EE203 – Electrical Circuits Laboratory

Experiment 1 Laboratory Report

DC Voltage and Current Measurements

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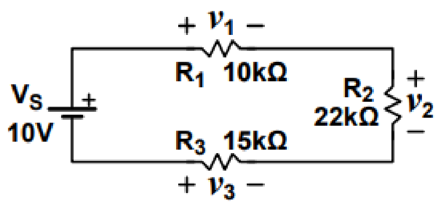
Preliminary Work

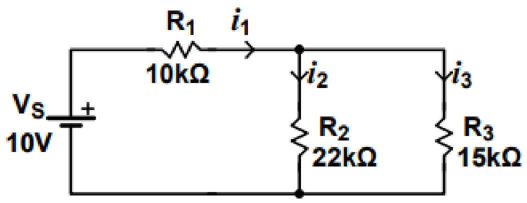
1.Calculate v1, v2 and v3 for the circuit shown below. Enter the results in the table given for procedure step 2.2



V= I.R V_S=10V R_{tot}=10k+15k+22k=47k
I_{tot}=10/47.000=2.13*10^{-4} A
$V_1=I*R_1=2.13*10^{-4}*10k=2.13$ V
$V_2=I*R_2=2.13*10^{-4}*22k=4.68$ V
$V_3=I*R_3=2.13*10^{-4}*15k=3.19$ V but because of opposite direction -3.19V

2. If the polarity of VS is reversed, what happens to V_1, V_2 and V_3?
If the Vs is reserved, direction of current will be change and sign of voltages will be changed.(V_1=-2.13V, V_2=-3.19V , V_3=4.68V)

3. Calculate i1, i2 and i3 for the circuit shown below. Enter the results in the table given for procedure step 3.2.

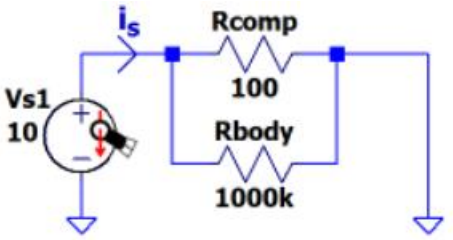


V= I*R V_S=10V $R_{tot}= R_1+(R_2||R_3)=R_1+(R_2*R_3 / R_2+R_3)=18.92K\Omega$
$I_1=(V/ R_{tot})=(10V/18.92K\Omega)=0.528mA$
$I_2=(V/ R_{tot})$*rate of $R_3=(10V/18.92K\Omega)*15/37=0.214mA$
$I_3=(V/ R_{tot})$* rate of $R_2=(10V/18.92K\Omega)*22/37=0.314mA$

4. If the polarity of VS is reversed, what happens to i_1, i_2 and i_3?
If the Vs is reserved, direction of current will be change.(i_1=-0.528mA , i_2=-0.214mA and i_3=-0.314mA)

Results

1.1 Create a new schematic in LTspice and build the following circuit



¬ Vs1 is a voltage source set to constant 10 V.

¬ Rcomp is the resistor value that needs to be measured.

¬ Rbody is the body resistance connected in parallel, and it introduces some error in mesurement of Rcomp.

¬ Place the SPICE directive ".tran 3m" to set the simulation duration to 3 milliseconds.

1.2 Run the simulation first, and measure the current is through Vs1 voltage source. Place the mouse pointer over Vs1 to see the current probe as shown above and left-click to display the I(Vs1) current through Vs1 on the waveform window. You can zoom into the DC plot to obtain five significant digits (i.e. 100.01mA) on the waveform window.

1.3 Calculate the parallel resistance Rpar that is measured according to the I(Vs1) current:

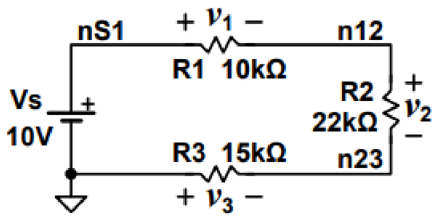
1.3 Calculate the % error between Rcomp and the calculated Rpar:

1.4 Record your measurements in the table given below. Repeat measurements for the other Rcomp and Rbody values listed in the table.

Rcomp	**Rbody**	**I(Vs1)** current measured on **Vs1** supply	**Rpar** resistance calculated with **I(Vs1)**	**% error** between **Rcomp** and the calculated **Rpar**
100 Ω	1000 kΩ	-100.0 mA	100	0
1 kΩ	1000 kΩ	-10.01 mA	999,0009	0.099
10 kΩ	1000 kΩ	-1.01 mA	9.9k	1.0
100 kΩ	1000 kΩ	-0,11 mA	90.909k	9.09
100 Ω	100 kΩ	-100.100 mA	99.9	0.1
1 kΩ	100 kΩ	-10.10 mA	990.091	0,99
10 kΩ	100 kΩ	-1.1 mA	9090,91	9.09
100 kΩ	100 kΩ	-0.2 mA	50k	50

In this table we see the percentage error increases as they approach each other at high resistances. Because if we touch resistance, our body and resistance will be parallel circuit and, at the closer values to each other we get greater error because our circuit is parallel circuit.

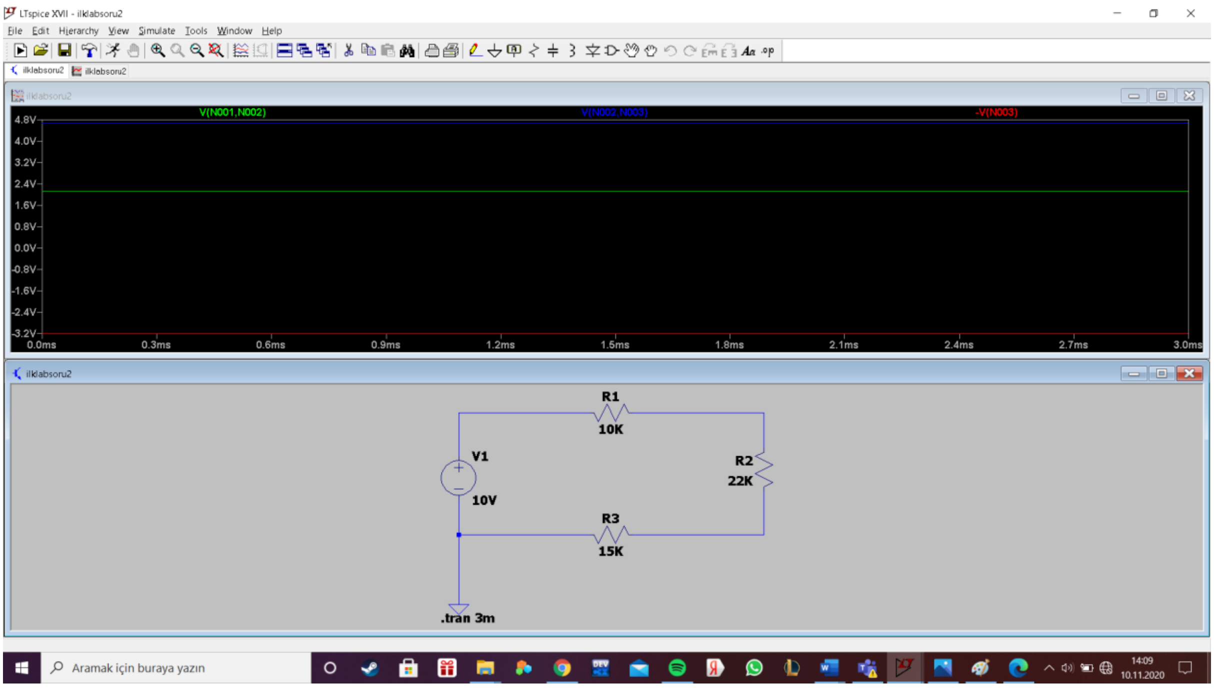
2.1 Build the following circuit on the LTspice schematic window. ¬ Set DC power supply output to 10V. ¬ Assign labels (nS1, n12, n23) to the circuit nodes to easily identify voltage plots on the waveform window. ¬ Place the SPICE directive ".tran 3m" to set the simulation duration to 3 milliseconds.



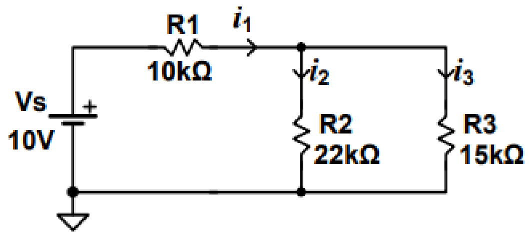
2.2 Measured voltages and error in measurements with respect to the calculated values:

	measured voltage	expected voltage calculated in preliminary work	% error with respect to the calculated values
V_1(V)	2.12766 V	2.1277 V	0.001
V_2(V)	4.68085 V	4.6809 V	0.001
V_3(V)	-3.19149 V	-3.1915 V	0.001

Because of Significant Figures, we have a little bit %error. Our measured values and calculated values are so close because simulation is ideal. There is no error because of measured device, person or environment because it is ideal.



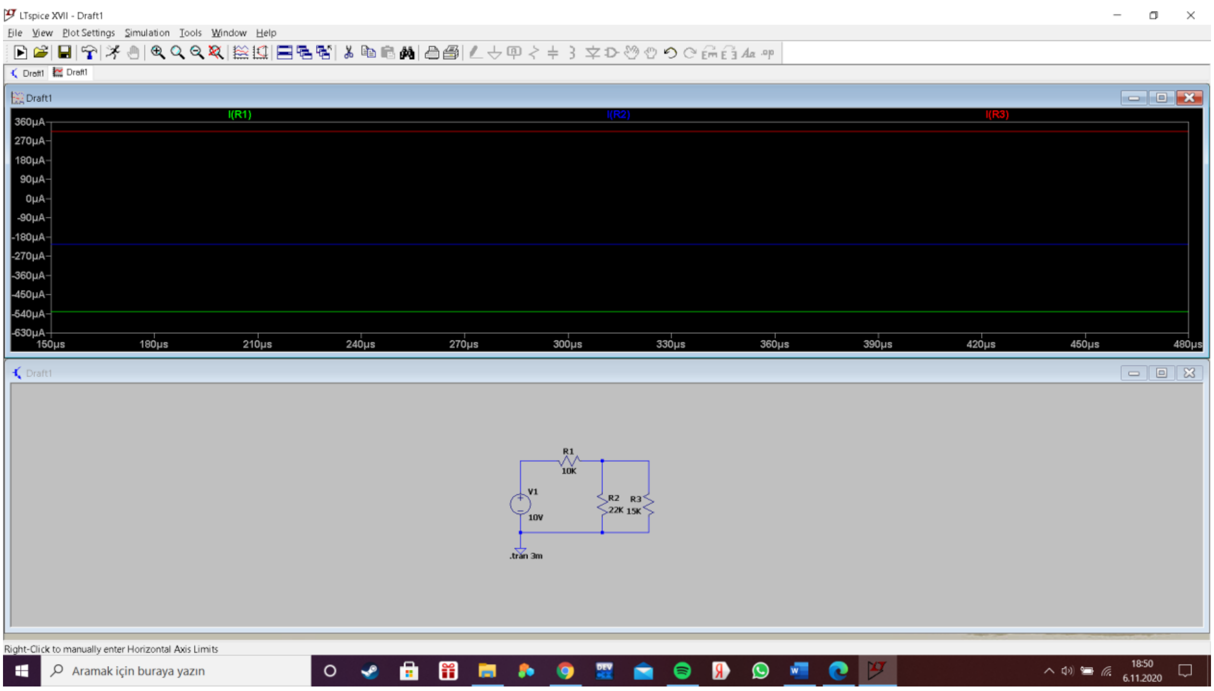
3.1 Build the following circuit on the LTspice schematic window.
¬ Set DC power supply output to 10V.
¬ Place the SPICE directive ".tran 3m" to set the simulation duration to 3 milliseconds.



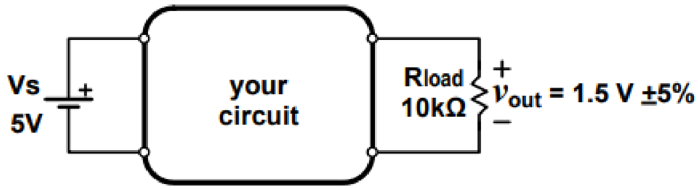
3.2 Measured currents and error in measurements with respect to the calculated values:

	measured current	expected current calculated in preliminary work	% error with respect to the calculated values
İ$_1$(mA)	0.52857	0.528	0.1
İ$_2$(mA)	0.214285	0.214	0.1
İ$_3$(mA)	0.314286	0.314	0.1

We have a little bit of a percentage error because of Significant Figures. Since simulation is ideal, our measured values and estimated values are so similar. There is no mistake because of measured device, person or environment because it is ideal.



4. As a design problem, determine the components of a resistive circuit that will deliver 1.5 V across a 10 kΩ load resistor with maximum +_5% error.

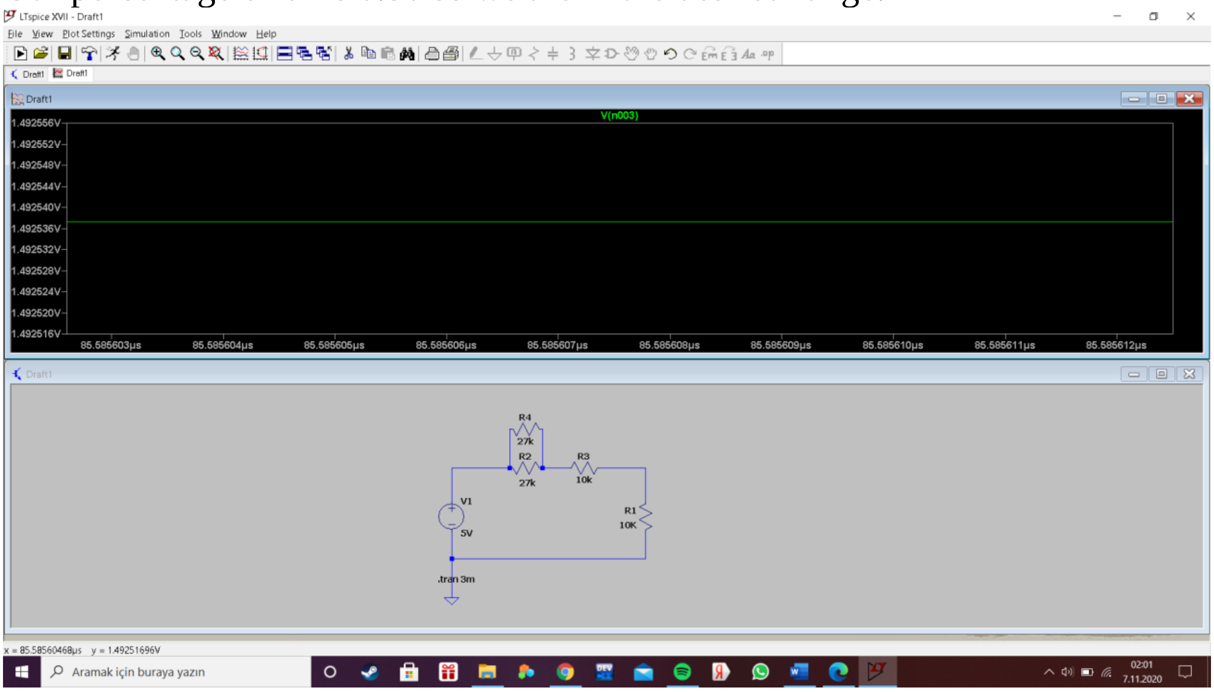


The resistors available for use are 1 kΩ, 6.2 kΩ, 10 kΩ, 15 kΩ, and 27 kΩ. You may use more than one resistor of a particular value, but as a design constrait, you cannot use more than three resistors in total. Draw the schematic of your proposed circuit and build it on LTspice. Verify that the circuit meets the design criteria by measuring vout. When your circuit is working, demonstrate the design to the lab instructor.

Our output voltage must be between 1.425 and 1.575 so our total resistance must be between 21.746kΩ and 25.087kΩ. We choose two 27k resistance parallel and 10k resistance in series of them to get closest desired output voltage.

$$V_{out}=1.492538V$$

Our percentage error is 0.50 so we are in the desired range.



Conclusion

In this experiment, in first part we set a circuit using different combination of 100 Ω, 1k Ω, 10k Ω,100k Ω with 1000k Ω and 100k Ω. We evaluated current on Vs1 supply and then using this value we calculate R_{par} resistance value and last step we compare difference between R_{par} and R_{comp}. In second part, we built a circuit using 10k Ω,22k Ω,15 Ω resistors with 10V power supply. We measured voltage values for every resistors and we compare them with calculated values in preliminary work. In third part we set a circuit using 10k Ω,22k Ω,15 Ω resistors with 10V power supply. We measured the current through each resistor and then we compare them with calculated values in preliminary work. In fourth part to get desired voltage we built a circuit using two 27 Ω resistors in parallel and a 10k Ω resistor in series with them.

To sum up in this experiment, we learnt how to use Ltspice, set a circuit and measure voltage, current values. We learnt how to give input voltage and get output voltage, how to plotting a graph and some graph options. We observed consequences of Kirchhoff's Voltage Law and Kirchhoff's Current Law. We understood how to use potentiometer and we saw advantages and disadvantages of using potentiometer. We saw if we touch resistance we will get error because hand-to-hand body resistance, Rbody, is connected in parallel with Rcomp of the component. We learnt calculate the percentage of error. We learnt how to set up the necessary circuit to find the desired output voltage.

Answers

Q1)

Rcomp	**Rbody**	**I(Vs1)** current measured on **Vs1** supply	**Rpar** resistance calculated with **I(Vs1)**	**% error** between **Rcomp** and the calculated **Rpar**
100 Ω	1000 kΩ	-100.0 mA	100	0
1 kΩ	1000 kΩ	-10.01 mA	999,0009	0.099
10 kΩ	1000 kΩ	-1.01 mA	9.9k	1.0
100 kΩ	1000 kΩ	-0,11 mA	90.909k	9.09
100 Ω	100 kΩ	-100.100 mA	99.9	0.1
1 kΩ	100 kΩ	-10.10 mA	990.099	0,99
10 kΩ	100 kΩ	-1.1 mA	9090,91	9.09
100 kΩ	100 kΩ	-0.2 mA	50k	50

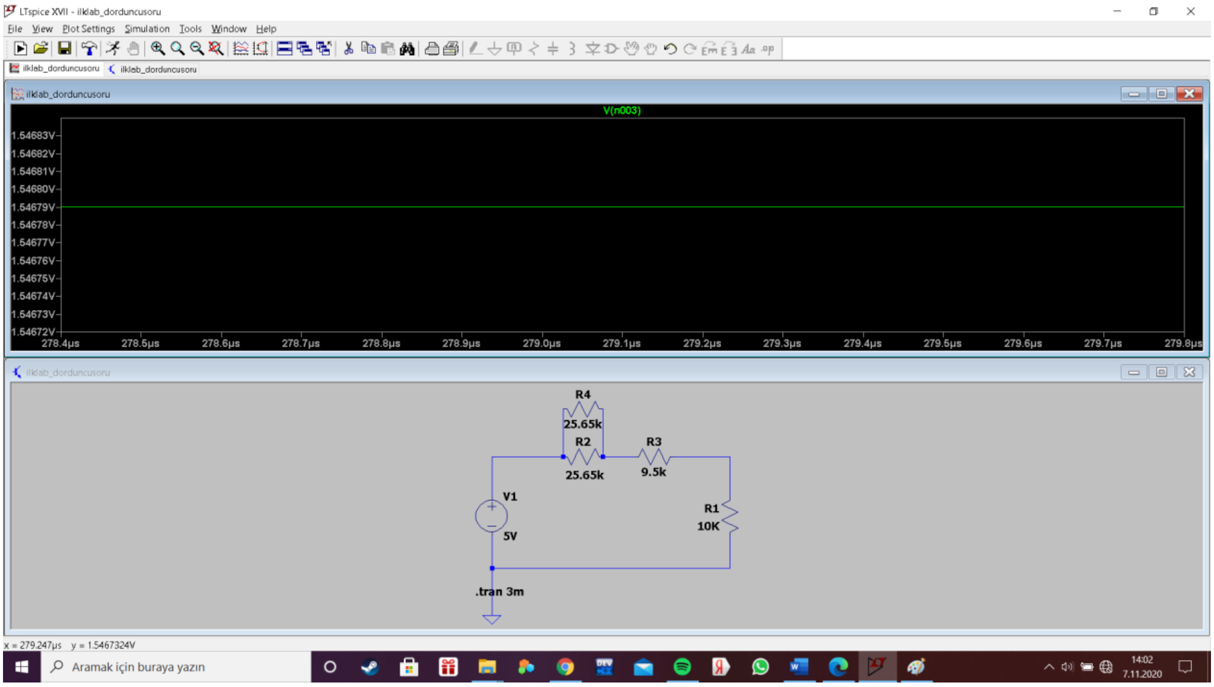
When we examine this chart, we see for constant Rbody values we get bigger error when Rcomp increase. We see for constant Rcomp when Rbody smaller we get bigger error. We get biggest error for Rcomp= 100 kΩ and Rbody=100 kΩ , because in our parallel circuit, at the closer values to each other we get greater error because to get Rcomp,voltage and current values, we calculate according to the parallel circuit.

Q2) If there is no ground in the electric line and you touch it with wet hands, the body acts as a conductor and starts conducting current. When we are wet, our body's resistance to electricity decreases, because of that so much more current flows. For example the typical value of body resistance between dry fingers is 1000 kΩ and for wet fingers is 100 kΩ this meaning is wet fingers is 10 times more dangerous so that electrical shocks are much more dangerous in wet places.

Q3)
a) In this case source of error is multimeter get our fingers as a resistance and calculate as a parallel circuit.
b) If the material of table is conductive, this can be cause of error.
c)There is no error.
d) In this situation source of error is multimeter get my partner fingers as a resistance and calculate as a parallel circuit.
e) There is no error.

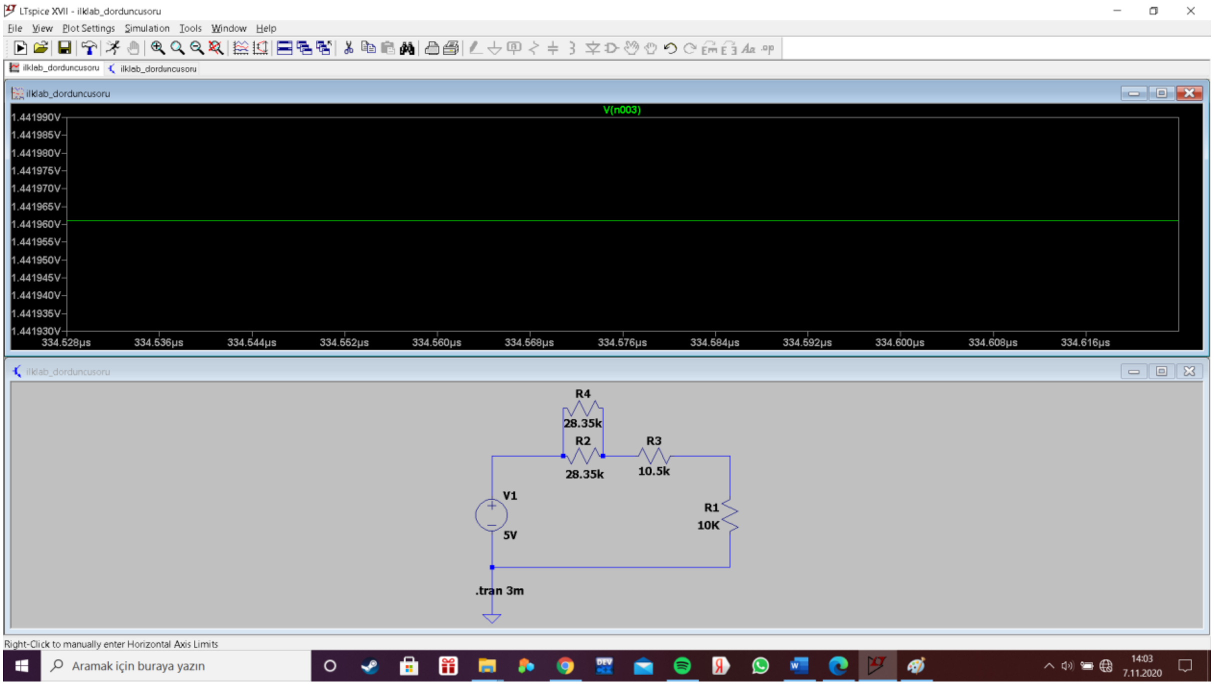
Q4)
a)

To get maximum output voltage, our resistances are
$0.95*R_1=0.95*27k=25.65k$
$0.95*R_2=0.95*27k=25.65k$
$0.95*R_3=0.95*10k=9.5k$



Maximum Output Voltage= 1.5468

To get minimum output voltage, our resistances are
$1.05*R_1=1.05*27k=28.35k$
$1.05*R_2=1.05*27k=28.35k$
$1.05*R_3=1.05*10k=10.5k$



Minimum Output Voltage= 1.4420

b) Our output voltage must be between 1.425 and 1.575 . For output voltage will be in the specified error range our total resistance must be between 31.746kΩ-35.087kΩ and because of R_{load}=10kΩ our specific circuit resistance value must be between 21.746kΩ and 25.087kΩ. The total value of the resistors we will chose must be in this range. We should choose that type resistors.