Problem Set #1, EE part

Issue date: Nov. 6, 2020; Deadline: 23:59, Nov. 13, 2020

Student Name: _____ Student No.: _____

1. Electrical and electronic technology

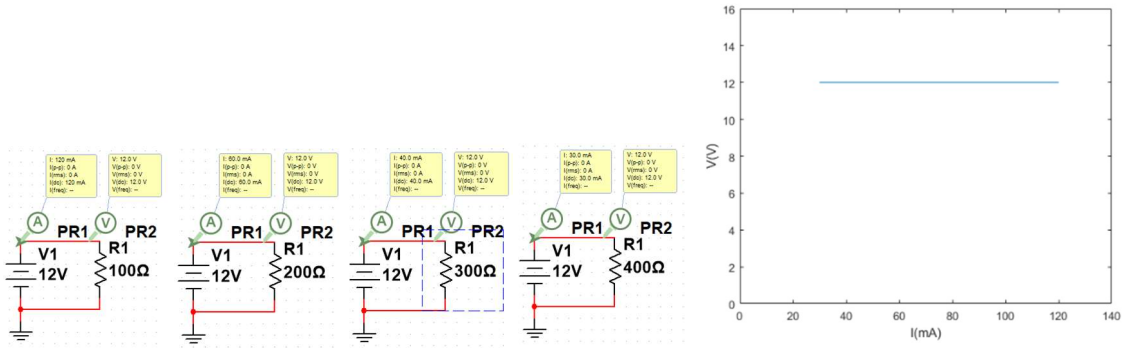
As introduced during the first lecture, many milestone technologies enable electrification (电气化) and informatization (信息化) during the second and third industrial revolutions. In this problem, you are asked to search the Internet (google, bing, baidu, etc.), and find out the specific details of these two concepts.

- Can you specify the different features of electrification and informatization? (10')
  - Electrification: to use electricity as power supply instead of traditional fossil energy.
  - Informatization: to further manage, share and use the information in industrial production and daily life, especially in digitalized form.
- Besides the winners of the five Nobel Prize winner, tell us another one pioneering scientist or engineer who has made significant contributions towards electrification or informatization. (5')
  - Clarence Zener
- Point out one of his/her most representative discoveries or inventions. Briefly explain the working principle of such discovery or invention and its relation to electrical engineering (10')
  - Discovered Zener effect, which become the basis of Zener diode, a voltage regulator.
  - Make a highly doped P–N junction in the diode to obtain a low Zener voltage. It can regulate the voltage when the diode is reversely connected into the circuit.
  - Zener diode has become a basic electronic component of circuit.

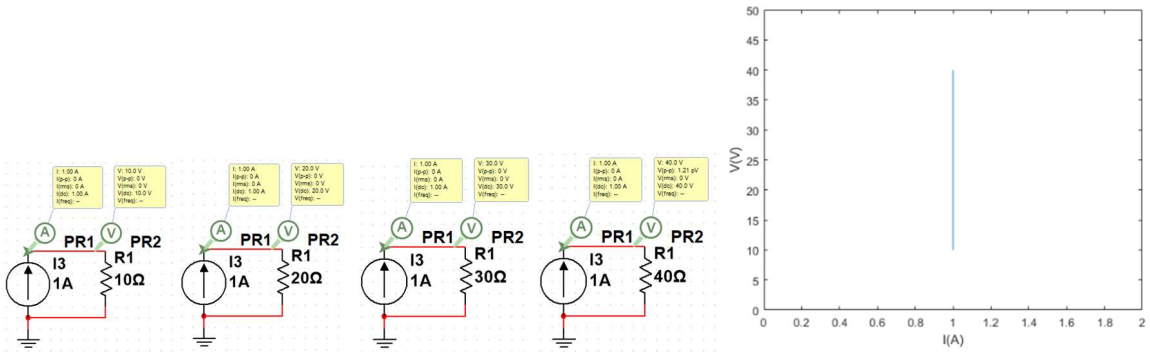
2. Linear resistive network

- Use Multisim simulation to study the I-V characteristics of a current source and a voltage source (hint: connect a resistor and change its value, mark down the current and voltage history). (5')

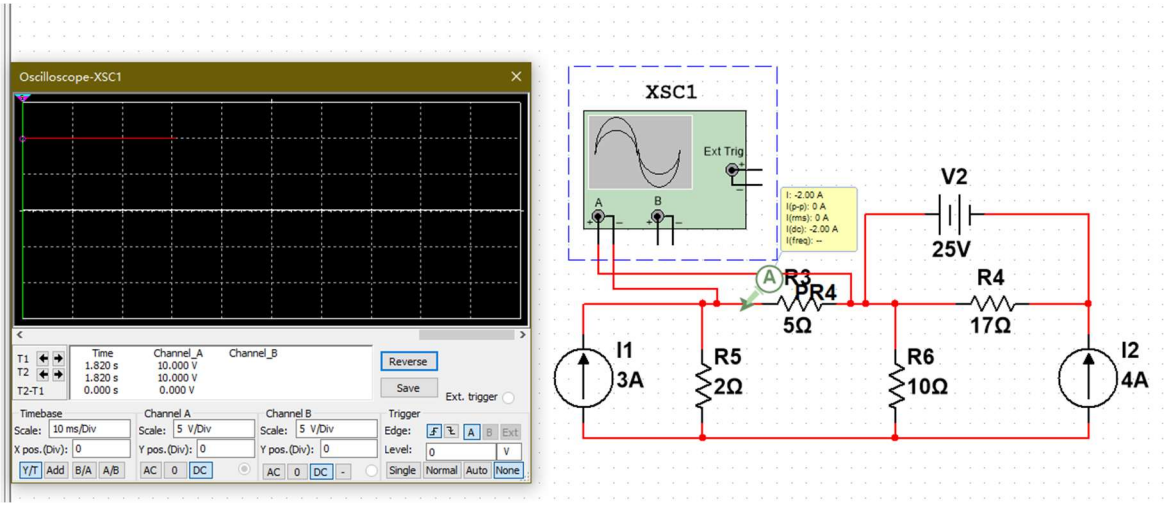
Voltage source:



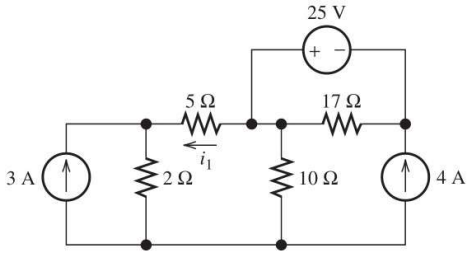
Current source:



- Determine the value of i_1 in the following circuit using
  - Multisim simulation tool (show the circuit schematic, simulation waveform). (15')

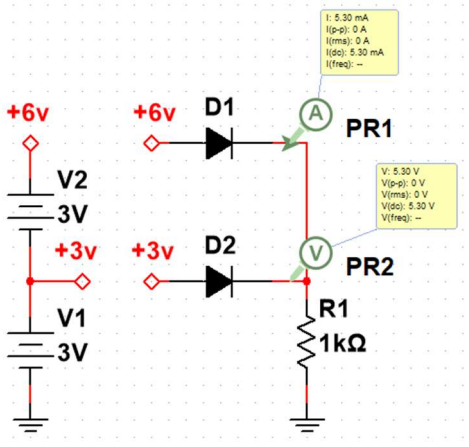


  - Superposition principle 叠加原理. Search the Internet for more information about superposition in circuit analysis. (5')
    - Superposition principle: To ascertain the contribution of each individual source, select one source, replace all other independent voltage sources with a short circuit and all other independent current sources with an open circuit, then analyze the new circuit. The resultant circuit is the superposition of all the contributions of voltage and current sources.
  - What effect does the 17-Ω resistance have on the answer? Explain. (5')
    - When calculating the contribution of two current sources, the 17-Ω resistance is short circuited; When calculating the contribution of voltage source, the other part of the circuit (except the 17-Ω resistance) is short circuited. Thus the 17-Ω resistance has NO EFFECT to the answer of i_1.



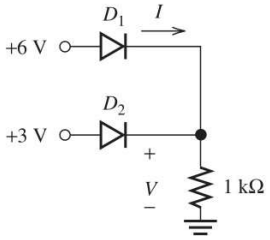
3. Diode circuits

- Find the values of I and V for the circuits of the following figures using Multisim. (15')



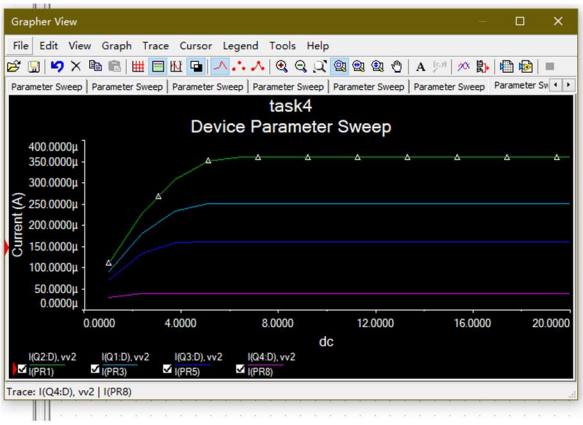
- o I=5.30 mA, V=5.30 V

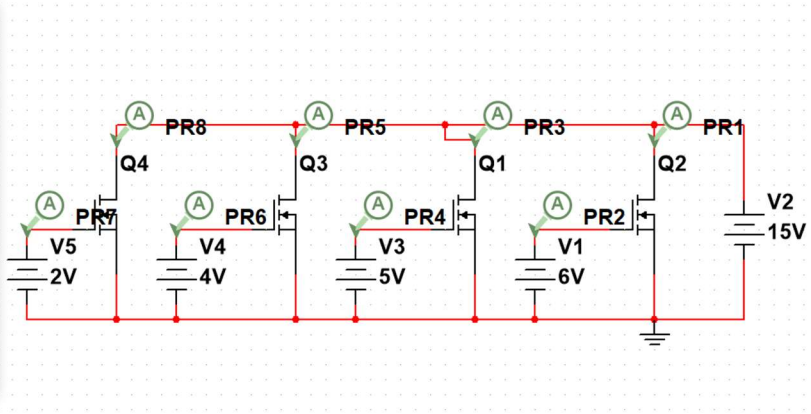
- Which diode is conducted? Why? Can you further explain the working principle of this circuit? (5')
  - o D1 is conducted.
  - o Once D1 is conducted, according to the characteristics of diode, the voltage between two sides of D1 will be 0.7V(if silicon diode), then the voltage between two sides of D2 will be reverse(3v<5.3V), D2 is on reverse bias so not conducted.



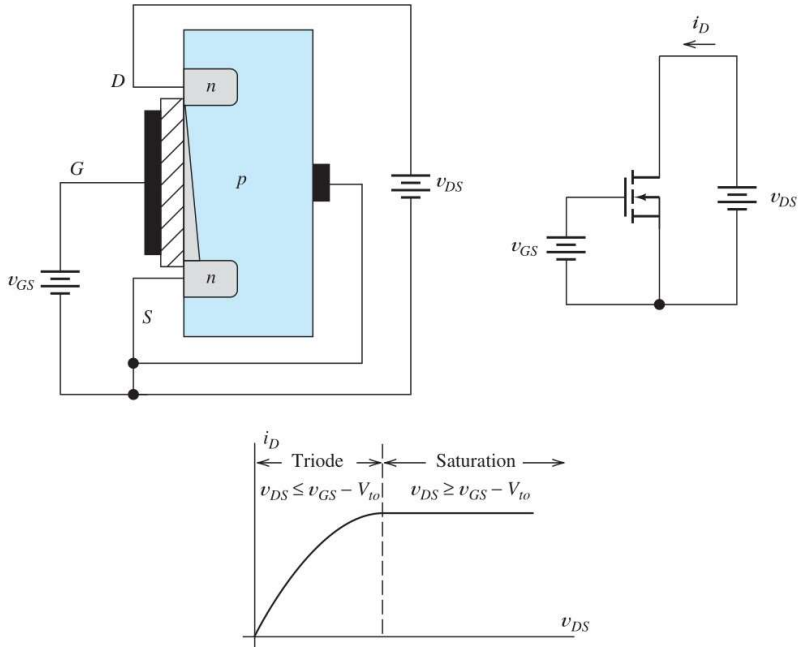
4. Transistor characteristics.

- Select an NMOS model in Multisim. Build a simple single-MOSFET circuit, as shown below. Generate the characteristic curves under different v_{GS} (as Figure 12.6 did in the EE textbook). (20')





- How to make it "on" or "off"? (5')
  - o Change the voltage v_{GS}. When $v_{GS} > v_{to}$ it is "on", when $v_{GS} \leq v_{to}$ it is "off".



** Please submit the softcopy of your solutions to the problems on gradescope.*

** All flow charts and codes should be enclosed in your solutions.*

** Discussion on methodology is allowed, yet, the assignment should be done individually. Plagiarism, once found, grades zero for the whole homework assignment!!*