<u>Assignment 1</u>

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EECS LAB I (ECS 327)

1. To solve the first part of the question wherein the bulbs are connected in parallel, let's first calculate the equivalent resistance.

We are given with Bulb 1 having a resistance of 3 **Ω**
Bulb 2 having a resistance of 6 **Ω**

Equivalent resistance, $R_{eq} = R_1R_2/(R_1 + R_2)$
$= 18/9 = 2$ **Ω**

Current I in the circuit, $I = V/R_{eq} = 6/2 = 3A$

Current through Bulb 1, $I_1 = I * R_2/(R_1 + R_2) = 2*3/3 = 2A$

Current through Bulb 2, $I_2 = I * R_1/(R_1 + R_2) = 1*3/3 = 1A$

Since P= V*I and P is directly proportional to I , **Bulb 1 will glow brighter** than Bulb 2.

2. In this case bulbs are connected in series, the current across both of them will be the same, hence the bulb with high resistance and more power dissipation will glow brighter than the other one.

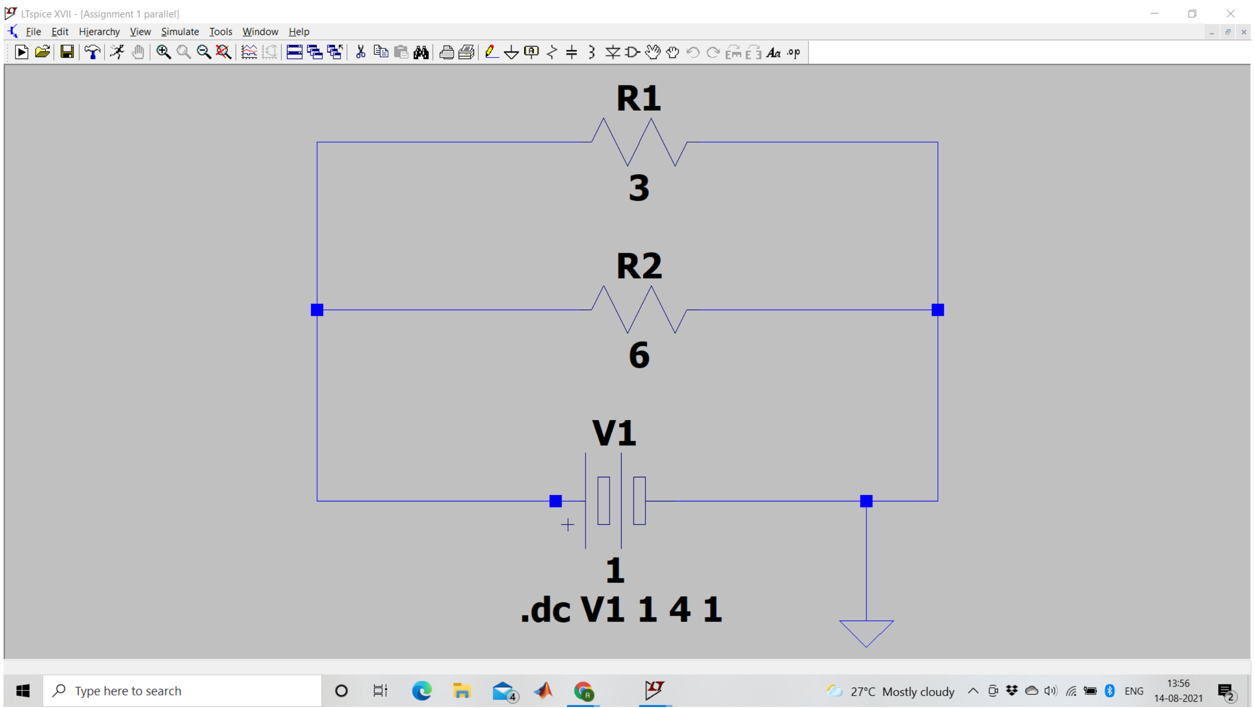
Equivalent Resistance of the network, $R_{eq} = 6 + 3 = 9$ **Ω**
I or current = V/R = 6/9 = 0.666 A
$V_1 = I * R_1 = 6*3/9 = 2V$
$V_2 = I * R_2 = 6*6/9 = 4V$

$P_1 = V_1^2 / R_1 = 4/3 = 1.333W$
$P_2 = V_2^2 / R_2 = 16/6 = 2.666W$

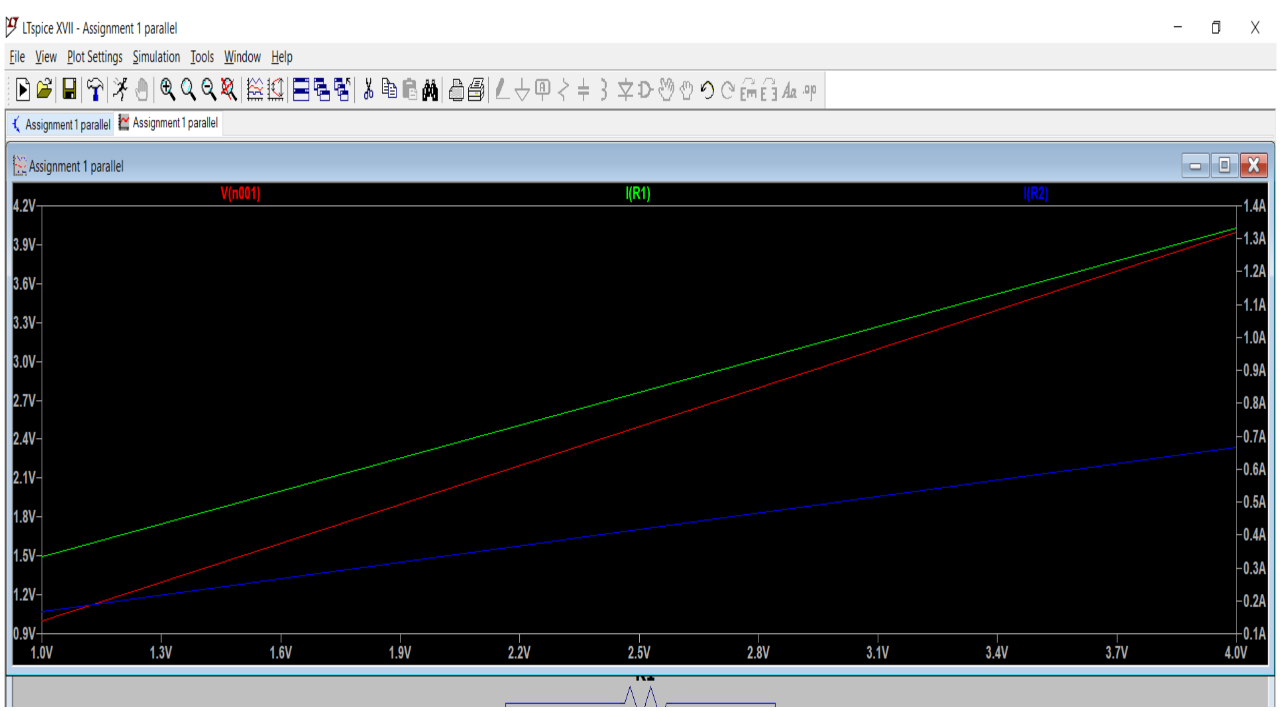
Therefore, since P_2 is greater than P_1 , **hence Bulb 2 would glow brighter in this case.**

Experimental Setup:

The parallel circuit in LTSpice:



Using DC sweep, the I-V curve was plotted for both the resistors with a starting Voltage of 1V to an ending voltage of 4V in steps of 1unit.
The following is the snip of the I-V curve obtained with Voltage on the X-axis and Current on the Y-axis.



According to Ohm's Law we hypothesize a **linear relationship** between current and voltage and expect current to increase linearly with Applied voltage which is precisely the case as obtained in the I-V characteristic graph above.

In the parallel circuit setup,
Equivalent resistance, $R_{eq} = R_1R_2/(R_1 + R_2)$
$= 18/9 = 2\ \Omega$
Calculating the Power for each of the cases:

Case 1: Voltage = 1V

Power Output of the circuit , $P = V^2/R_{eq} = \frac{1}{2} = 0.5$ W.
$I_{eq} = \frac{1}{2} = 0.5$ A

$P_1 = V^2/R_1 = \frac{1}{3} = 0.66$ W , (Power across bulb 1)
$P_2 = V^2/R_2 = \frac{1}{6} = 0.166$W (Power across bulb 2)

Case 2: Voltage=2V

Power Output of the circuit, $P = V^2/R_{eq} = 4/2 = 2$ W

$P_1 = V^2/R_1 = 1.33$ W , (Power across bulb 1)
$P_2 = V^2/R_2 = 0.666$W (Power across bulb 2)

Case 3: Voltage=3V

Power Output of the circuit, $P = V^2/R_{eq} = 9/2 = 4.5$ W

$P_1 = V^2/R_1 = 3$ W , (Power across bulb 1)
$P_2 = V^2/R_2 = 1.5$W (Power across bulb 2)

Case 4: Voltage=4V

Power Output of the circuit, $P = V^2/R_{eq} = 16/2 = 8$ W

$P_1 = V^2/R_1 = 5.33$ W , (Power across bulb 1)

$P_2 = V^2/R_2 = 2.66W$ (Power across bulb 2)

In this case, the bulb which has more current , I passing through it would glow higher than the other.

In the parallel configuration,

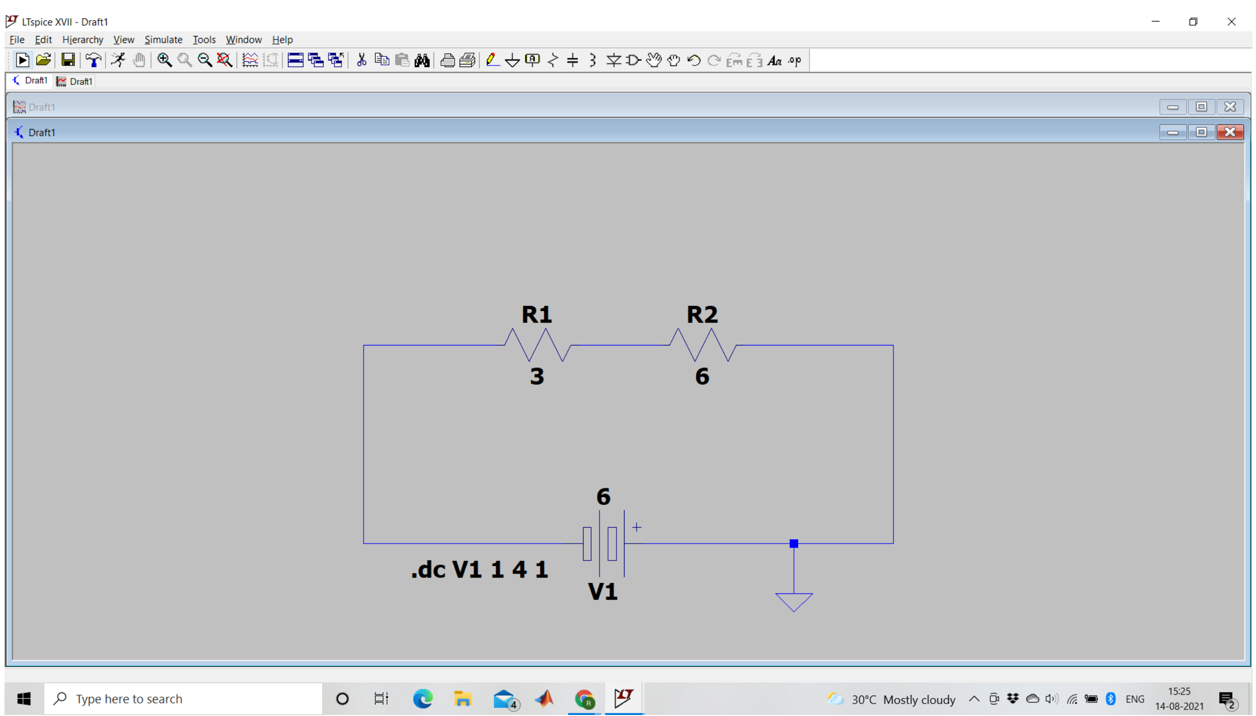
Current through Bulb 1, $I_1 = I_{eq} * R_2/(R_1 + R_2) = 6*I_{eq}/9 = I_{eq} \times 2/3$

Current through Bulb 2, $I_2 = I_{eq} * R_1/(R_1 + R_2) = 3*I_{eq} / 9 = I_{eq} \times 1/3$

Since in all the cases of different voltages, **$I_1 > I_2$, this implies that Bulb 1 will dissipate more heat** in all the cases of the parallel setup.

Part 2: Series connection

The simulated circuit setup is as follows :



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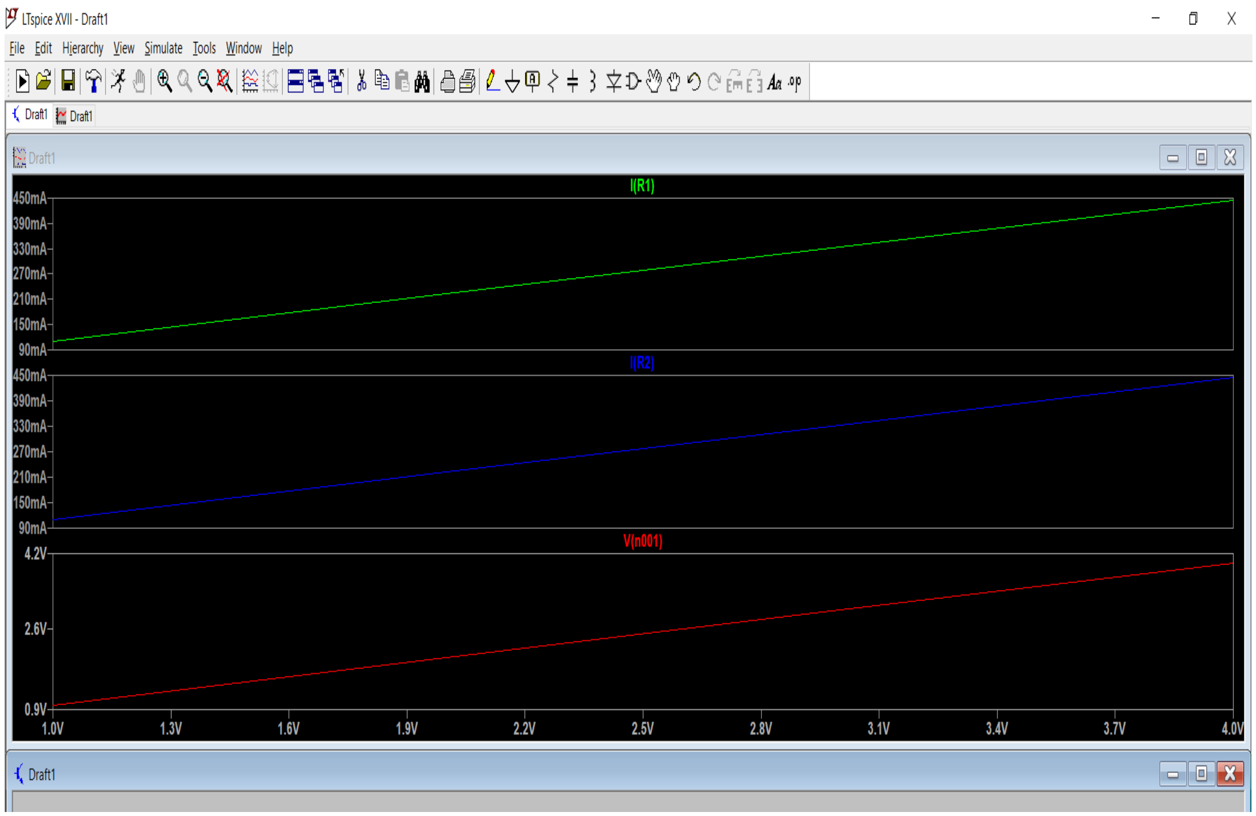

In this case as well, the characteristic I-V curve obtained for both the resistors is linear.

In series connection, we know that Current is the same across the resistors,

So in this set up,
$R_{eq} = R_1 + R_2 = 3+6 = 9\ \Omega$

Case 1: Voltage= 1V

I_{eq}= V/R_{eq}=1/9 A = 0.111 A

Power output of the circuit , P = I_{eq}^2 * R_{eq}= 0.111W
Power across bulb 1 = I_{eq}^2* R_1 = 0.037 W
Power across bulb 2 = I_{eq}2* R_2 =0.074 W

Case 2: Voltage= 2V

I_{eq}= V/R_{eq}=2/9 A = 0.66 A

Power output of the circuit , P = I_{eq}^2 * R_{eq}= 0.444W
Power across bulb 1 = I_{eq}^2* R_1 = 0.148 W
Power across bulb 2 = I_{eq}^2* R_2 = 0.296 W

Case 3: Voltage= 3V

I_{eq}= V/R_{eq}=3/9 A = 0.333 A

Power output of the circuit , P = I_{eq}^2 * R_{eq}= 1W
Power across bulb 1 = I_{eq}^2* R_1 = 0.33 W
Power across bulb 2 = I_{eq}^2* R_2=⅔ =0.66 W

Case 4: Voltage= 4V

I_{eq}= V/R_{eq}=4/9 A = 0.197 A

Power output of the circuit , P = I_{eq}^2 * R_{eq}= 1.77W
Power across bulb 1 = I_{eq}^2* R_1 = 0.59 W
Power across bulb 2 = I_{eq}^2* R_2=⅔ =1.185 W

Which bulb will dissipate more heat ?

Equivalent Resistance of the network, R_{eq} = 6+ 3= 9 **Ω**
We know that both the bulbs have a common value of current, I_{eq}
So $P_1 = I_{eq}^2 * R_1 = 3*I_{eq}$
And $P_2 = I_{eq}^2 * R_2 = 6*I_{eq}$

Hence, since $P_2 > P_1$ for all the cases of the series setup, Hence **Bulb 2 will dissipate more heat** than bulb 1.