Tutorial 4 Questions

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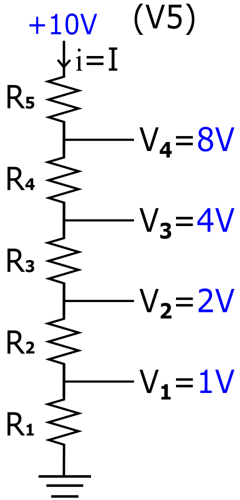
February 29, 2016

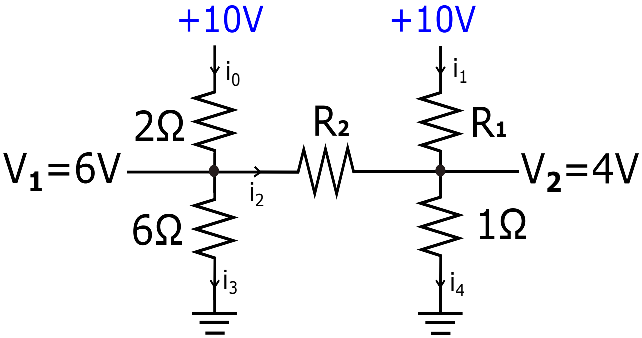
Question 1

* Determine the resistance value of $R_1, R_2, ..., R_5$ in the circuits. (Assume the resistance of R_1 is R)



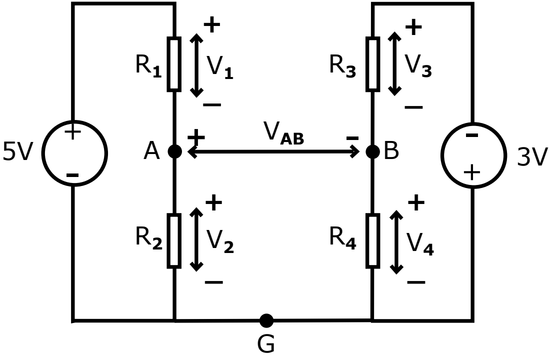
Question 2

- Determine the resistance of R_1 and R_2 in the circuit.



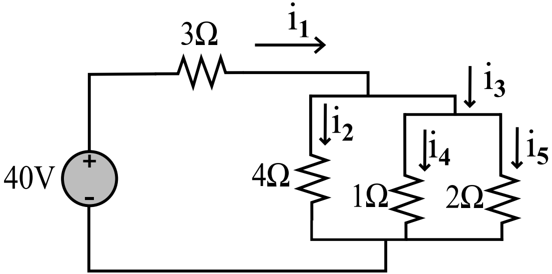
Question 3

- If $V_{AB} = 4V$, determine R_1,R_2,R_3 and R_4.

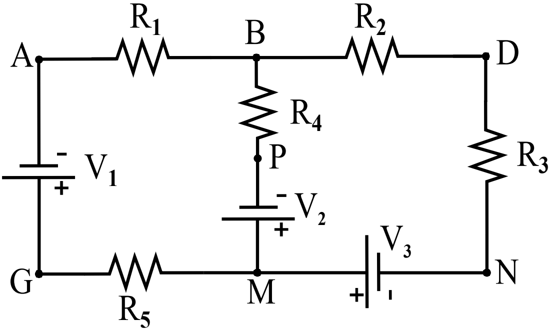


Question 4

- For the circuit in the figure, determine i_1 to i_5.



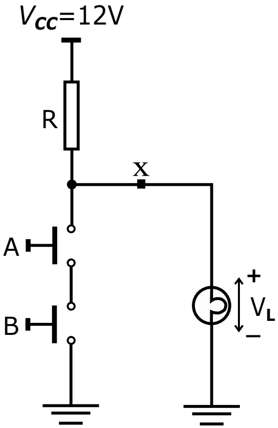
Question 5



- $R_1 = 80\Omega, R_2 = 10\Omega, R_3 = 20\Omega, R_4 = 90\Omega, R_5 = 100\Omega$
- Battery: $V_1 = 12V, V_2 = 24V, V_3 = 36V$
- Resistor: $I_1, I_2, ..., I_5 = ?$ $P_1, P_2, P_5 = ?$

Question 6

- You have connected the lamp, with $V_{cc} = 12V$. The datasheet of the lamp states that it only turns on when $V_L > 8V$. The lamp has an internal resistance of $1k\Omega$.
- What is the range of R that would allow the circuit to function correctly with all input combinations.

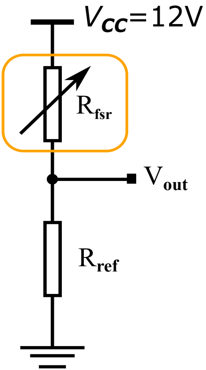


Question 7a

- A force sensitive resistor (FSR) is a resistor with its resistance changed according to the force applied to it.

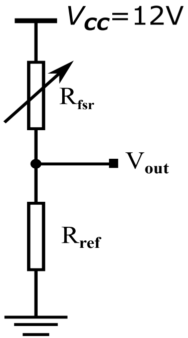
- For simplicity sake, your partner has wired up the FSR using a simple potential divider circuit

Force (N)	Resistance $R_{fsr}(\Omega)$
0	**1M**
0.5	**10k**
1	**6k**
10	**1k**



Question 7a

* Calculate the following quantities when $R_{ref} = 10k\Omega$:
  - Voltage across the FSR;
  - Voltage at V_{out};
  - Current owing through the FSR.

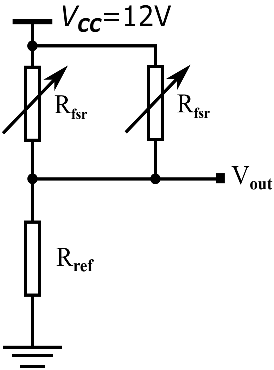


Question 7b

- The output V_{out} is used to detect the presence of a ball. Due to its light weight, the ball produces only 0.5N when it is located on top of the sensor. The rest of the system requires that $V_{IL} = 2V$ and $V_{IH} = 10V$
  - V_{IL}: Max. voltage that the system regards as logical LOW
  - V_{IH}: Min. voltage that the system regards as logical HIGH
- Determine the range of value that R_{ref} may take for correct functioning of the circuit.
  - It should output a logical HIGH when a ball is presence and a logical LOW otherwise.

Question 7c

* Your partner suggests that it may be possible to use 2 FSRs connected to perform a logical OR operation: When the ball rolls over either one of the 2 FSRs, the output V out is HIGH, and is LOW otherwise.

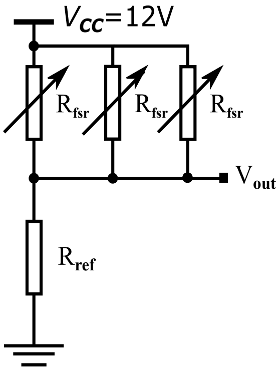


* What is the output voltage V_{out}?
  - one of the FSRs is under pressure of 0.5N;
  - both FSRs are under a pressure of 0.5N each;
  - none of the FSRs is under pressure;
  - assume R_{ref} is $100k\Omega$

Question 7d

- Recall that V_{IL} is $2V$ and V_{IH} is $10V$, is the circuit functioning correctly as a 2-input OR?

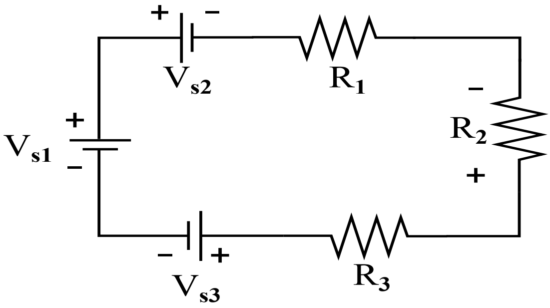
- If there are 3 FSRs connected in parallel, assumer R_{ref} remains at 100k, will the circuit behave as a 3-input OR?



Appendix(Question 8)

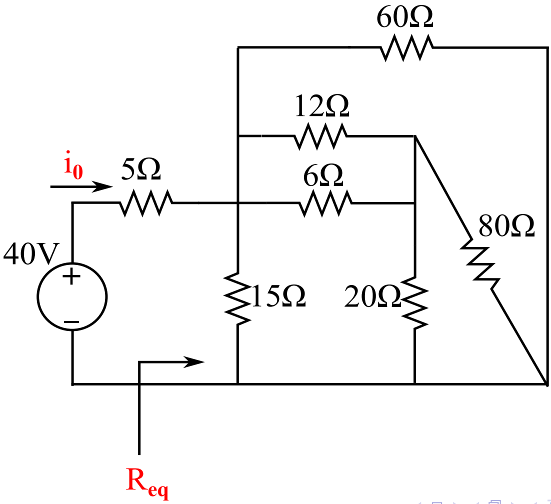
- Find V_2 using single loop analysis
  - Without simplifying the circuit
  - Simplifying the circuit

    $V_{s1} = 2V$, $V_{s2} = 2V$, $V_{s3} = 2V$, $R_1 = 1\Omega$, $R_2 = 2\Omega$, $R_3 = 4\Omega$



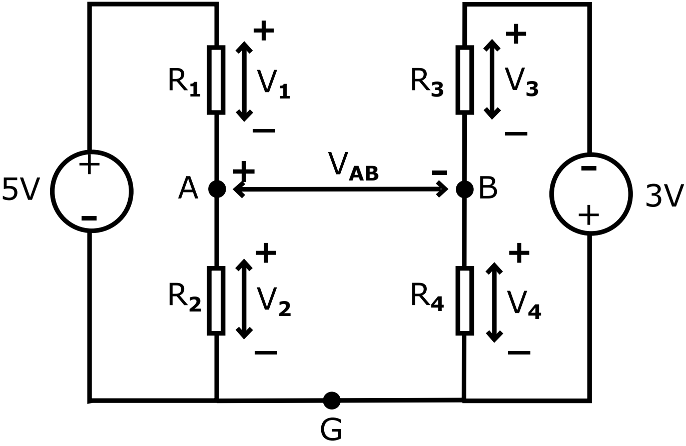
Appendix(Question 9)

* Find R_{eq} and i_o in the circuit of the figure.



Appendix(Question 10)

Assume all resistors have the same resistance, R. Determine the voltage V_{AB}.



Appendix(Rules Governing Currents and Voltages)

Rule 1: Currents flow in loops

The same amount of current flows into the bulb (top path) and out of the bulb (bottom path)

Rule 2: Like the flow of water, the flow of electrical current (charged particles) is incompressible

Kirchoffs Current Law (KCL): the sum of the currents into a node is zero

Rule 3: Voltages accumulate in loops

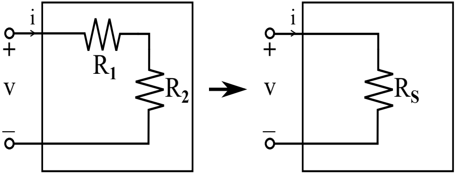
Kirchoffs Voltage Law (KVL): the sum of the voltages around a closed loop is zero

Appendix(Analyzing Circuits)

- Assign node voltage variables to every node except ground (whose voltage is arbitrarily taken as zero)
- Assign component current variables to every component in the circuit
- Write one constructive relation for each component in terms of the component current variable and the component voltage
- Express KCL at each node except ground in terms of the component currents
- Solve the resulting equations
- $Power = IV = I^2R = V^2/R$

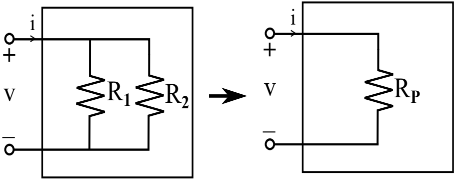
Appendix(Parallel/Series Combinations of Resistance)

- To simplify the circuit for analysis



$v = R_1 I + R_2 i$
$v = R_s i$
$\therefore R_s = R_1 + R_2$

Series

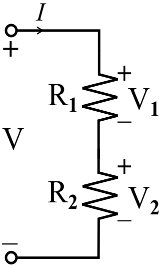


$$R_p = \frac{1}{1/R_1 + 1/R_2} = \frac{R_1 R_2}{R_1 + R_2}$$

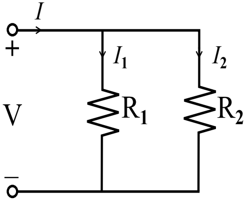
Parallel

$$= R_1 \parallel R_2$$

Appendix(Voltage/Current Divider)



← **Voltage Divider**



Current Divider →

$$I = \frac{V}{R_1+R_2}$$
$$V_1 = R_1 I = \frac{R_1}{R_1+R_2} V$$
$$V_2 = R_2 I = \frac{R_2}{R_1+R_2} V$$

$$V = (R_1 \parallel R_2) I$$
$$I_1 = \frac{V}{R_1} = \frac{R_1 \| R_2}{R_1} I = \frac{R_2}{R_1+R_2} I$$
$$I_2 = \frac{R_1}{R_1+R_2} I$$

The End