EE 206 Test #2c - Name ____________________

Thevenin Equivalents - Max Power Transfer - Superposition - Operational Amplifiers. April 27, 2020

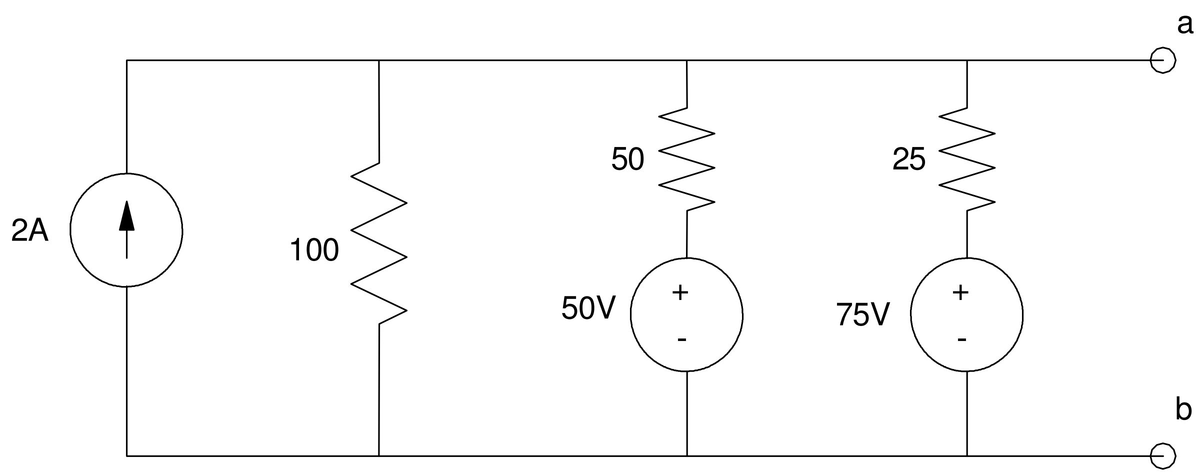
Due Tuesday, April 28th at midnight (solutions posted on Wednesday)

Open book, open notes, internet, calculators, matlab permitted. Individual effort only.

No aid given, received, or observed: (signature) ________________________

1) Determine the Thevenin equivalent for the following circuit.

Vth	Rth
85.714 V	**14.286 Ohms**



Convert everything to Norton:

(2A, 100 Ohms) (1A, 50 Ohms) (3A, 25 Ohms)

Currents in parallel add

(2A + 1A + 3A = 6A)

Resistors in parallel change as

100 || 50 || 25 = 14.286 Ohms

So

I(Norton) = 6A,

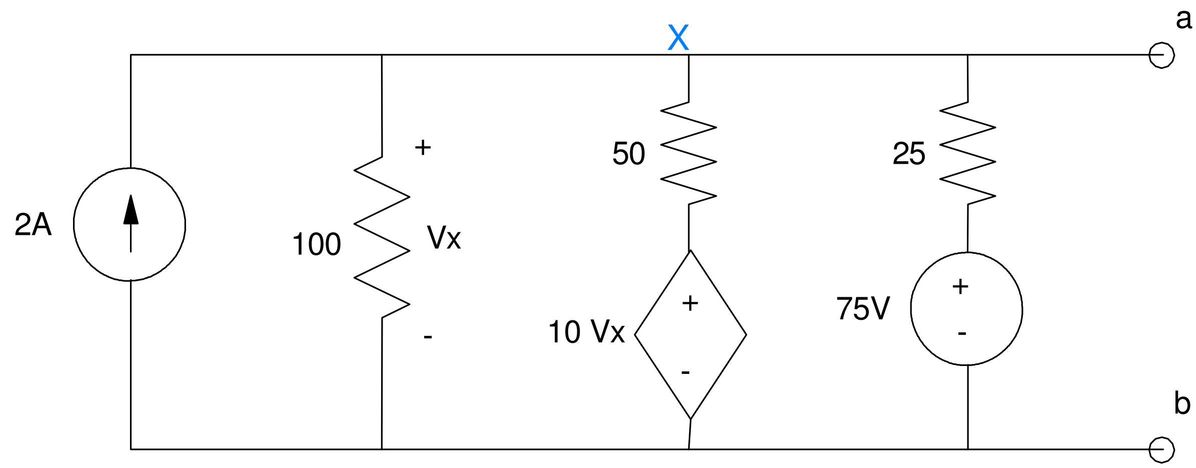
R(Norton) = 14.286 Ohms

and

V(Thevenin) = In * Rn = 85.714V

2) Determine the Thevenin equivalent for the following circuit

Vth	Rth
-38.462V	**-7.692 Ohms**



Vth: Determine X

$$-2+\frac{x}{100}+\frac{x-10x}{50}+\frac{x-75}{25}=0$$

$$x=-38.462V$$

Rth: Turn off the sources. Apply 1V to Va. determine the current

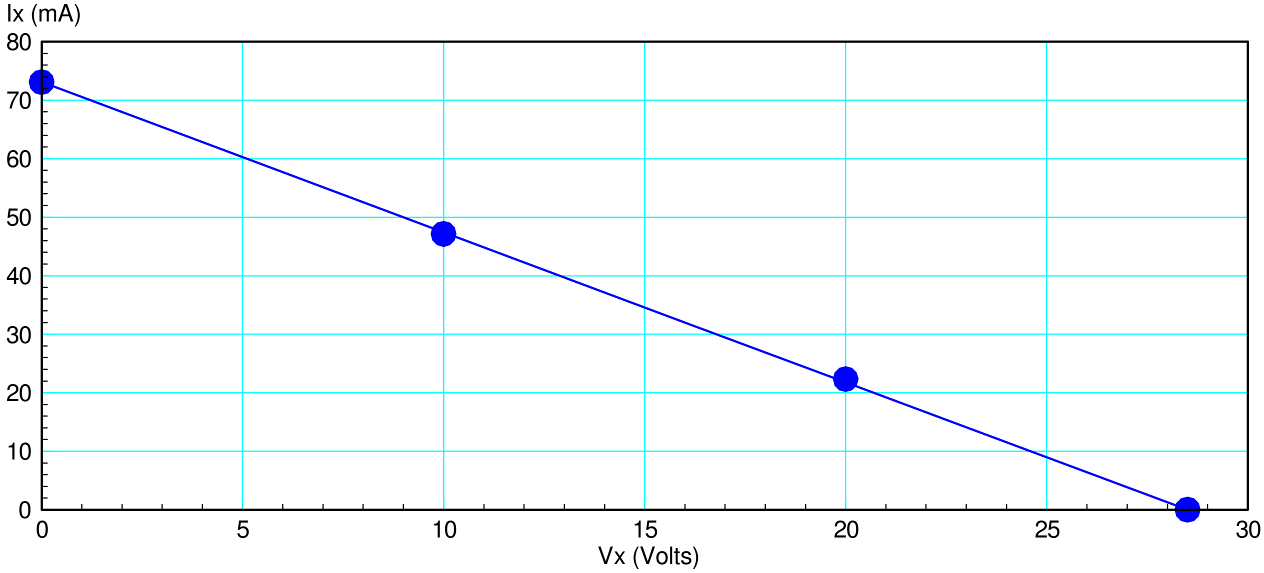
$$I=\left(\frac{1}{25}\right)+\left(\frac{1-10}{50}\right)+\left(\frac{1}{100}\right)=0$$

$$I=-130mA$$

$$R_{th}=\frac{1V}{-130mA}=-7.692\Omega$$

3) A resistor (R) is placed across the output of a circuit. The voltage and current through the resistor is then measured:

R	0 Ohms	100 Ohms	200 Ohms	infinity
V	0V	10V	20V	28.5V
I	73 mA	47.4 mA	21.8 mA	0 mA



From this data, determine the Thevenin equivalend and the maximum power you can get out of this circuit.

Vth	Rth	R for maximum power transfer	Max power to R
28.5V	**390.4 Ohms**	**390.4 Ohms**	**520mW**

$$R_{th} = \frac{28.5V}{73mA} = 390.4\Omega$$

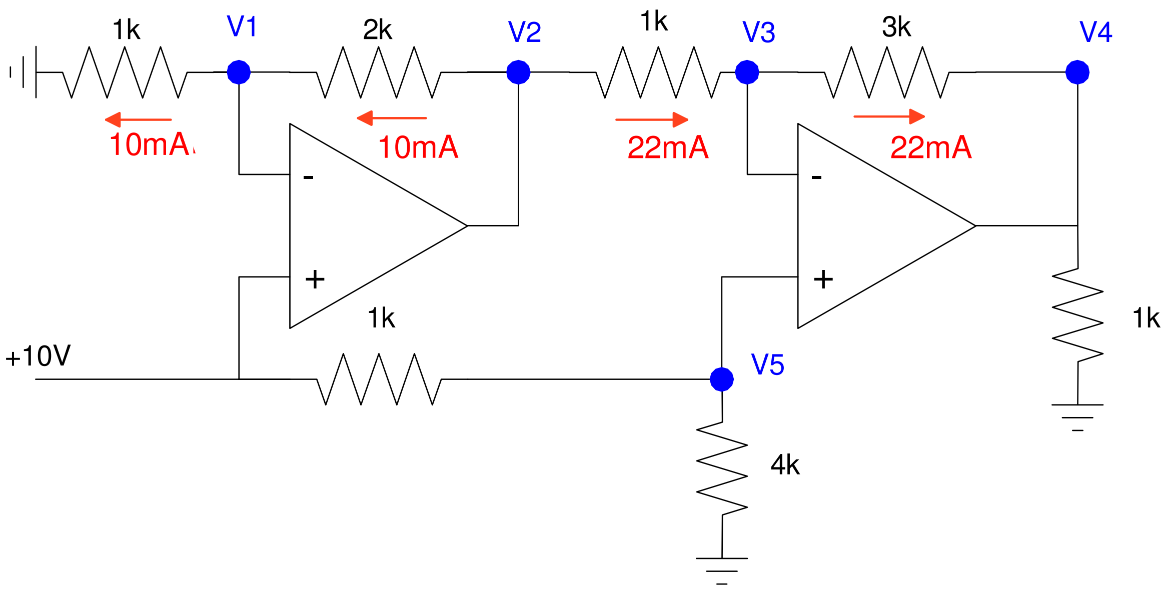
Max power is when Rload = Rth

At this point, Vload = 1/2 Vth

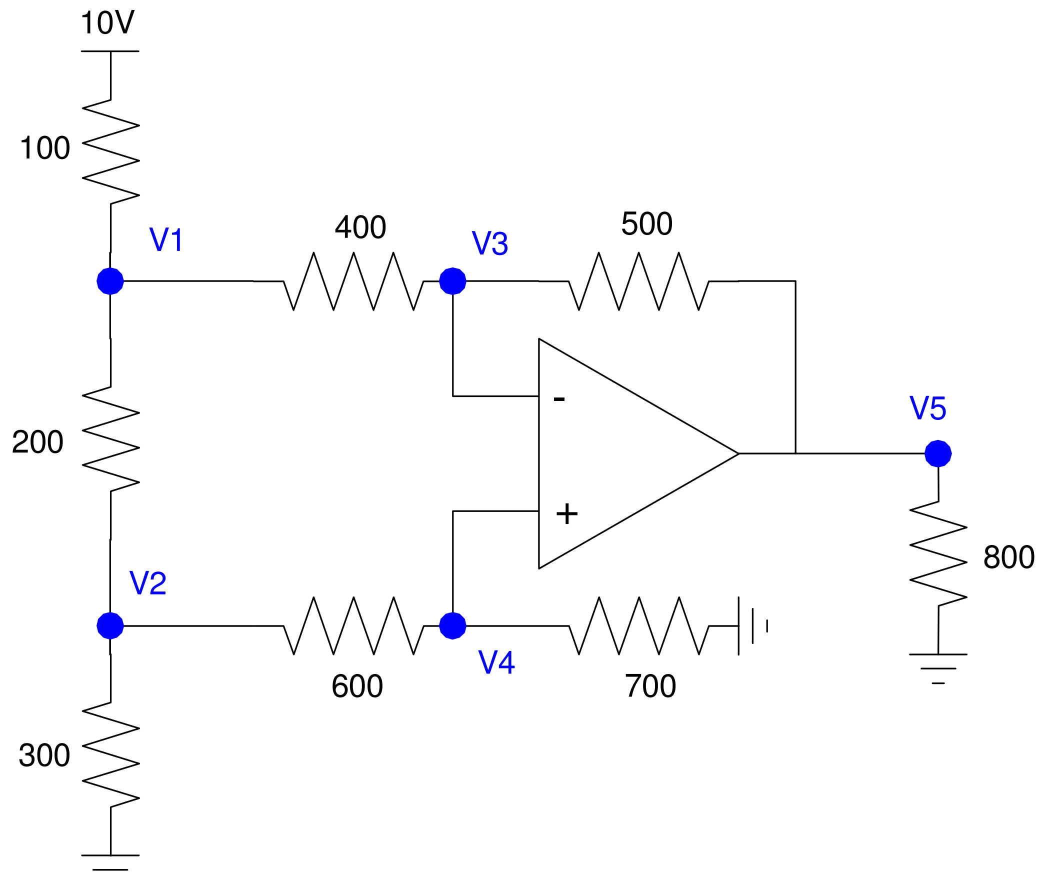
$$P = \left(\frac{V^2}{R}\right) = \left(\frac{14.25^2}{390.4\Omega}\right) = 0.520W$$

4) Determine the voltages for the following op-amp circuit. Assume ideal op-amps.

V1	V2	V3	V4	V5
10V	**30V**	**8V**	**-58V**	**8V**



5) Write the voltage node equations for the following circuit. Assume ideal op-amps.



$$V_3 = V_4$$

$$\left(\frac{V_1-10}{100}\right) + \left(\frac{V_1-V_2}{200}\right) + \left(\frac{V_1-V_3}{400}\right) = 0$$

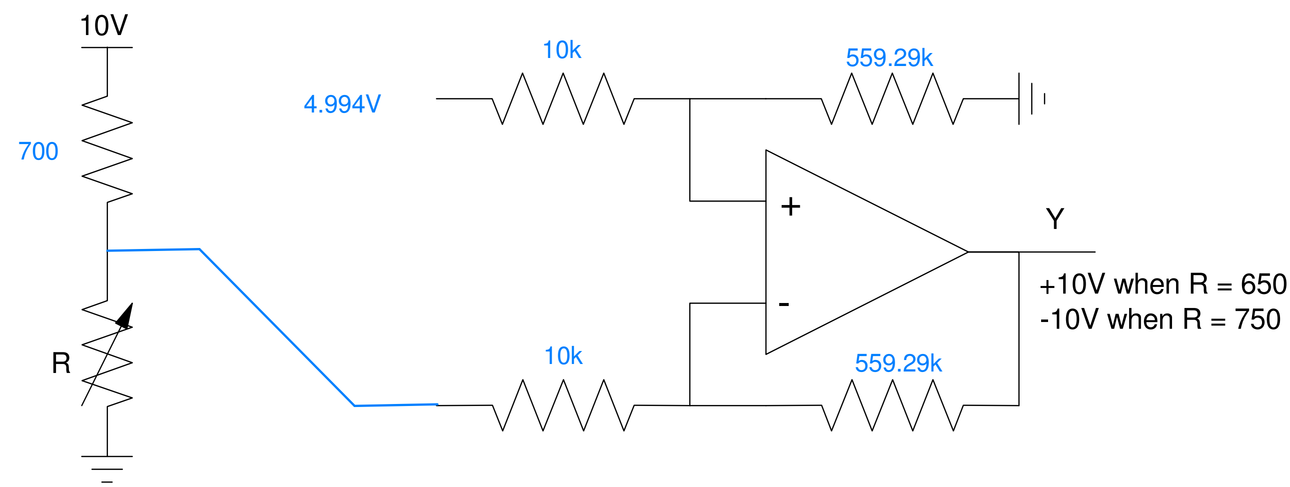
$$\left(\frac{V_2-V_1}{200}\right) + \left(\frac{V_2}{300}\right) + \left(\frac{V_2-V_4}{600}\right) = 0$$

$$\left(\frac{V_3-V_1}{400}\right) + \left(\frac{V_3-V_5}{500}\right) = 0$$

$$\left(\frac{V_4-V_2}{600}\right) + \left(\frac{V_4}{700}\right) = 0$$

6) Design a circuit which outputs

- Y = +10V when R = 650 Ohms
- Y = -10V when R = 750 Ohms
- Y is proportional to R for 650 < R < 750 Ohms



Assume a 700 Ohm resistor for the divider

At 650 Ohms

- $X = \left(\frac{650}{650+700}\right) 10V = 4.815V$
- Y = +10V

At 750 Ohms

- $X = \left(\frac{750}{750+700}\right) 10V = 5.172V$
- Y = -10V

As X goes up, Y goes down. Connect to the - input

The gain needed is

$$gain = \left(\frac{10-(-10)}{4.815V-5.172V}\right) = -55.929$$

pick the resistors in a 27.964 : 1 ratio

The output is 0V at midband. make the offset the midband value of X

$$offset = \left(\frac{4.815+5.127}{2}\right) = 4.994V$$