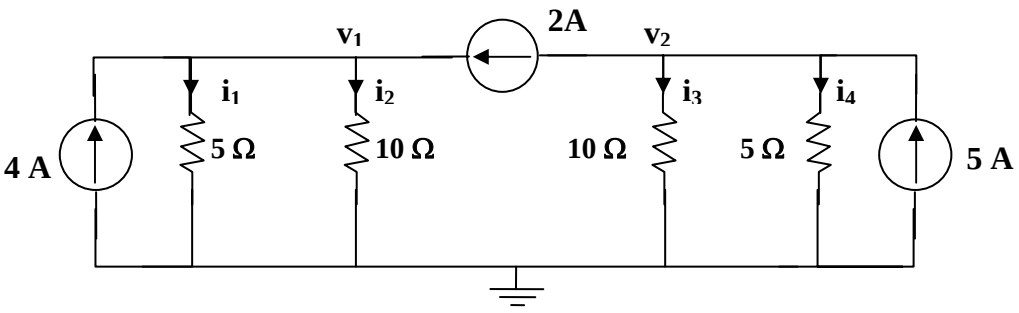
Spring 2008

EECS70A / CSE 70A Network Analysis I
Prof. Peter Burke

Midterm II solution

Grading criteria for all questions: no credits for answers without units and - 3pts for calculation error

Problem 1:



At node 1,

$4 + 2 = v_1/(5) + v_1/(10) \longrightarrow v_1 = 20$

At node 2,

$5 - 2 = v_2/(10) + v_2/(5) \longrightarrow v_2 = 10$

$i_1 = v_1/(5) = \underline{\mathbf{4\ A}}$, $i_2 = v_1/(10) = \underline{\mathbf{2\ A}}$, $i_3 = v_2/(10) = \underline{\mathbf{1\ A}}$, $i_4 = v_2/(5) = \underline{\mathbf{2\ A}}$

Grading criteria: 3pts for only KCL at ground or at one node
5pts for only KCL equation or mesh equation with wrong sign
10pts for correct KCL equation at V_1 and V_2 or mesh equation with incorrect answer

Problem 2:

At the top node, KVL gives

$$\frac{V_o - 36}{1} + \frac{V_o - 0}{2} + \frac{V_o - (-12)}{4} = 0$$

$1.75V_o = 33V$ or $V_o = 18.86V$

Alternatively, mesh analysis can be used

i_1=17.14A, i_2=7.71A

V_0= 2(i_1-i_2)=18.86 V

Grading criteria: 5pts for only KCL or mesh equation with wrong sign
5pts for correct mesh current i_1 and i_2 on mesh analysis
10pts for correct KCL or mesh equation with incorrect answer

Problem 3:

We replace the box with the Thevenin equivalent.

When i = 1.5, v = 3, which implies that $V_{Th} = 3 + 1.5R_{Th}$ (1)

When i = 1, v = 8, which implies that $V_{Th} = 8 + R_{Th}$ (2)

From (1) and (2), R_{Th} = 10 ohms and V_{Th} = 18 V.

(a) When R = 4, $i = V_{Th}/(R + R_{Th}) = 18/(4 + 10) =$ **1.2857 A**

(b) For maximum power, $R = R_{TH}$

$P_{max} = (V_{Th})^2/4R_{Th} = 18^2/(4x10) =$ **8.1 watts**
$= i^2R_{Th} = (0.9)^2X10 =$ **8.1 watts**

Grading criteria: No credit for final answers without R_{Th}, V_{Th}
2pts for showing equivalent circuit in the box (R_{Th}, V_{Th})
3pts for correct i equation
3pts for correct power equation showing R= R_{Th}

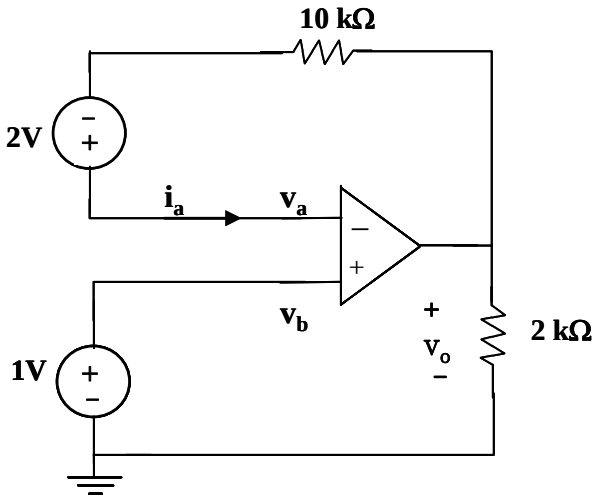
5pts for correct R_{Th} and V_{Th}

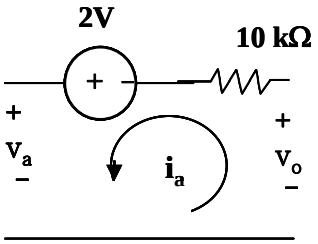
Problem 4:

(a) If v_a and v_b are the voltages at the inverting and noninverting terminals of the op amp.

$v_a = v_b = 0$

$$1\text{mA} = \frac{0 - v_0}{2\text{k}} \longrightarrow v_0 = \underline{\mathbf{-2V}}$$





(a) (b)

Since $v_a = v_b = 1V$ and $i_a = 0$, no current flows through the 10 kΩ resistor.
From Fig. (b),

$$-v_a + 2 + v_0 = 0 \longrightarrow v_0 = v_a - 2 = 1 - 2 = \underline{\mathbf{-1V}}$$

Grading criteria: 3 pts for correct V_a and V_b for each question
5pts for correct KCL equation for (a) with wrong answer
-3pts for wrong sign of final answer with correct steps

Problem 5:

C_{eq} = 3F// 6F// 4F = 3+6+4= 13F

Grading criteria: 3pts for showing parallel connection with wrong answer
-3pts for calculation error

Problem 6:

L//L = 0.5L, L + L = 2L

$$L_{eq} = L + 2L // 0.5L = L + \frac{2Lx0.5L}{2L + 0.5L} = \underline{1.4L} = \mathbf{\underline{1.4\ L}}.$$

Grading criteria: 3pts for showing correct connections with wrong answer
-3pts for calculation error