B: -.004-I(R1)+I(R2)=0
D: -.002-I(R4)+I(R5)=0
L3: 8-5000*I(R2)-6000*I(R1)=0
L24: -8-1000*I(R3)+3000*I(R4)+2000*I(R5)=0

R1: -1.0909mA -6.5454V
R2: 2.9090mA 14.5454V
R3: -4.0000mA -4.0000V
R4: 0.0000mA 0.0000V
R5: 2.0000mA 4.0000V

V_th=4V

b) resistance
V_test = 1V, circuit simplifies, R_th=1.333k ohm

c) current
V_th=I_no*R_th, 4=I_no*(4/3)k,

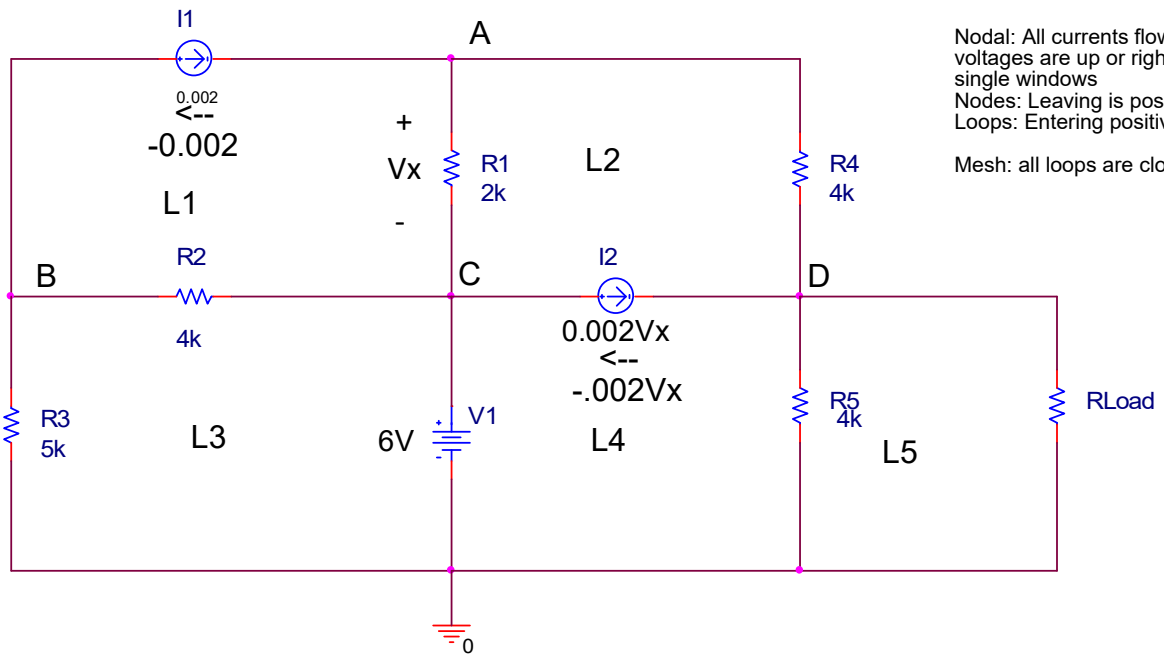
I_no=3mA

confirm) test R_Load=1k
A: .004+I(R3)+I(R4)=0
B: -.004-I(R1)+I(R2)=0
D: -.002-I(R4)+I(R5)+I(RL)=0
L3: 8-5000*I(R2)-6000*I(R1)=0
L24: -8-1000*I(R3)+3000*I(R4)+2000*I(R5)=0
L5: -2000*I(R5)+1000*I(RL)=0

Linsolve, not writing it all down
RL: I=1.714mA V=1.714V

I=V/R=4/(4/3+1)k=1.714mA ✓

3) Thevenin/Norton Voltage



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a) Determine VTH using any analysis method, IN using any analysis method, and RTH using the test method for the above circuit. Verify your answers.

voltage) nodal
A: -.002+I(R1)+I(R4)=0
B: .002-I(R2)+I(R3)=0
D: -.002*2000*I(R1)-I(R4)+I(R5)=0
L3: -5000*I(R3)-4000*I(R2)+6=0
L24: -6-2000*I(R1)+4000*I(R4)+4000*I(R5)=0

A: -.002+I(R1)+I(R4)=0
B: .002-I(R2)+I(R3)=0
D: -4*I(R1)-I(R4)+I(R5)=0
L3: -5000*I(R3)-4000*I(R2)+6=0
L24: -6-2000*I(R1)+4000*I(R4)+4000*I(R5)=0

I(R5)=-3mA V(R5)=-12V

current) nodal
A: -.002+I(R1)+I(R4)=0
B: .002-I(R2)+I(R3)=0
L3: -5000*I(R3)-4000*I(R2)+6=0
L24: -6-2000*I(R1)+4000*I(R4)=0

I(R4)=1.666mA
V(R1)=.333mA*2k=.666V
I(I2)=.002*.666V=1.333mA
D:-1.333mA+1.666mA+I_No=0

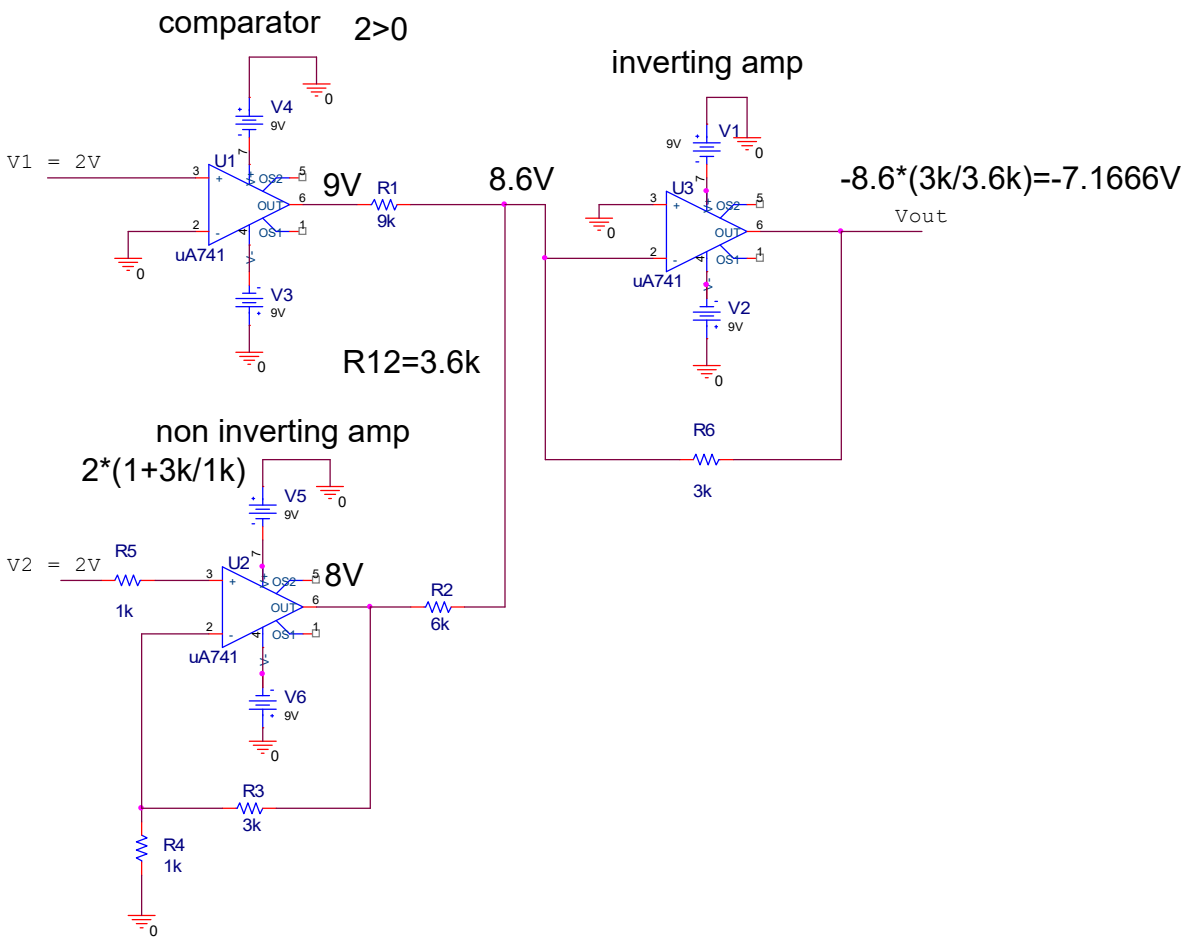
I_No=-0.3mA

resistance) test voltage 1V
circuit simplifies, L1 and L3 gone
Vx=1*2k/(2k+4k)=.333V
I2=.666mA up
I(R14)=1/6k=.1666mA
I(R5)=1/4k=.25mA
I=.1666+.25-.6666=-.25mA
1V=-.25mA*R
R=-4k ohm

It's 2am and physics is at 8am so I just verified everything in LTspice :)

well the voltages are swapped, so all they're given and all they can output is -9V...

4) Amplifier Circuits



a) Find the output voltage, Vout. The voltages to power the op-amps are 9V and -9V.

Vout=-7.1666V

5) Amplifier Circuits - Designing problem

a) Design a two stage amplifier such that the output of the first stage is V1 = 5*Vin and the output of the second stage is V2 = -V1.