ECE 209 — Exam # 2

Estimated time for completion: <1.25 hour
24 October 2017

Rules of the Exam

Rule 1: The examination period begins at 9:30am on Tuesday 24 October 2017 and ends at 10:45pm on Tuesday 24 October 2017.

Rule 2: There are four problems.

Rule 3: The exam is closed book and closed notes. You may have an 8.5" x 11" sheet of paper with notes and a calculator.

Rule 4: Do not leave the room until you have completed the exam.

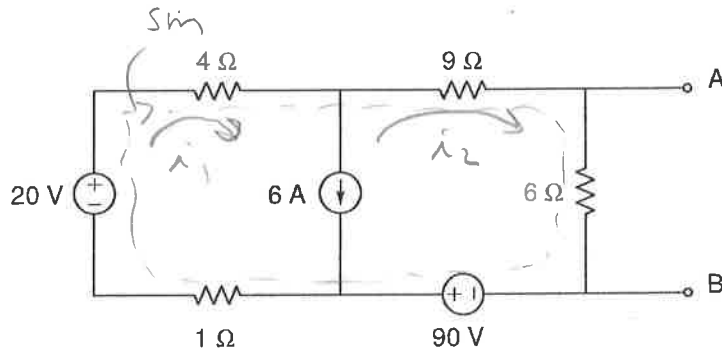**Rule 5**: To receive full credit for an answer include the units along with the numerical answer.

Rule 6: Show all work - answers without supporting work will not receive credit.

Answer Key
_____
Name

Problem 1 (30 points)

Consider the circuit below:

Part A: Draw the Thévenin Equivalent Circuit with respect to terminals A and B.

Supermesh: $4i_1 + 9i_2 + 6i_2 - 90 + i_1 - 20 = 0$

$\left(i_1 - i_2 = 6 \Rightarrow i_1 = 6 + i_2 \right.$

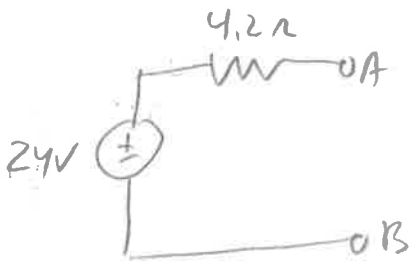$5i_1 + 15i_2 = 110$

$30 + 5i_2 + 15i_2 = 110$

$20i_2 = 80$

$i_2 = 4A$

$V_{AB} = 6i_2 = 24V$

$R_{AB} = 6 || 14$

$z \; 4.2\Omega$
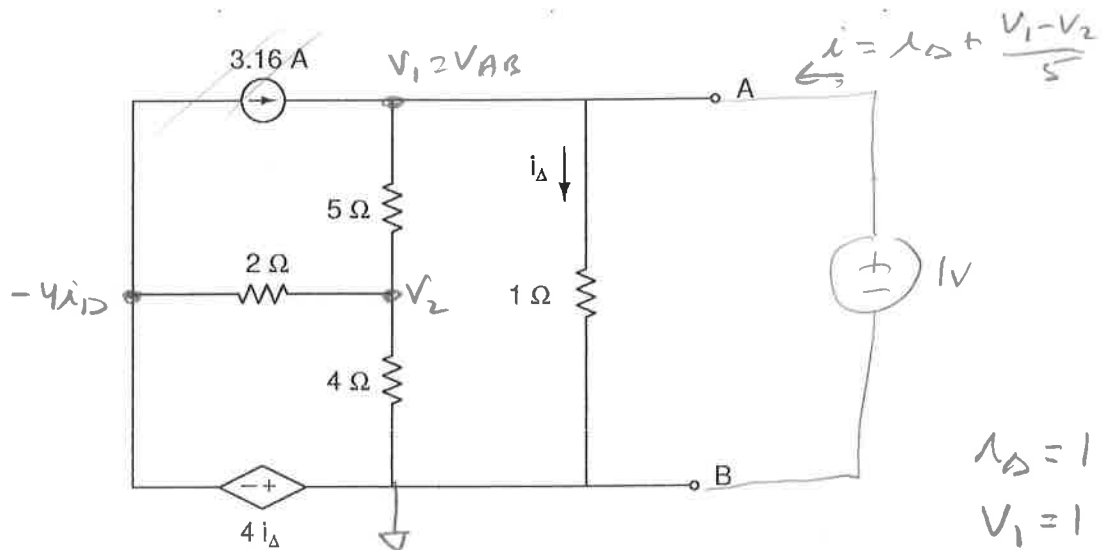
$P = \dfrac{24^2}{4 \times 4.2}$

Part B: If a load resistor R_L is placed between terminals A and B:

What value of R_L produces maximum power transfer to the load? __4.2Ω__

What is the maximum power dissipated by R_L? __34.3 W__

Problem 2 (20 points)

Consider the circuit below:

3.16 A $V_1 = V_{AB}$ A $i = i_\Delta + \dfrac{V_1 - V_2}{5}$

$i_\Delta \downarrow$

5 Ω

2 Ω V_2 1 Ω $\pm$ 1V

$-4i_D$

4 Ω

$-+$ B

$4\,i_\Delta$

$i_\Delta = 1$
$V_1 = 1$

KCL @ V_2:

$\dfrac{V_2}{4} + \dfrac{V_2 + 4i_\Delta}{2}$

$+ \dfrac{V_2 - 1}{5} = 0$

$V_2 = \dfrac{-36}{19}$

$i = 1 + \dfrac{V_1 - V_2}{5}$

$= \dfrac{30}{19}\,A$

$\boxed{R_{Th} = 0.63}$

Draw the Thévenin Equivalent Circuit with respect to terminals A and B.

KCL @ V_1: $-3.16 + \dfrac{V_1 - V_2}{5} + V_1 = 0$

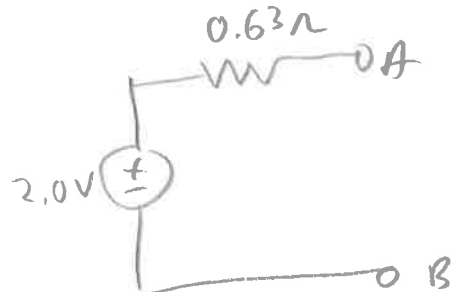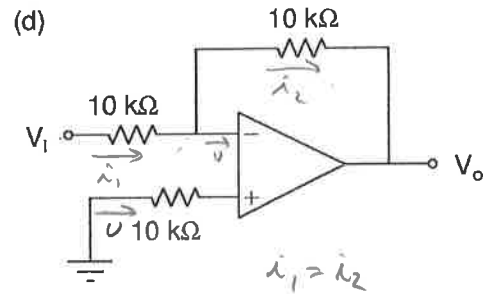KCL @ V_2: $\dfrac{V_2 + 4i_D}{2} + \dfrac{V_2}{4} + \dfrac{V_2 - V_1}{5} = 0$

Constraint: $i_D = V_1$

$V_1 = 2.0\,V$
$V_2 = -3.8\,V$

$\boxed{V_{AB} = 2.0V}$

0.63 Ω A

2.0V $\pm$

B

Problem 3 (20 points)

The OpAmp in the circuits below is ideal. For each of the circuits, find the voltage gain, V_o / V_i.
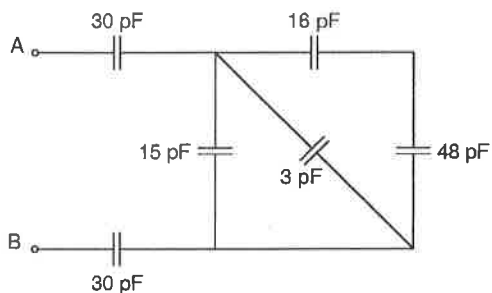
(a)

100 kΩ

i_c

10 kΩ

V_i

$-$

$+$

$\hat{i}_1$

$\circ\ V_o$

$-10V_{in}$

$i_1 = i_2$

(c)

25 kΩ

i_2

5 kΩ

V_i

$-$

$+$

$\hat{i}_1$

$\circ\ V_o$

25 kΩ

$i_1 = i_2$

(b)

100 kΩ

i

i_2

5 kΩ

V_i

$-$

$+$

$V_o = 0$

$\circ\ V_o$

5 kΩ

$= -20V_{in}$

$i_1 = i_2$

(d)

10 kΩ

i_2

10 kΩ

V_i

$-$

$+$

$\hat{i}_1$

v

$\circ\ V_o$

v 10 kΩ

$i_1 = i_2$
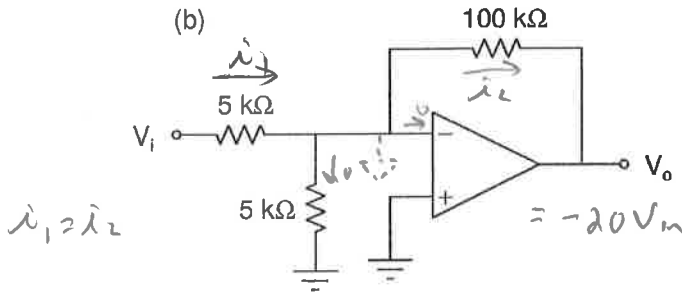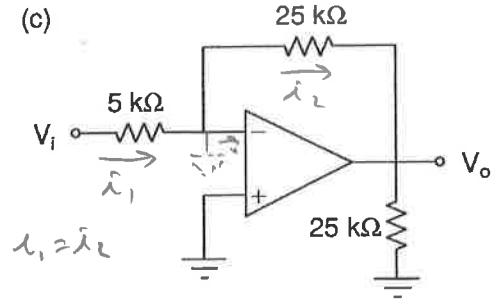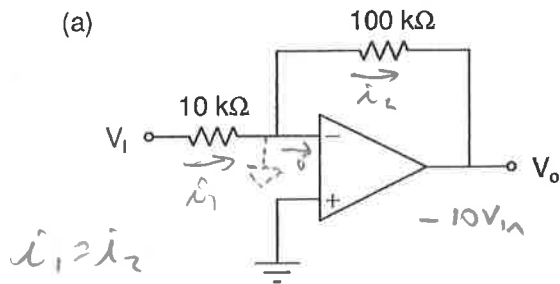
Circuit (a) Voltage Gain = ___−10___

Circuit (b) Voltage Gain = ___−20___
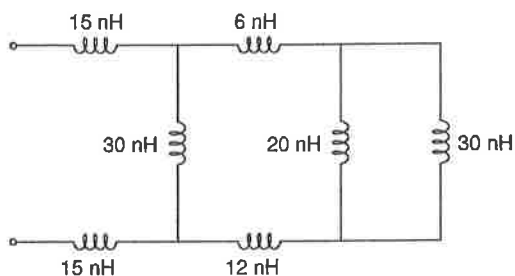
Circuit (c) Voltage Gain = ___−5___

Circuit (d) Voltage Gain = ___−1___

Problem 4 (30 points)

Consider the circuits below:

Circuit A

Circuit B

Circuit A: What is the equivalent capacitance between terminals A and B? ___10 pF___

Circuit B: What is the equivalent inductance between terminals A and B? ___45 nH___

(A)

48 + 16 = 12

12 || 3 || 15 = 30

30 + 30 + 30 = 10

(B)

30 || 20 = 12

12 + 12 + 6 = 30

30 || 30 = 15

15 + 15 + 15