SYMBULATOR 9

A Baker's Dozen

Twelve solved examples from the documentation, and a bonus

Each of these circuits looks like an afternoon's work by hand. Symbulator solves each one in a single run, or in two when a switch splits the problem into intervals. No two of them make the same point. Every description below is the one in the app's built-in examples, and every answer was checked against the app on 16 September 2026. The link under each run opens the entry in the online app.

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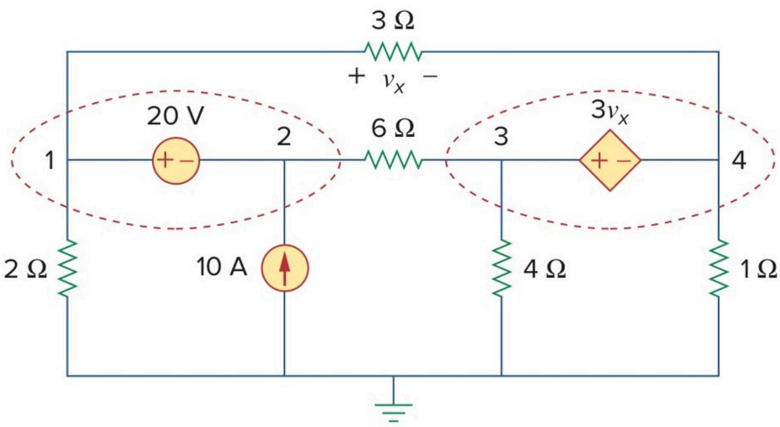
AS7's Example 3.4

Supernodes around a dependent source

Alexander & Sadiku sampler

Find the node voltages in the circuit of the figure.



> **Why it is here.** Two voltage sources float between non-reference nodes, and one of them is worth three times the drop across a resistor. By hand that is two supernodes and a constraint equation. Here it is eight lines typed as they are drawn.

DC

```
e1,1,2,20
r3,1,4,3
r6,2,3,6
e2,3,4,3*vr3
r2,1,0,2
j,0,2,10
r4,3,0,4
r1,4,0,1
```

Analysis: DC. Rounding: approx.

$v_1 = 26.667$ V

$v_2 = 6.6667$ V

$v_3 = 173.33$ V

$v_4 = -46.667$ V

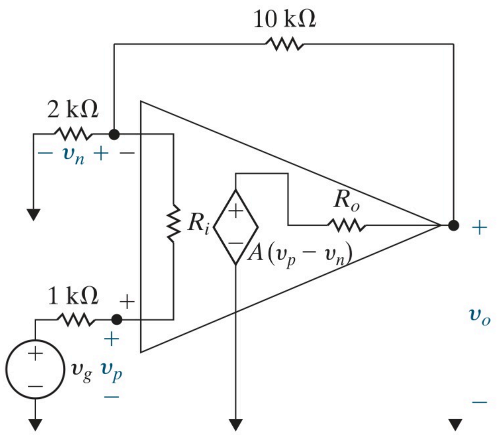
https://symbulator.pythonanywhere.com/?lesson=as7&entry=2

NR12's Example 5.7

An op amp with its flaws left in

Nilsson & Riedel sampler

Analyze the noninverting amplifier using the realistic op amp model, with open-loop gain A = 50,000, input resistance R_i = 100 kΩ and output resistance R_o = 7.5 kΩ. Find the gain v_o/v_g.



> **Why it is here.** No ideal op amp here. The model is a dependent source with a finite gain, an input resistance and an output resistance, written as three ordinary elements. The source stays a symbol, so the gain is read straight off the answer.

DC

```
eg,1,0,vg
rg,1,p,1'k
ri,p,n,100'k
rs,n,0,2'k
rf,n,3,10'k
ro,4,3,7.5'k
ea,4,0,50000*(vp-vn)
```

Analysis: DC. Rounding: approx. Evaluate: v_3/vg.

$v_3/v_g = 5.9988$

https://symbulator.pythonanywhere.com/?lesson=nr12&entry=14

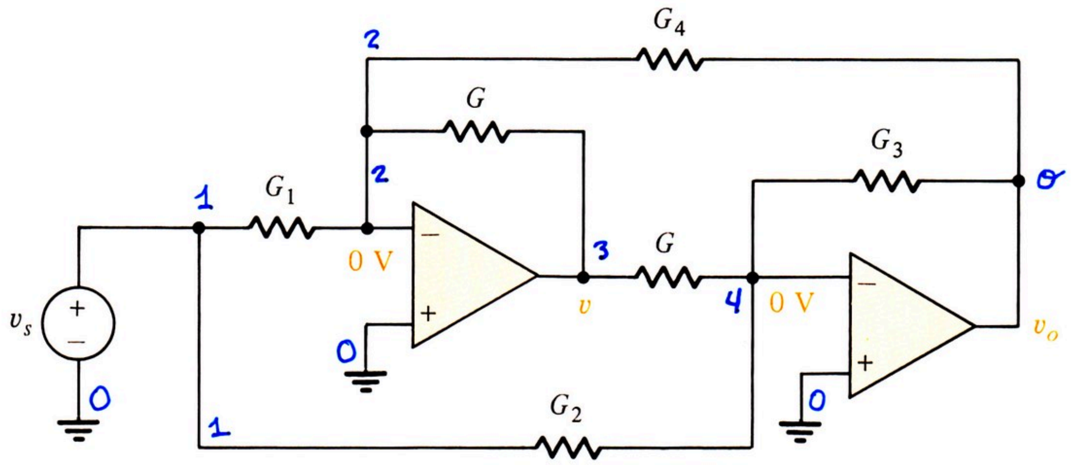
SAMPLE 3 OF 12

Bo2's Example 3.3

Two op amps, every conductance a symbol

Course, Lesson 5 (Operational Amplifiers)

Find v_o in terms of the conductances and the applied voltage v_S.



> **Why it is here.** There is not a single number in the circuit. The answer is the gain as a formula, and its shape explains the circuit: a difference of conductances over a difference of conductances.

DC

```
e,1,0,vs
r12,1,2,1/g1
r14,1,4,1/g2
r4o,4,o,1/g3
r2o,2,o,1/g4
r23,2,3,1/g
r34,3,4,1/g
o1,0,2,3
o2,0,4,o
```

Analysis: DC. Rounding: exact.

$$v_o = \frac{(g_1 - g_2)\, v_s}{g_3 - g_4}$$

https://symbulator.pythonanywhere.com/?lesson=5b&entry=14

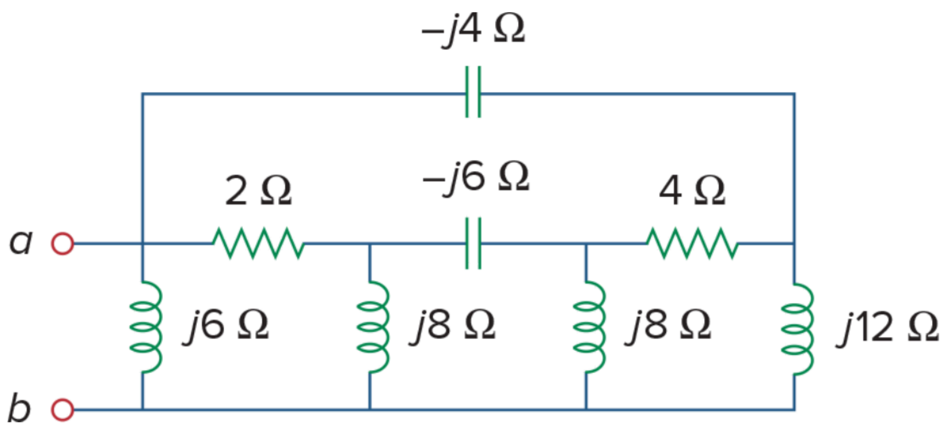
SAMPLE 4 OF 12

AS7's Problem 9.73

Eight impedances that will not reduce

Course, Lesson 7 (AC)

Determine the equivalent impedance for the circuit.



> **Why it is here.** No two of these impedances are in series or in parallel, so by hand the circuit needs a delta-wye transformation. Find equivalent does it in one run.

AC

```
r10,1,0,6j
r20,2,0,8j
r30,3,0,8j
r40,4,0,12j
r12,1,2,2
r23,2,3,-6j
r34,3,4,4
r14,1,4,-4j
```

Analysis: Find equivalent, Resistance / impedance, between nodes 1 and 0, in AC.

$Z_{eq} = 0.3794 + 1.46\,\mathrm{j}\ \Omega$

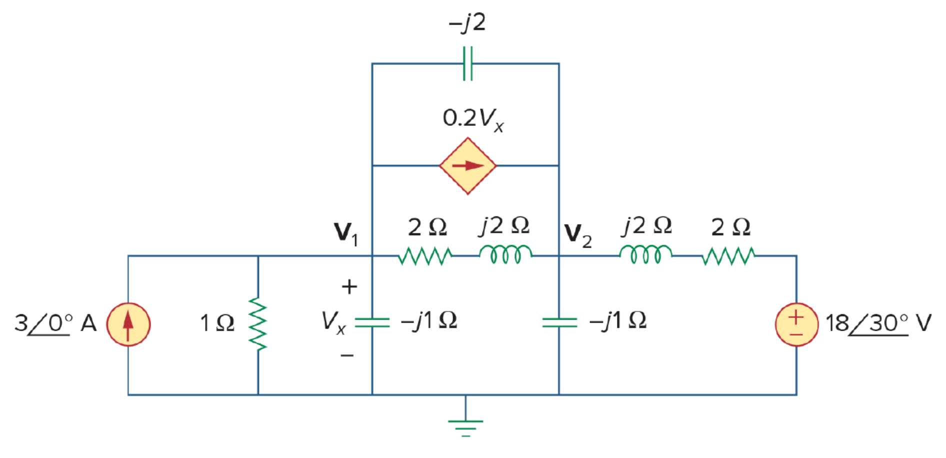
https://symbulator.pythonanywhere.com/?lesson=7&entry=6

AS7's Example 10.14

Phasors with a dependent source

Course, Lesson 7 (AC)

Find V_1 and V_2 in the circuit.



Why it is here. Nine elements, three sources, one of them controlled by the voltage across a capacitor, and complex impedances on every branch. Nodal analysis by hand means complex algebra in two unknowns.

AC

```
j1,0,1,3
r1,1,0,1
rx,1,0,-1j
r3,1,2,-2j
j2,1,2,.2*vrx
r4,1,2,2+2j
r5,2,0,-1j
r6,2,3,2+2j
e,3,0,(18∠30°)
```

Analysis: AC. Show AC answers as polar phasors.

$V_1 = 2.708\angle{-56.73^\circ}\ \mathrm{V}$

$V_2 = 6.914\angle{-80.70^\circ}\ \mathrm{V}$

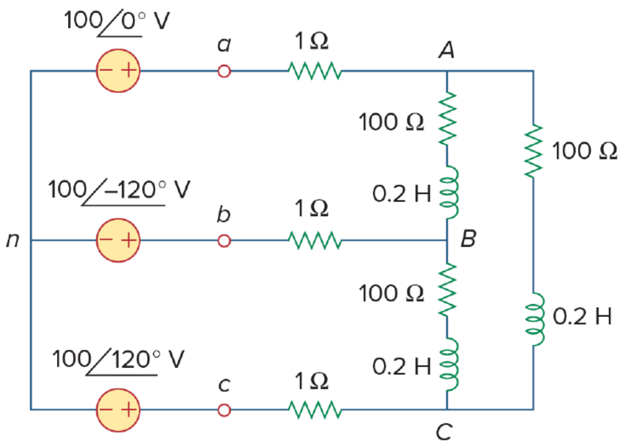
https://symbulator.pythonanywhere.com/?lesson=7&entry=10

AS7's Example 12.11

Three-phase wye-delta with line impedances

Course, Lesson 9 (Three-Phase)

For the balanced Y-Δ circuit, find the line current I_{aA}, *the phase voltage* V_{AB} *and the phase current* I_{AC}.



> **Why it is here.** The textbook converts the delta to a wye and works a single-phase equivalent. Symbulator needs neither: the three sources, the three lines and the delta go in as drawn.

AC

```
ea1,na1,0,100
eb1,nb1,0,(100∠-120°)
ec1,nc1,0,(100∠120°)
raa,na1,na2,1
rbb,nb1,nb2,1
rcc,nc1,nc2,1
rac,na2,nc2,100+24*pi*j
rcb,nc2,nb2,100+24*pi*j
rba,nb2,na2,100+24*pi*j
```

Analysis: AC. Rounding: 4 digits. Polar phasors. Evaluate: vna2-vnb2.

$I_{aA} = i_{raa} = 2.350\angle{-36.20}^\circ$ A

$V_{AB} = v_{na2} - v_{nb2} = 169.94\angle 30.81^\circ$ V

$I_{AC} = i_{rac} = 1.357\angle{-66.20}^\circ$ A

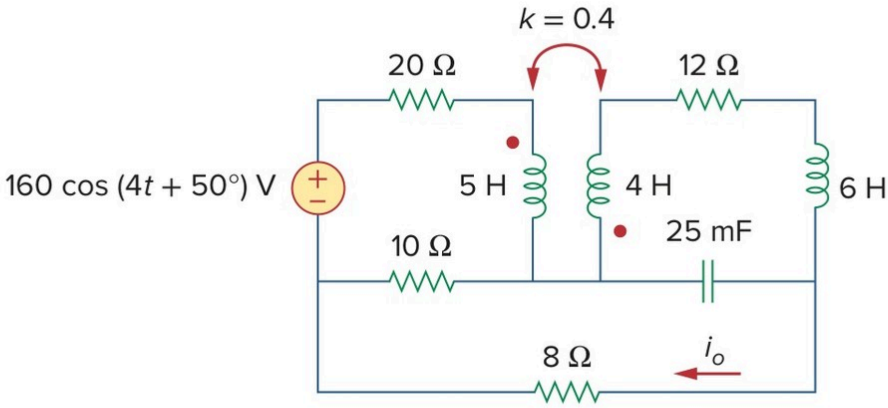
https://symbulator.pythonanywhere.com/?lesson=9&entry=6

AS7's Practice Problem 13.13

Coupled coils in a tangle

Alexander & Sadiku sampler

Find i_o in the circuit of the figure.



Why it is here. Two coils coupled by k = 0.4, dots at opposite ends, a third coil, and a capacitor hung from the node the coupled coils share. The coupling is one line naming the two coils.

AC

```
e,1,0,(160∠50°)
r20,1,a,20
l1,a,m,5
l2,m,b,4
m,l1,l2,k=0.4
r12,b,c,12
l3,c,r,6
c,m,r,25'm
r10,0,m,10
r8,r,0,8
```

Analysis: AC, ω = 4. Rounding: 4 digits.

$i_o = i_{r8} = 2.011\angle 68.51°\ \text{A}$

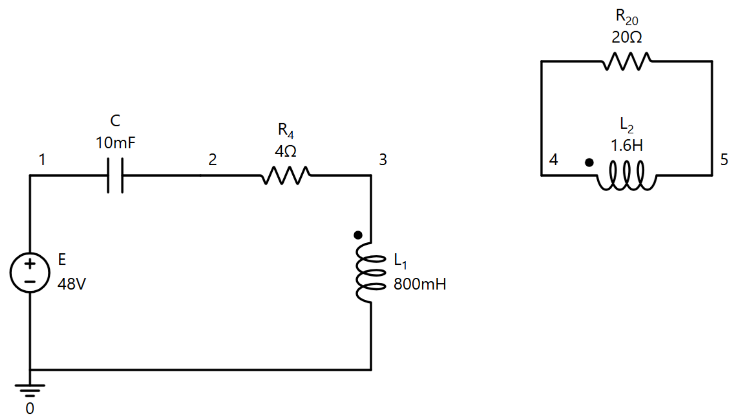
https://symbulator.pythonanywhere.com/?lesson=as7&entry=48

NR11's switched RLC with coupled coils

A transient across a coupling

Course, Lesson 10 (Coupling)

A 48 V source feeds a 10 mF capacitor, a 4 Ω resistor and a 0.8 H coil in series. A switch across the capacitor has been closed a long time and opens at t = 0. The coil is coupled, M = 0.8 H, to a 1.6 H coil across a 20 Ω resistor. Find v_o, the voltage across the 20 Ω, for t > 0.



M = 800mH (couples L_1 and L_2)

> **Why it is here.** A second-order primary talking to a first-order secondary through a mutual inductance. The answer carries both natural responses, an oscillation at 10 rad/s and a decay at 25 per second.

DC, T < 0

```
e,1,0,48
r4,1,3,4
l1,3,0,0.8
l2,4,5,1.6
r20,4,5,20
m,l1,l2,0.8
```

Analysis: DC.

$$i_{l1} = 12\ \text{A}$$

$$i_{l2} = 0\ \text{A}$$

https://symbulator.pythonanywhere.com/?lesson=10&entry=17

TR, T > 0

```
e,1,0,48
c,1,2,10'm,0
r4,2,3,4
l1,3,0,0.8,12
l2,4,5,1.6,0
r20,4,5,20
m,l1,l2,0.8
```

Analysis: TR. Evaluate: v4-v5.

$$v_o = e^{-5t}\,(60\cos 10t - 120\sin 10t) - 60\,e^{-25t}\ \text{V}$$

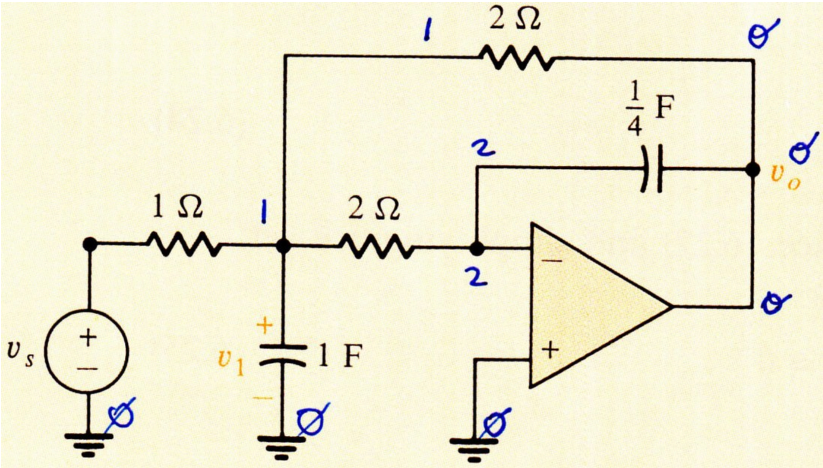
https://symbulator.pythonanywhere.com/?lesson=10&entry=18

Bo2's Drill Exercise 6.6

Two capacitors around an op amp

Course, Lesson 6 (Transients)

In the circuit, suppose that $v_S(t) = 2 - 2u(t)$ *V. Find* $v_o(t)$ *for t ≥ 0.*



> **Why it is here.** An active second-order circuit whose two poles land in the same place. The repeated pole shows as the t in the answer, which no hand-picked solution form has to anticipate.

DC, T < 0

```
e,3,0,2
r1,3,1,1
r2,1,2,2
r3,1,o,2
ca,1,0,1
cb,2,o,1/4
o,0,2,o
```

Analysis: DC.

$v_{ca} = 0$ V

$v_{cb} = 4$ V

https://symbulator.pythonanywhere.com/?lesson=6d&entry=7

TR, T > 0

```
r1,0,1,1
r2,1,2,2
r3,1,o,2
ca,1,0,1,0
cb,2,o,1/4,4
o,0,2,o
```

Analysis: TR.

$v_o = (-4t - 4)\, e^{-t}$ V

https://symbulator.pythonanywhere.com/?lesson=6d&entry=8

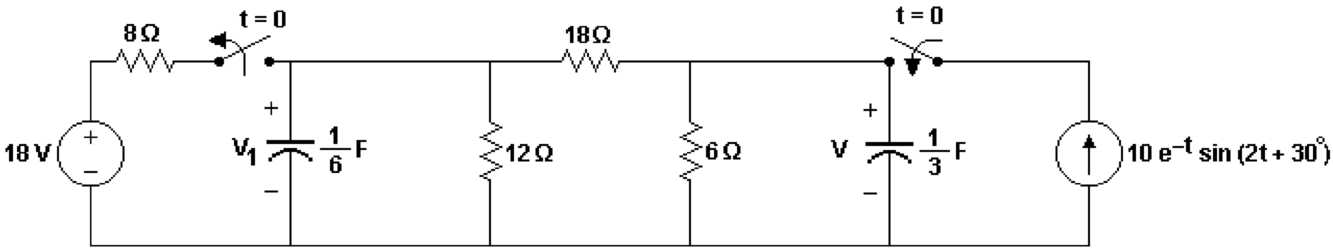
SAMPLE 10 OF 12

Prof. Boulet's exam problem

The switch, the ladder and the damped sine

Course, Lesson 6 (Transients)

The circuit comes from the circuits analysis class of Professor Eliane Boulet de Cabrera, at Universidad Tecnológica de Panamá. Find v_1 and v.



Why it is here. Two capacitors with their own initial conditions, and after the switch a current source that is itself a damped sinusoid. The answer holds two natural modes and a forced response. The TI calculator took 78 seconds and version 9 takes about one.

DC, T < 0

```
e,3,0,18
r8,3,1,8
ca,1,0,1/6
r12,1,0,12
r18,1,2,18
r6,2,0,6
cb,2,0,1/3
```

Analysis: DC. Rounding: exact.

$$v_{ca} = 9\ \mathrm{V}$$

$$v_{cb} = 9/4\ \mathrm{V}$$

https://symbulator.pythonanywhere.com/?lesson=6d&entry=18

TR, T > 0

```
ca,1,0,1/6,9
r12,1,0,12
r18,1,2,18
r6,2,0,6
cb,2,0,1/3,9/4
j,0,2,10e^(-t)*sin(2t+30*pi/180)
```

Analysis: TR. Limit the results to v1, v2.

$$v_1 = \left(\frac{5\sqrt{3}}{17} - \frac{20}{17}\right) e^{-t} \cos 2t - \left(\frac{20\sqrt{3}}{17} + \frac{5}{17}\right) e^{-t} \sin 2t + \left(\frac{80\sqrt{3}}{17} + \frac{193}{34}\right) e^{-t/2} + \left(\frac{9}{2} - 5\sqrt{3}\right) e^{-t}\ \mathrm{V}$$

$$v_2 = -\left(\frac{245\sqrt{3}}{34} + \frac{20}{17}\right) e^{-t} \cos 2t + \left(\frac{245}{34} - \frac{20\sqrt{3}}{17}\right) e^{-t} \sin 2t + \left(\frac{80\sqrt{3}}{17} + \frac{193}{34}\right) e^{-t/2} + \left(\frac{5\sqrt{3}}{2} - \frac{9}{4}\right) e^{-t}\ \mathrm{V}$$

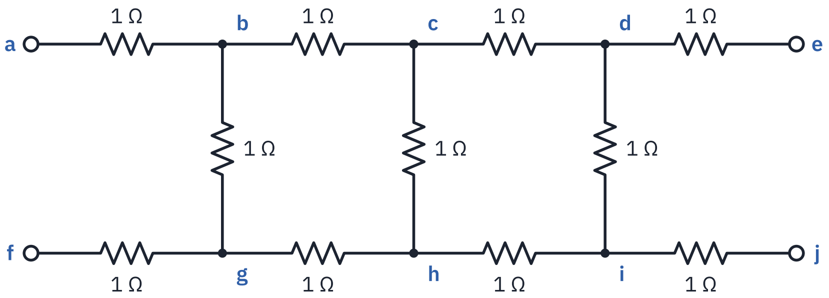
https://symbulator.pythonanywhere.com/?lesson=6d&entry=19

AS7's Problem 19.2

A two-port with no ground

Course, Lesson 13 (Two-Ports)

Determine the impedance parameters of the ladder: four 1 Ω resistors in the upper rail, four in the lower, three 1 Ω rungs.



> **Why it is here.** Eleven resistors and no node 0 anywhere. Each port is written as its pair of terminals, so the lower rail stays in the circuit instead of being shorted to ground.

DC

```
r1,a,b,1
r2,b,c,1
r3,c,d,1
r4,d,e,1
r5,f,g,1
r6,g,h,1
r7,h,i,1
r8,i,j,1
r9,b,g,1
r10,c,h,1
r11,d,i,1
```

Analysis: Find equivalent, Two-port parameters, z, between [a,f] and [e,j].

$z_{11} = z_{22} = 41/15 = 2.733\ \Omega$

$z_{12} = z_{21} = 1/15 = 0.06667\ \Omega$

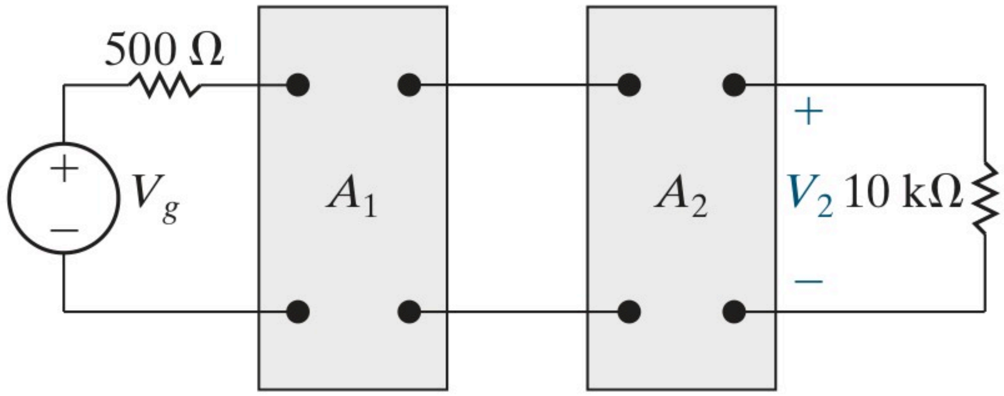
https://symbulator.pythonanywhere.com/?lesson=13&entry=14

NR12's Example 18.6

Two amplifiers known only by their h parameters

Nilsson & Riedel sampler

Two identical amplifiers are connected in cascade. Each is described by its h parameters: h_{11} = *1000 Ω,* h_{12} = *0.0015,* h_{21} = *100,* h_{22} = *100 µS. The source has 500 Ω of internal resistance and the load is 10 kΩ. Find the voltage gain* V_2/V_g.



Why it is here. Each amplifier is a single element carrying its four parameters, and the cascade is two lines sharing a node. No matrix products, no conversions between parameter sets.

DC

```
e,1,0,vg
rs,1,a,500
h1,a,b,[1000,0.0015,100,0.0001]
h2,b,c,[1000,0.0015,100,0.0001]
rl,c,0,10'k
```

Analysis: DC. Rounding: approx. Evaluate: v_c/vg.

$V_2/V_g = v_c/v_g = 33333.33$

https://symbulator.pythonanywhere.com/?lesson=nr12&entry=16

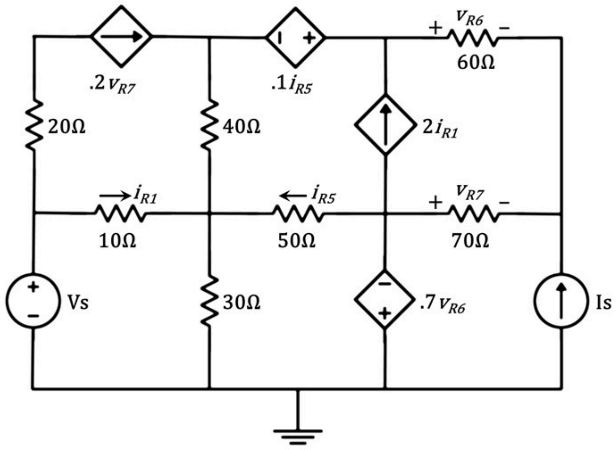
BONUS

A freebie, on the house

One dependent source of each kind

Course, Lesson 3 (Sources), as the Showing-off Problem

Find positive values for V_s and I_s that will result in 80 W delivered by the VCCS and 0 W dissipated in the CCVS.



Why it is here. Invented by Roberto Perez-Franco in 2013 to show off. A VCCS, a CCVS, a CCCS and a VCVS woven through seven resistors, and the question runs backwards, from powers to sources. The two power conditions are quadratic, so four solutions fit, and the conditions pick the positive one. The answers also show why the CCVS dissipates nothing: its controlling current is exactly zero.

DC, EXPERT MODE

```
es,e,0,vs
js,0,d,is
r1,e,m,10
r2,a,e,20
r3,m,0,30
r4,b,m,40
r5,n,m,50
r6,c,d,60
r7,n,d,70
jd1,a,b,0.2vr7
ed2,c,b,0.1ir5
jd3,n,c,2ir1
ed4,0,n,0.7vr6
```

Analysis: DC. Rounding: 4 digits. Expert Mode: equations pjd1 = -80 and ped2 = 0, unknowns vs, is, conditions vs > 0 and is > 0.

$v_s = 17.61$ V

$i_s = 0.3973$ A

$i_{r5} = 0$ A

https://symbulator.pythonanywhere.com/?lesson=3&entry=49