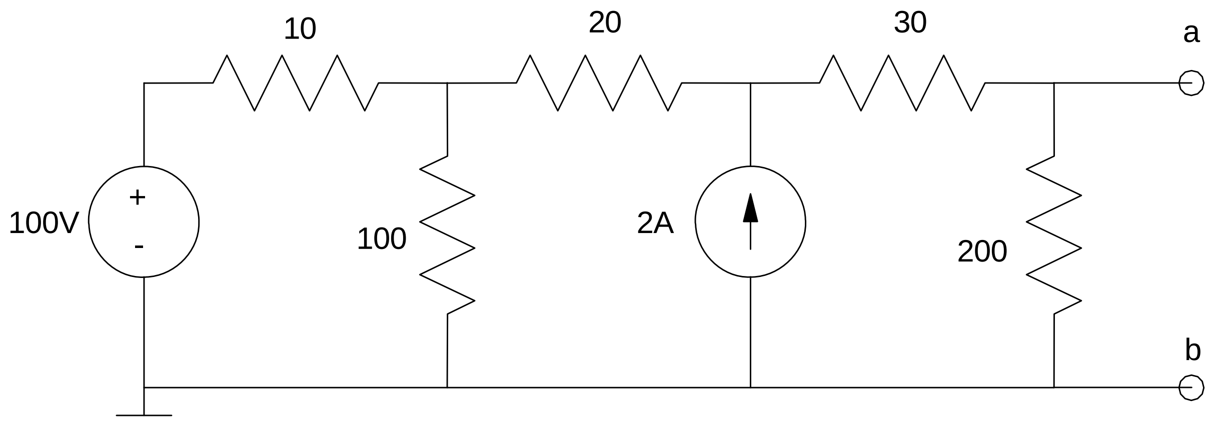
EE 206 Test #2c - Name ________________________

Thevenin Equivalents - Max Power Transfer - Superposition - Operational Amplifiers. April 22-23, 2019

1) Determine the Thevenin equivalent for the following circuit.

Vth	Rth
115 V	**45.61 Ohms**



Rth: Turn off the sources (V = 0, I = 0)

$$10||100 = 9.09$$

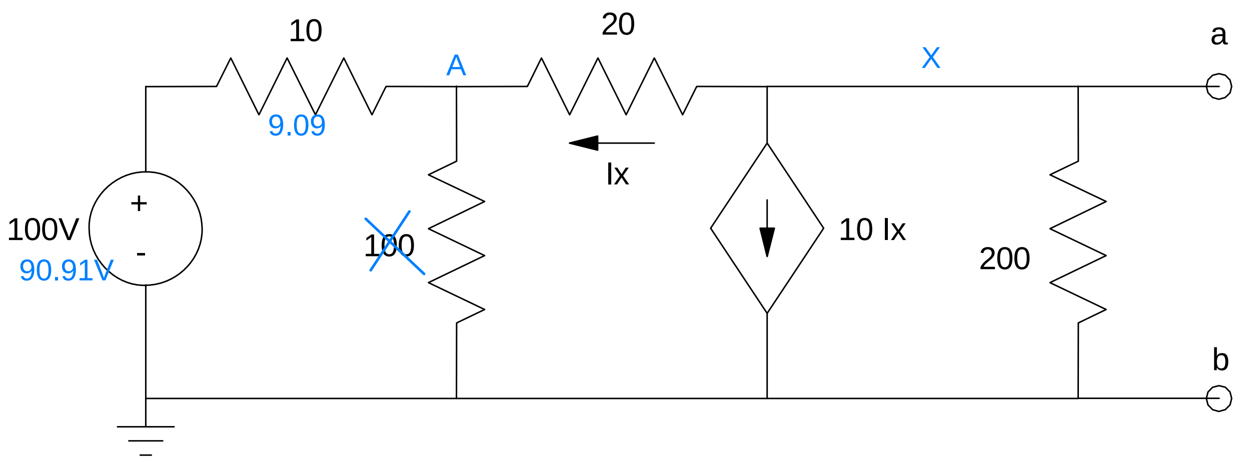
$$9.09 + 20 + 30 = 59.09$$

$$59.09||200 = 45.61\Omega$$

Vth: Switch from Thevenin to Norton and back

2)Determine the Thevenin equivalent for the following circuit

Vth	Rth



Take the Thevenin equivalent at A:

$$V_{th} = \left(\frac{100}{100+10}\right)100V = 90.91V$$

$$R_{th} = 10||100 = 9.01\Omega$$

Write the voltage node equation at X

$$\left(\frac{X-90.91}{29.09}\right) + 10\left(\frac{X-90.91}{29.09}\right) + \left(\frac{X}{200}\right) = 0$$

$X = 90.90V$ (which is Vth)

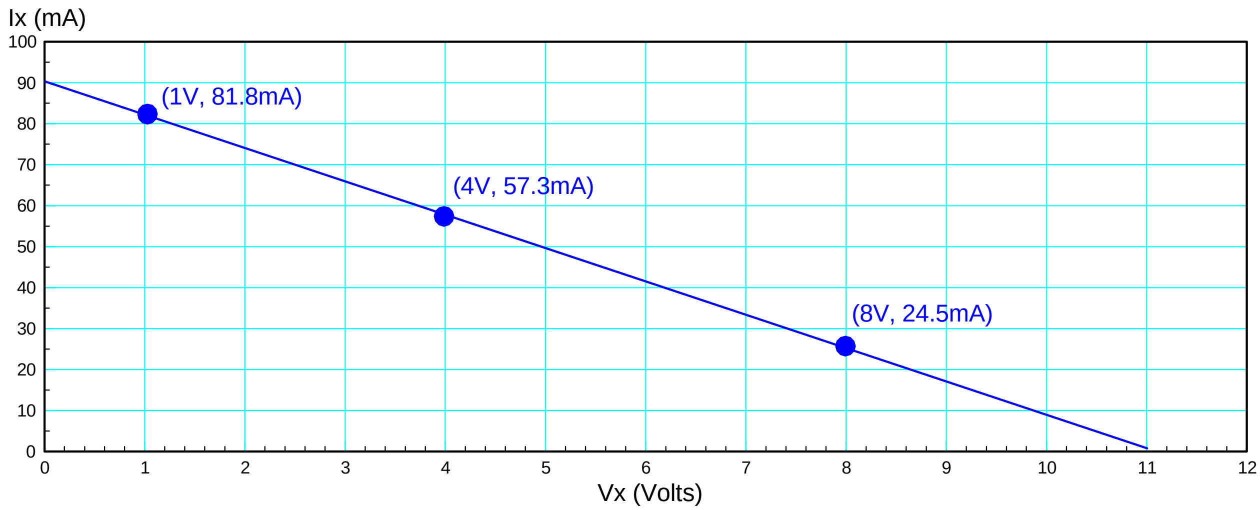
Rth: Apply a 1V test voltage at A and measure the current

$$I = \left(\frac{1V}{29.09\Omega}\right) + 10\left(\frac{1V}{29.09\Omega}\right) + \left(\frac{1V}{200\Omega}\right) = 383mA$$

$$R_{th} = \frac{1V}{383mA} = 2.61\Omega$$

3) The voltage and current for a circuit is measured as the resistance changes.

R	12.2 Ohms	69.8 Ohms	326.5 Ohms
V	1.0 V	4.0 V	8.0 V
I	81.8 mA	57.3 mA	24.5 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
11 V	**122 Ohms**	**122 Ohms**	**248 mW**

Vth is the X intercept (11V)

$$R_{th} = \left(\frac{V_{open}}{I_{short}}\right) = \left(\frac{11V}{90mA}\right) = 122\Omega$$

Max power is when RL = Rth

At this point

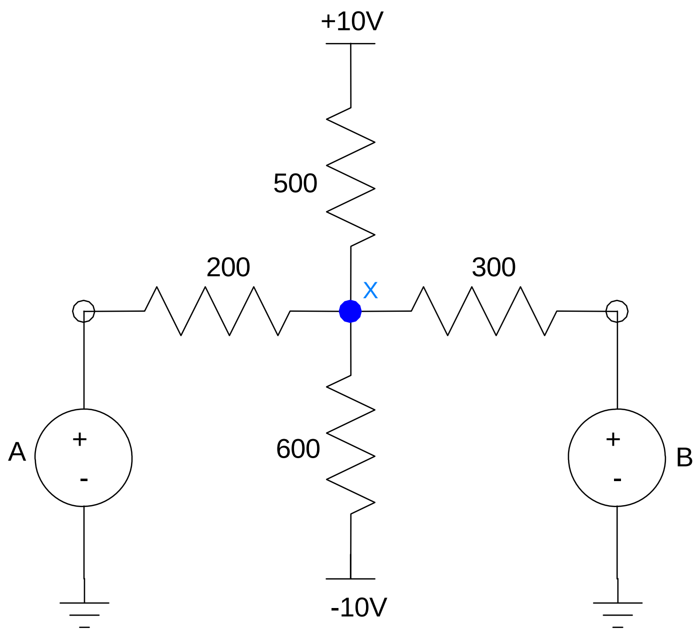
$$V_L = \frac{11V}{2} = 5.5V$$

$$P_L = \frac{V^2}{R} = \frac{5.5^2}{122} = 248mW$$

4) Find the voltage at Y as a function of A and B

$$Y = aA + bB + c$$

a	b	c
0.417	**0.278**	**0.278**



Shortcut:

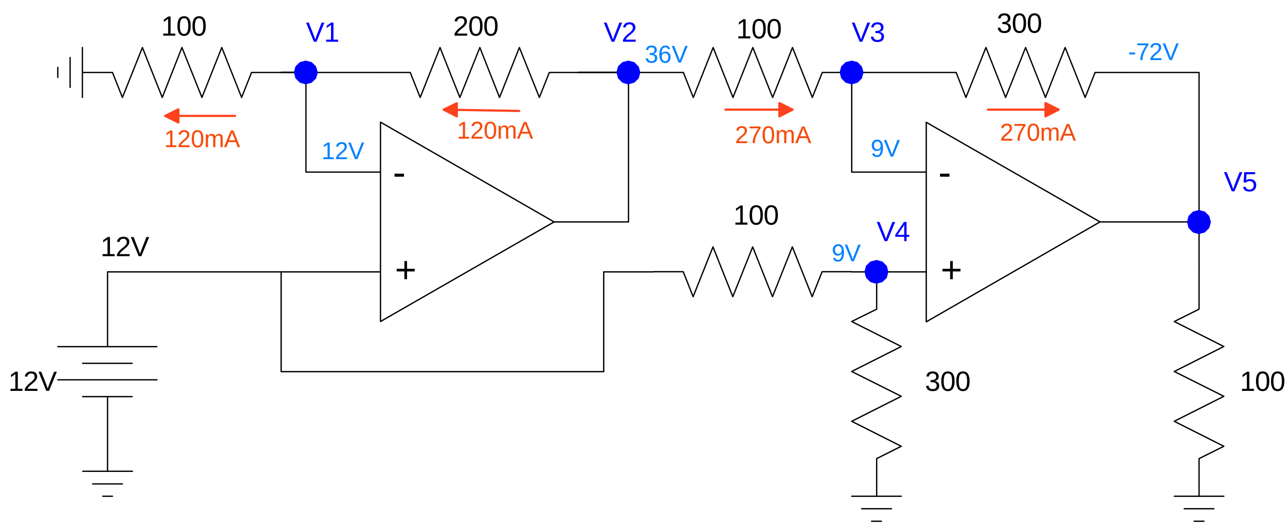
$$\left(\frac{X-A}{200}\right) + \left(\frac{X-B}{300}\right) + \left(\frac{X-10}{500}\right) + \left(\frac{X-(-10)}{600}\right) = 0$$

$$\left(\frac{1}{200} + \frac{1}{300} + \frac{1}{500} + \frac{1}{600}\right)X = \left(\frac{1}{200}\right)A + \left(\frac{1}{300}\right)B + 0.003333$$

$$X = 0.417A + 0.278B + 0.278$$

5) Determine the votlages V1, V2, V3, V4. Assume ideal op-amps.

V1	V2	V3	V4	V5



$$V_p = V_m$$

$$V_1 = 12V$$

$$V_3 = V_4 = 9V$$

$$I_a = \frac{12V}{100\Omega} = 120mA$$

$$V_{21} = 120mA \cdot 200\Omega = 24V$$

$$V_2 = V_1 + 24V = 36V$$

$$I_b = \left(\frac{36V - 9V}{100\Omega}\right) = 270mA$$

$$V_{35} = 270mA \cdot 300\Omega = 81V$$

$$V_5 = V_3 - 81V = -72V$$