1. **Abstract:**

The operating point (Q) of BJT is very important for amplifiers, since a wrong ‘Q’ point selection increases amplifier distortion. It is imperative to have a stable ‘Q’ point, meaning that the operating point should not be sensitive to variation to temperature or BJT ***β***, which can vary widely. In this experiment, four different circuits will be analyzed for two different ***β*** to check the stability of biasing points.

The analysis of the BJT circuits is a systematic process. Initially, the operating point of a transistor circuit is determined then the small signal BJT model parameters are calculated. Finally, the dc sources are eliminated, the BJT is replaced with an equivalent circuit model and the resulting circuit is analyzed to determine the voltage amplification (AV), current amplification (Ai), Input impedance (Zi), Output Impedance (Zo), and the phase relation between the input voltage (Vi) and the output voltage (Vo).

The experiment is a very good practical realization of bipolar junction transistor (BJT) biasing circuit.A BJT biasing circuit will be designed and simulated to find a DC operating point using a circuit simulation tool. Then a fixedbiasing and a self-biasing BJT circuits will be implemented on the trainer board to find a DC operating point for two different β of the transistor.

1. **Introduction:**

The main objectives of this experiment are to- 1. Establish the proper operating point

2. Study the stability of the operating point with respect to changing ***β*** in different biasing circuits

1. **Theory and Methodology:**

The dc analysis is done to determine the mode of operation of the BJT and to determine the voltages at all nodes and currents in all branches. The operating point of a transistor circuit can be determined by mathematical or graphical (using transistor characteristic curves) means. Here we will describe only the mathematical solution.

Q

R

C

V

cc

R

B

1

I

c

I

B

I

E

R

B

12

R

C

Q

R

C

V

cc

R

TH

I

c

I

B

I

E

R

C

V

TH

Fig 1:Biasing Circuit

We will use the most commonly applied biasing circuit to operate the BJT as an amplifier. A single power supply is used and the voltage divider network consisting of RB1 and RB2 is used to adjust the base voltage. Using the Theveninequivalent, the voltage divider network is replaced by Vth and Rth where,

𝑉𝑡ℎ = 𝑅𝐵𝑅1+𝐵2𝑅𝐵2 𝑉𝐶𝐶 and 𝑅𝑡ℎ = 𝑅𝑅𝐵𝐵11+𝑅𝑅𝐵𝐵22

The dc analysis of the circuit is simple by applying two KVL's at the input and theoutput loop.

𝑉𝑡ℎ = 𝐼𝐵𝑅𝑡ℎ + 𝑅𝐵𝐸 + 𝐼𝐸𝑅𝐸 = 𝐼𝐵(𝑅𝑡ℎ + (𝛽 + 1)𝑅𝐸) + 𝑉𝐵𝐸

𝑅𝐵2

𝑉𝐶𝐶 = 𝐼𝐶𝑅𝐶 + 𝑉𝐶𝐸 + 𝐼𝐸𝑅𝐸 = 𝐼𝐶 (𝑅𝐶 + ) + 𝑉𝐶𝐸

𝛼

𝑉𝐵 − 𝑉𝐵𝐸

𝐼𝐵 =

𝑅𝐵 + (1 + 𝛽)𝑅𝐸

𝐼𝐶𝑄 = 𝛽𝐼𝐵

𝐼𝐸𝑄 = (1 + 𝛽)𝐼𝐵

𝑉𝐶𝐸𝑄 = 𝑉𝐶𝐶 − 𝐼𝐶𝑅𝐶 − 𝐼𝐸𝑅𝐸

If the BJT is in the active mode the following typical values can be observed:

𝑉𝐵𝐸 ≈ 0.7 𝑉and𝐼𝐶 ≈ 𝛽𝐼𝐵

RC is used to adjust the collector voltage. Finally, RE is used to stabilize the dcbiasing point (operating point). Using the above equations, the stability of biasing points for different transistor of β can be calculated.

**Note:** It is a good idea to set the bias for a single stage amplifier to half the supply voltage, as this allows maximum output voltage swing in both directions of an output waveform. For maximum symmetrical swing, it is clear from the figuresthat VCE should be VCE= VCC/2.

1. **Apparatus:** 
   1. Trainer Board
   2. Transistor : C828(NPN), BD135(NPN)
   3. Resistors : R=22KΩ, RC= 470Ω, RB1 = 10KΩ, RE = 560Ω,

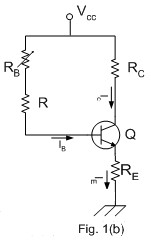
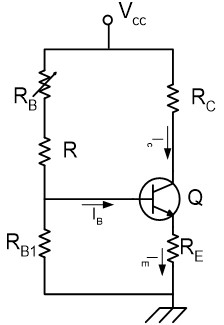
RB=500K(Potentiometer)

* 1. DC Power Supply (VCC = +15V DC)
  2. Multimeter
  3. Power Supply Cable

1. **Precautions:**

Transistors are sensitive to be damaged by electrical overloads, heat, humidity, and radiation. Damage of this nature often occurs by applying the incorrect polarity voltage to the collector circuit or excessive voltage to the input circuit. One of themost frequent causes of damage to a transistor is the electrostatic discharge from the human body when the device is handled. The applied voltage, current should not exceed the maximum rating of the given transistor.

**I.Circuit Diagrams:**

Q

R

C

R

B

Fig. 1(a

)

V

cc

R

I

c

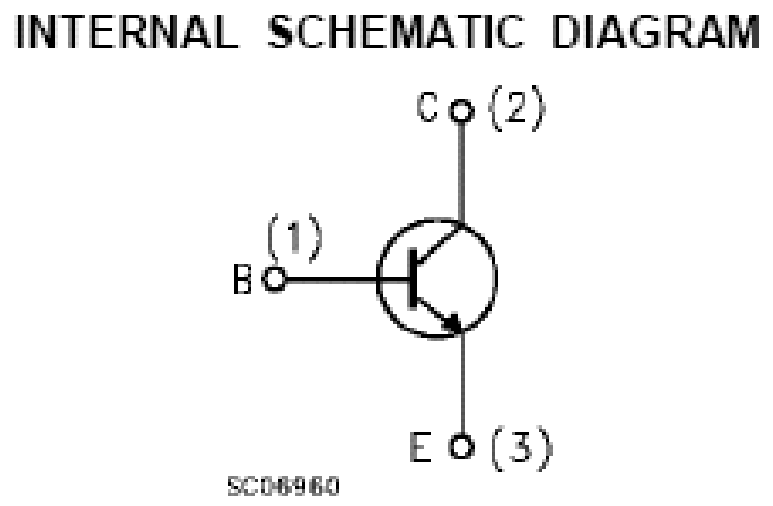
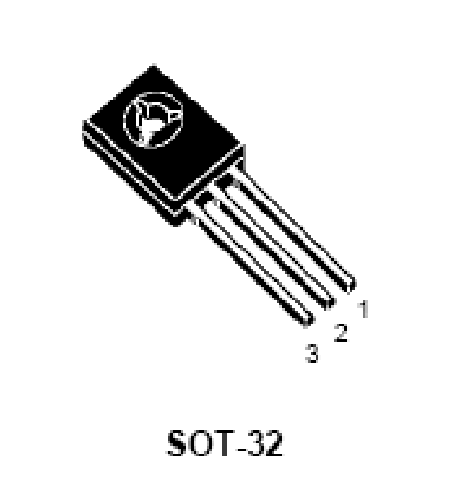
I

B

I

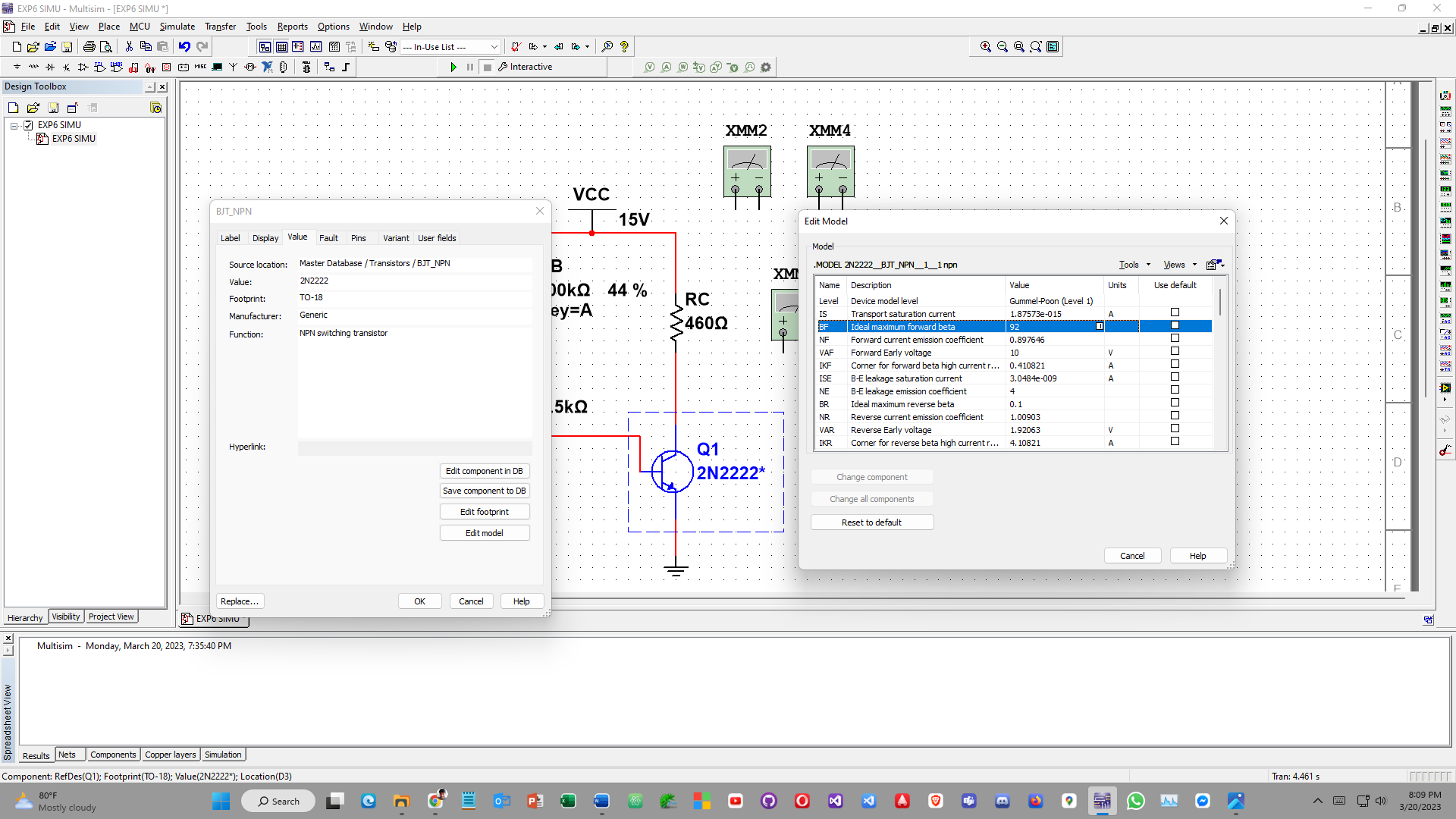
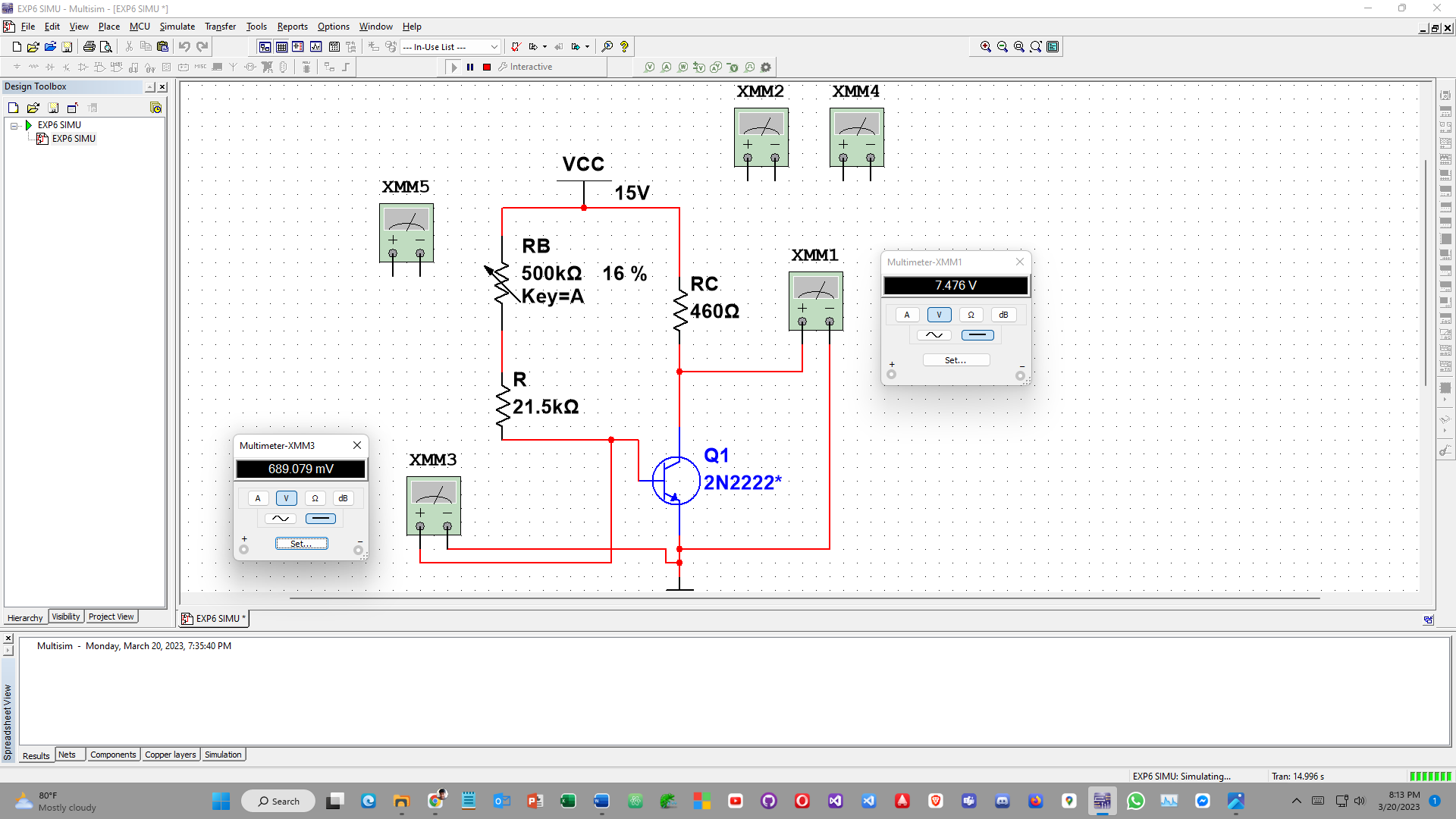
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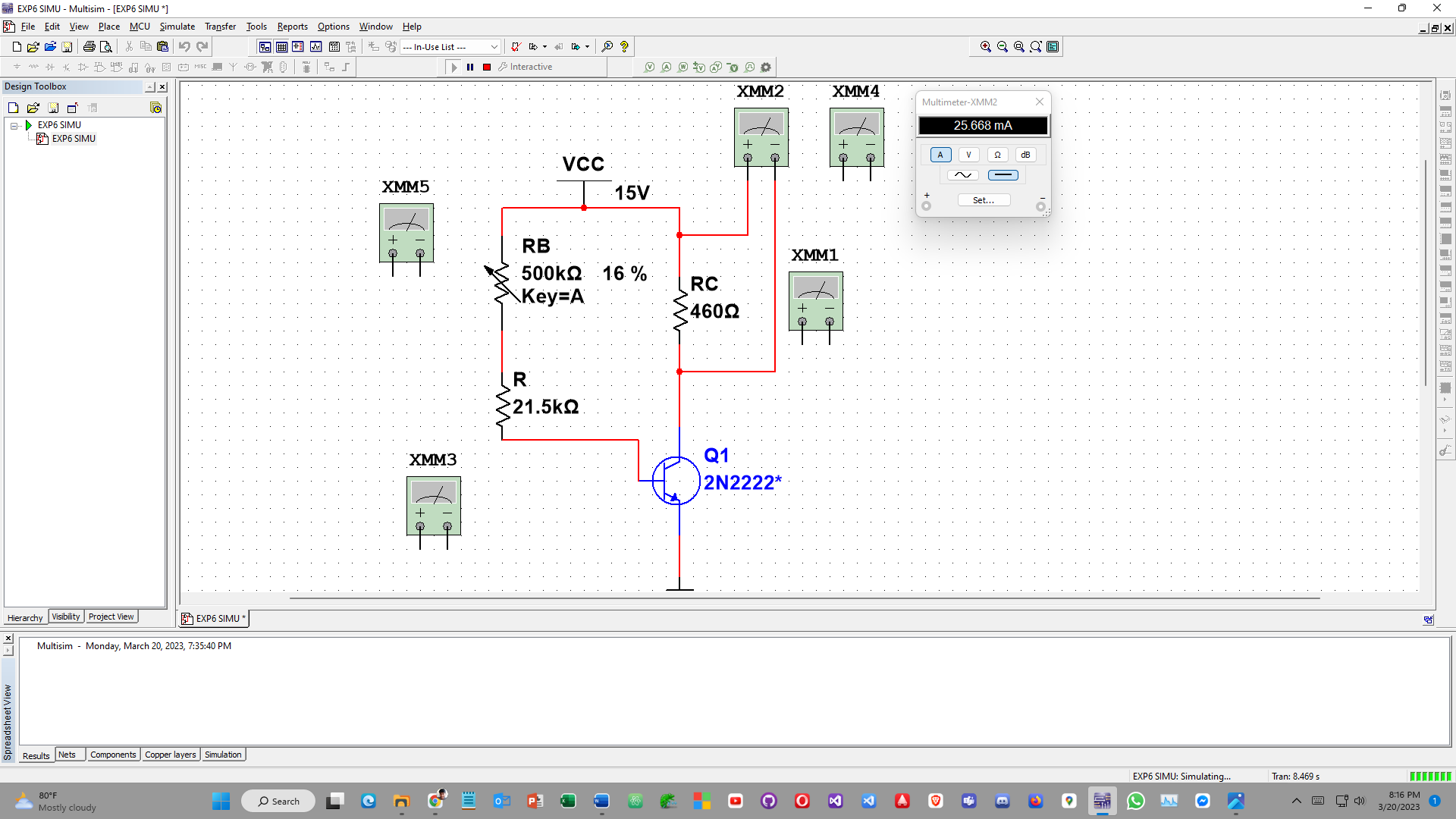
Fig. 2

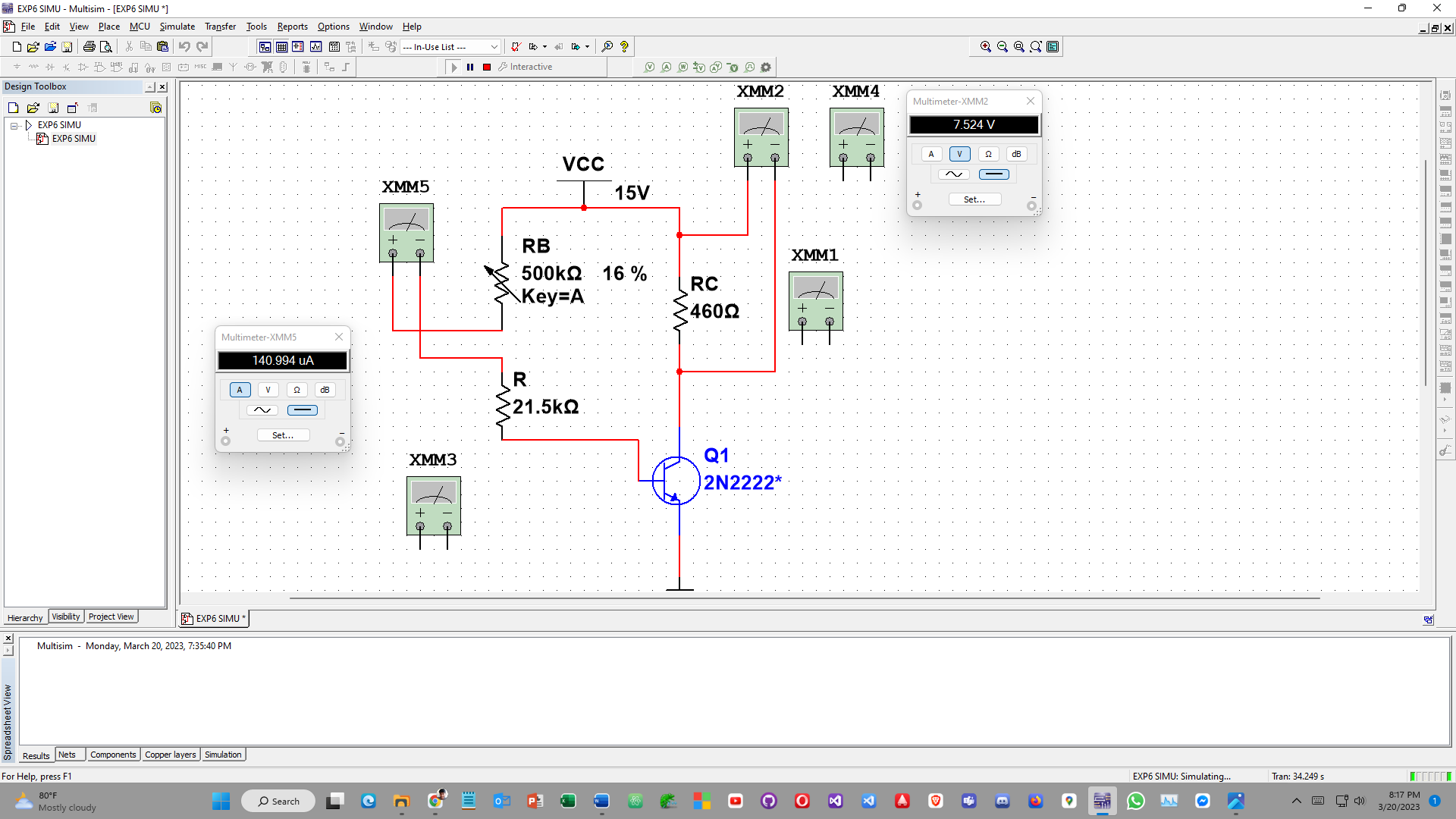


**Simulation:**

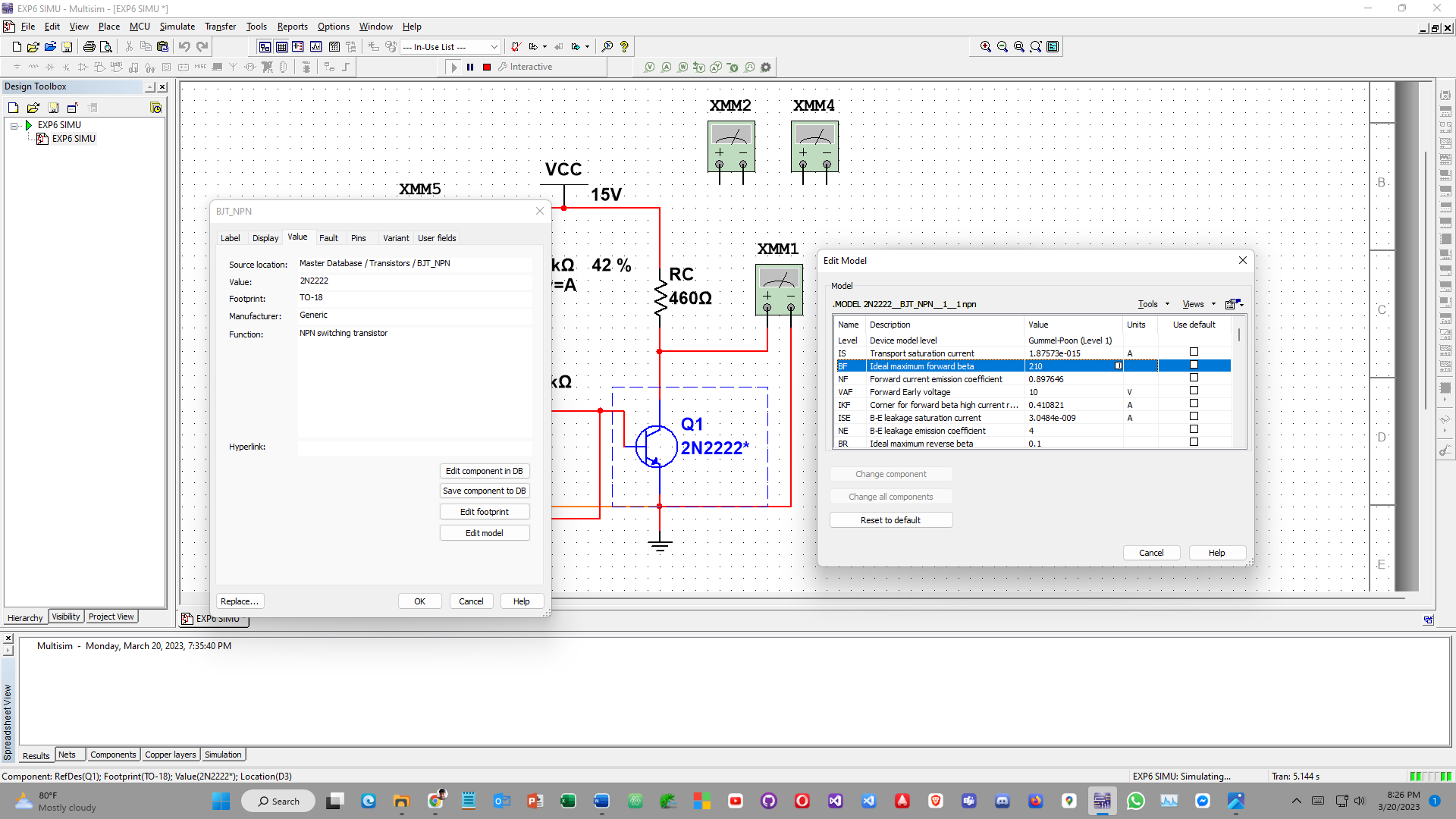
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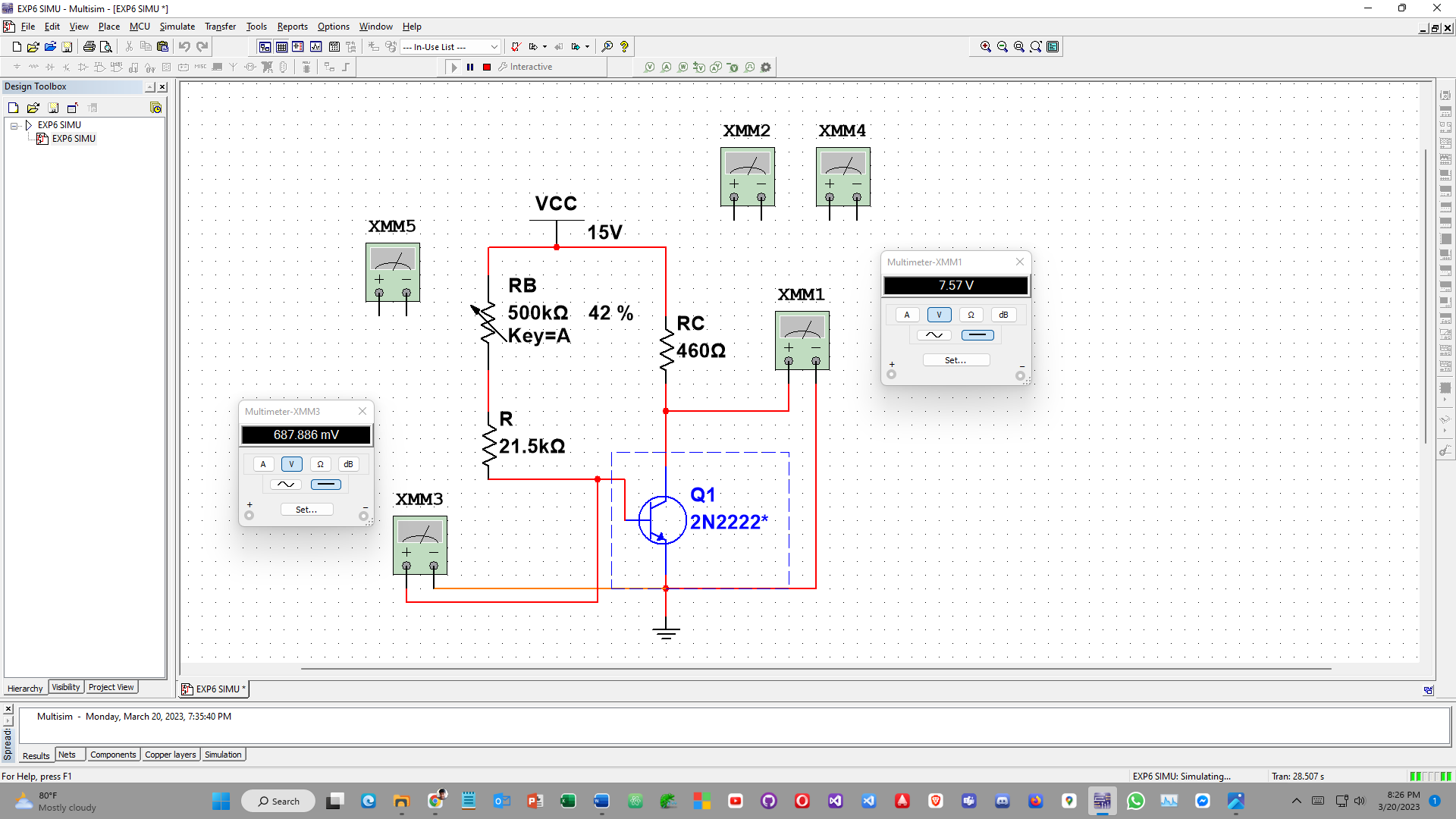
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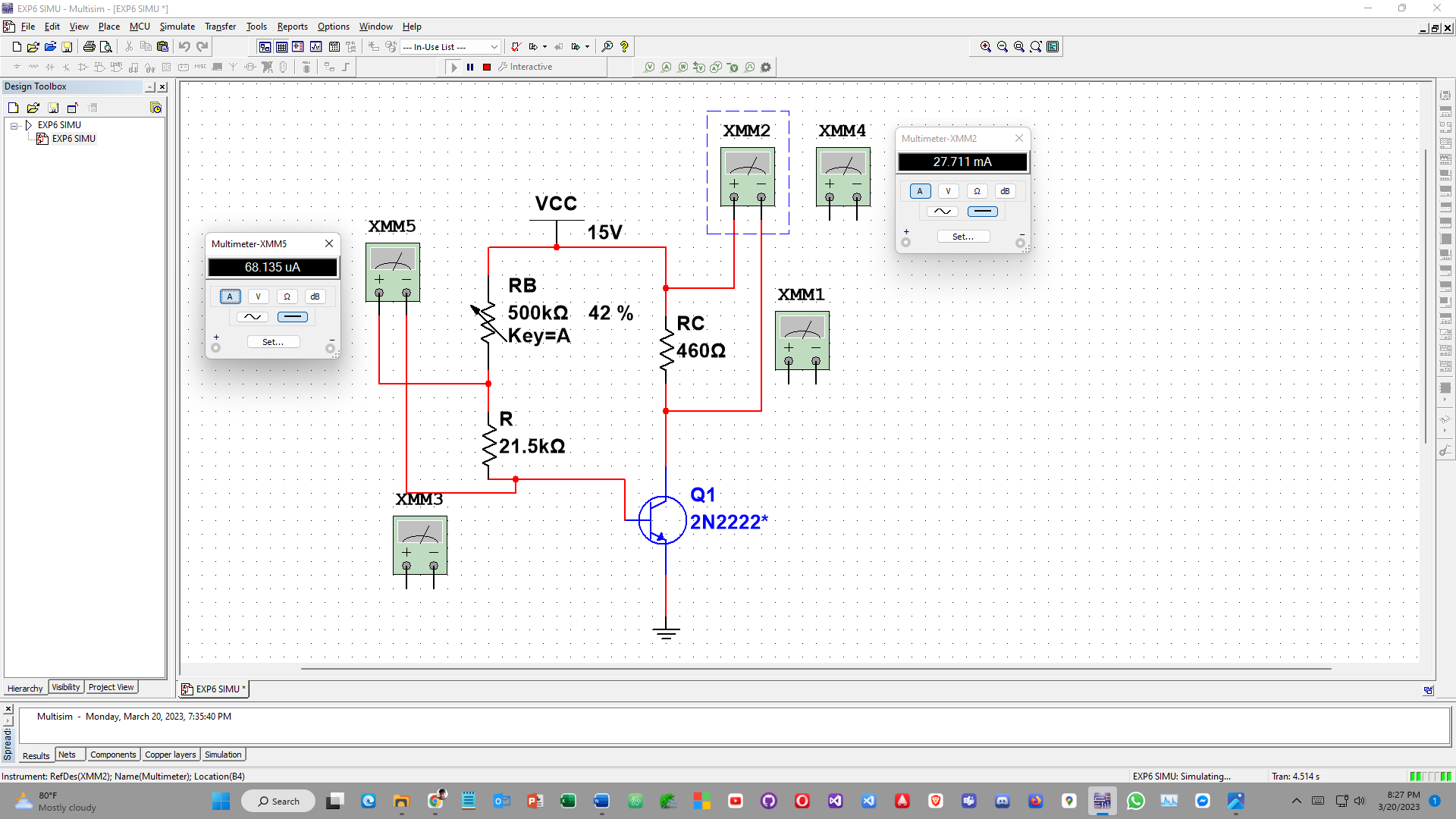


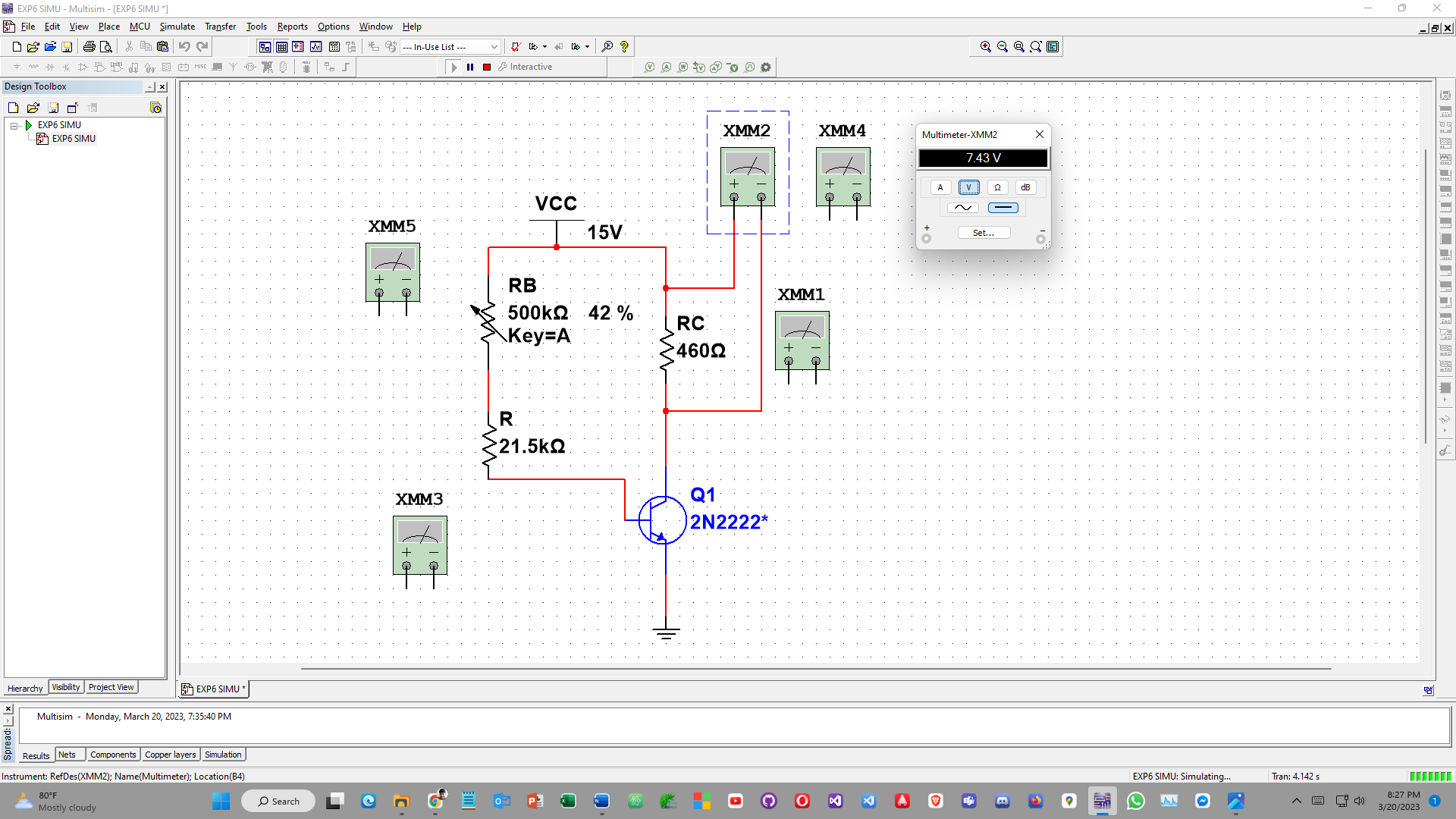


**Fixed bias(beta = 210)**

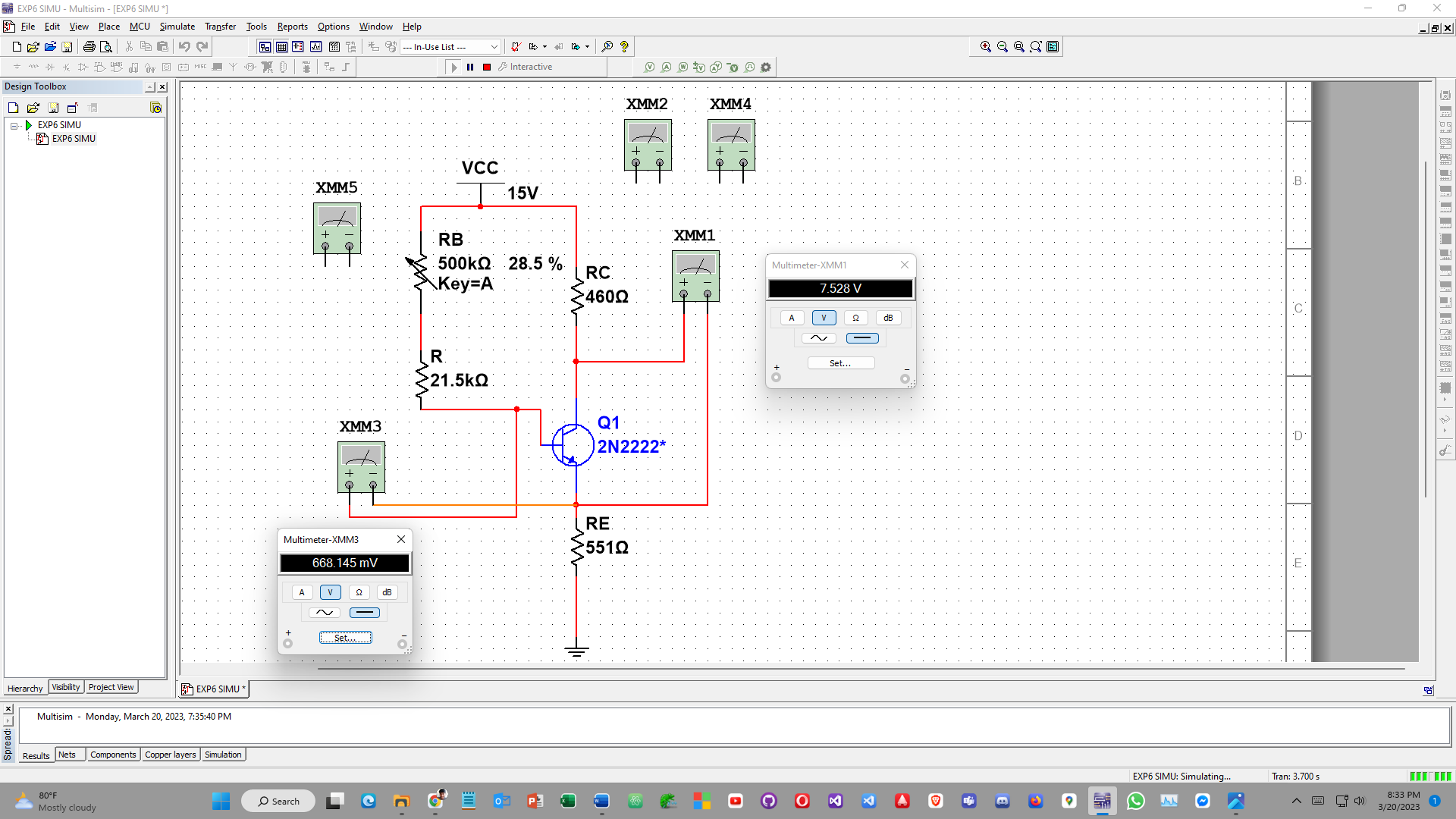
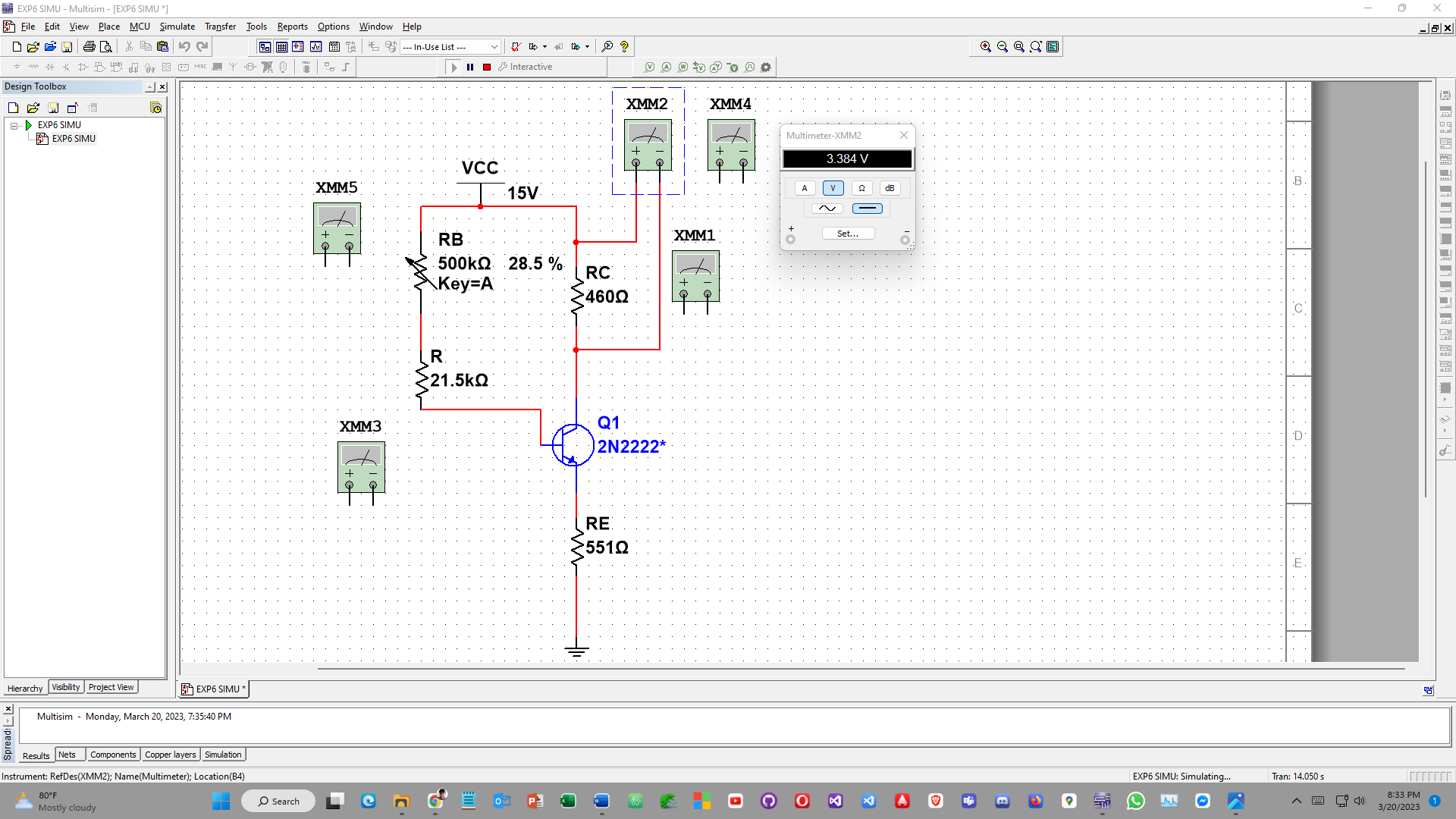
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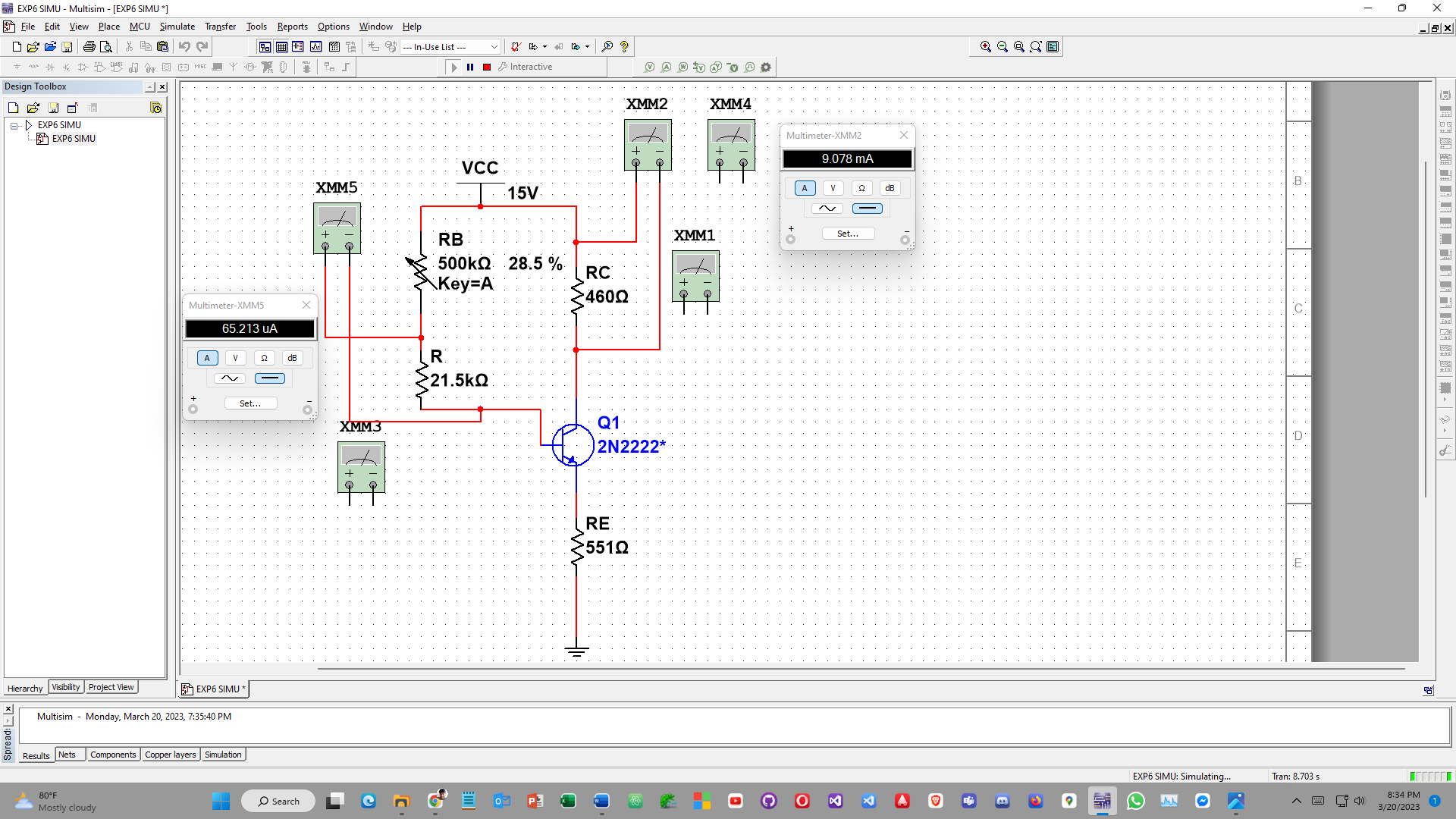
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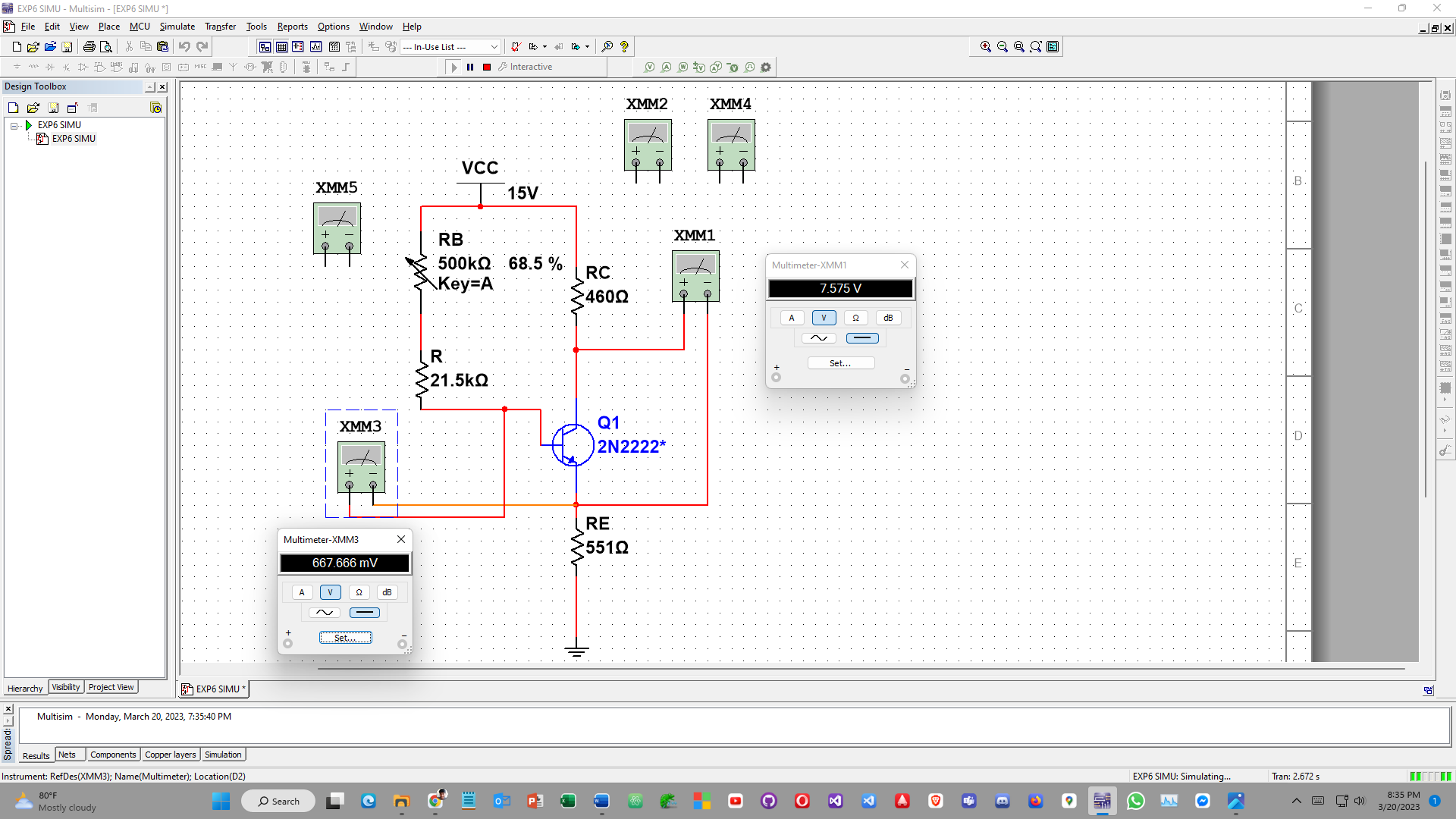


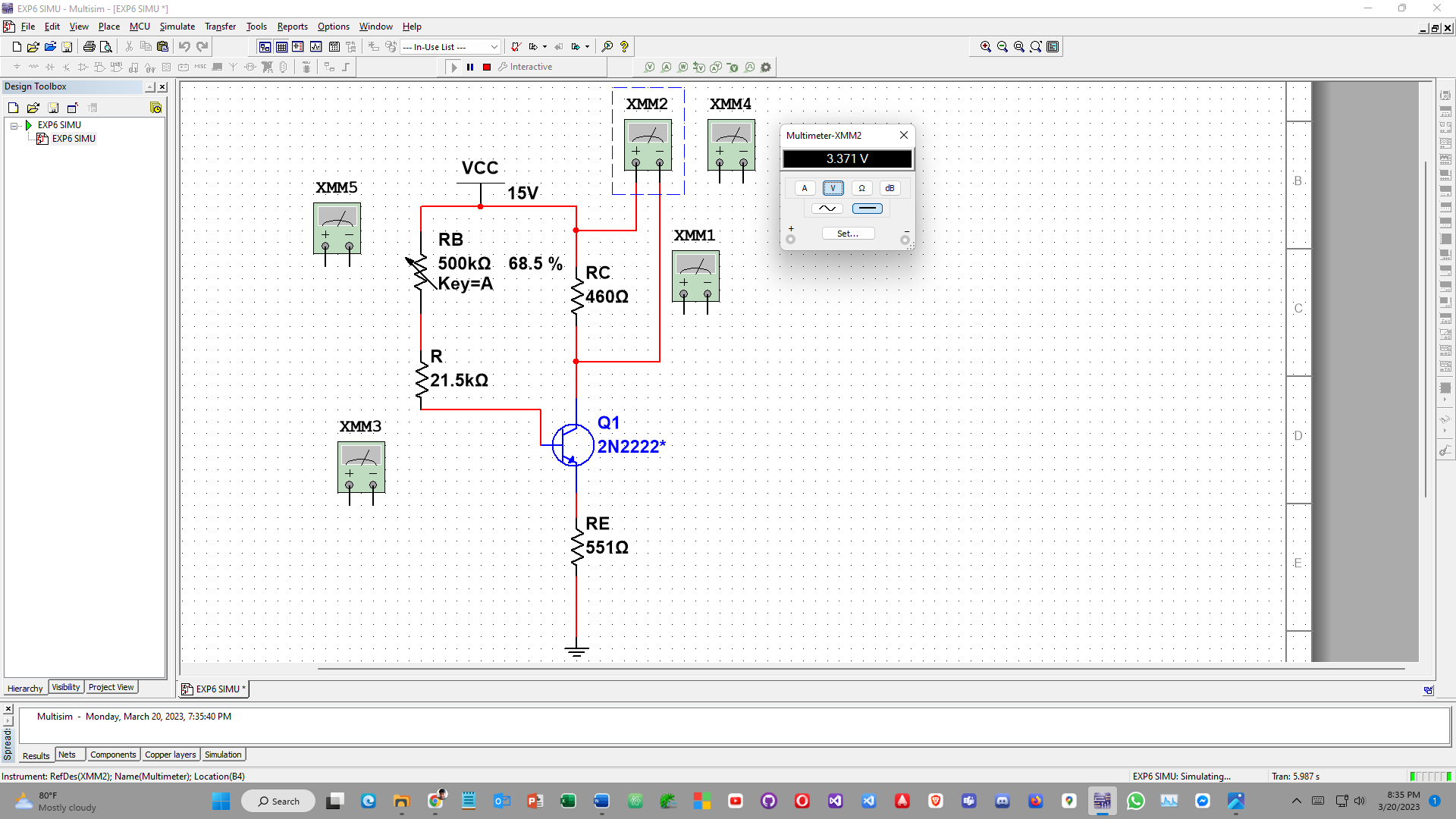
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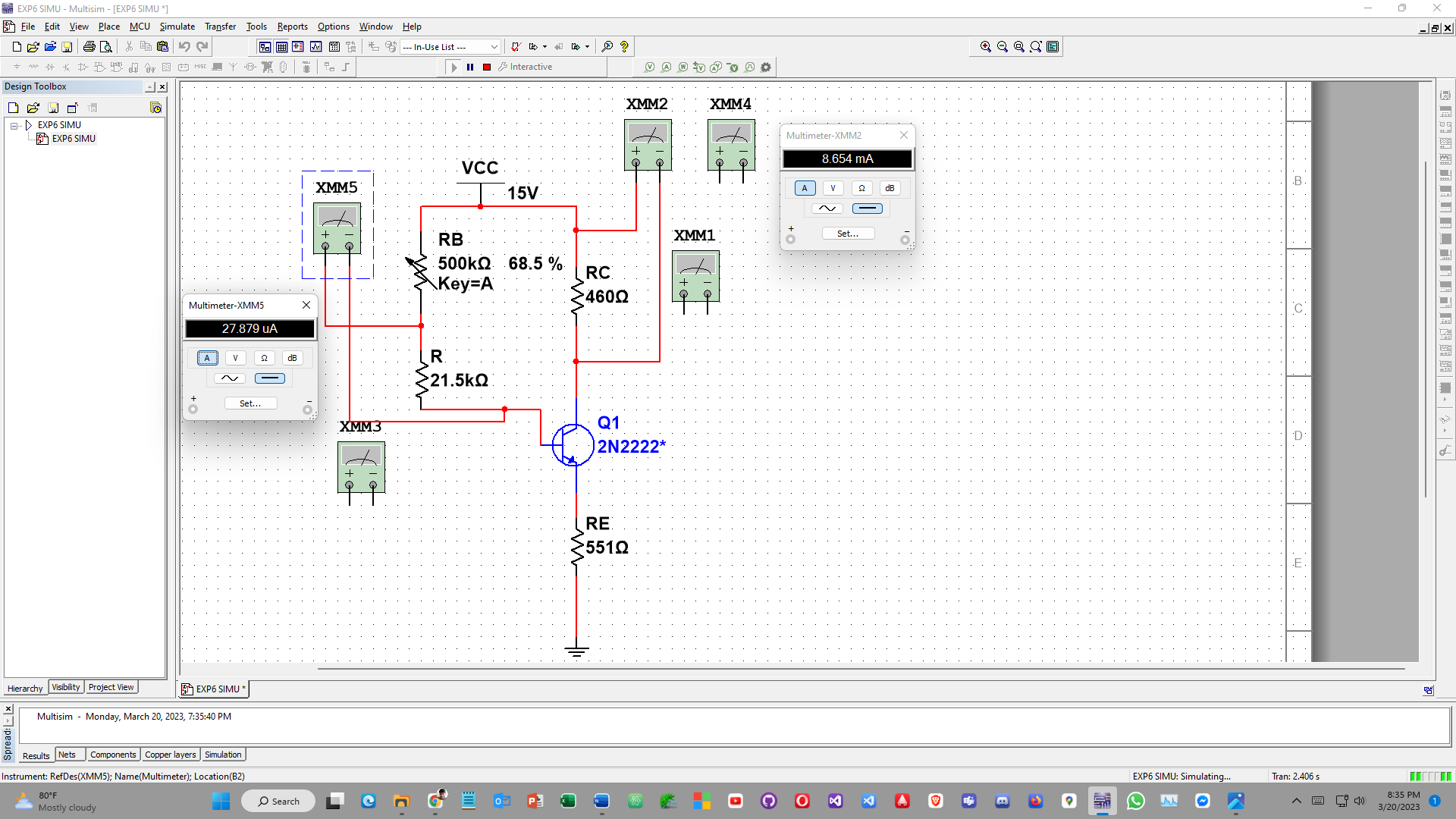


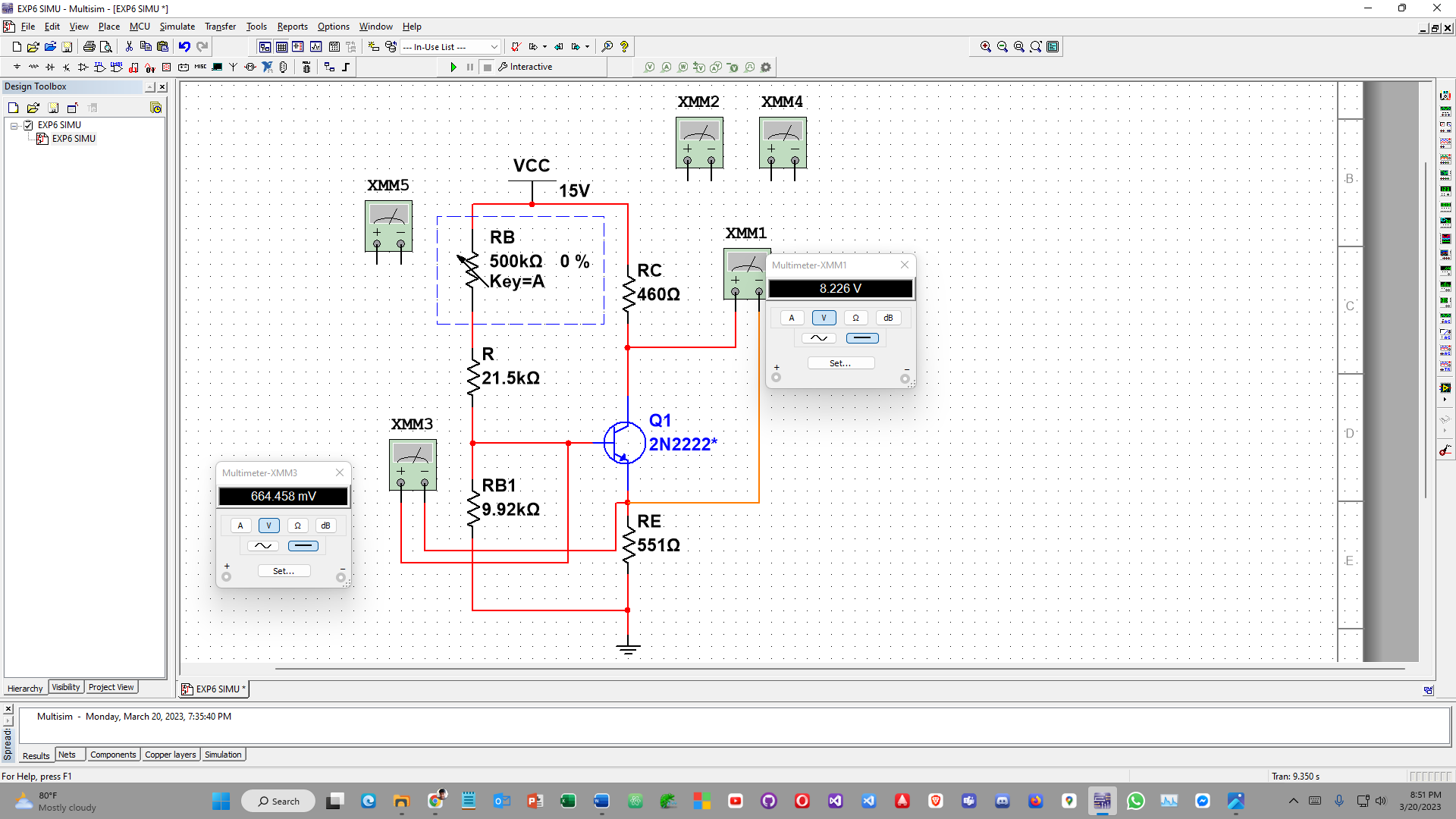


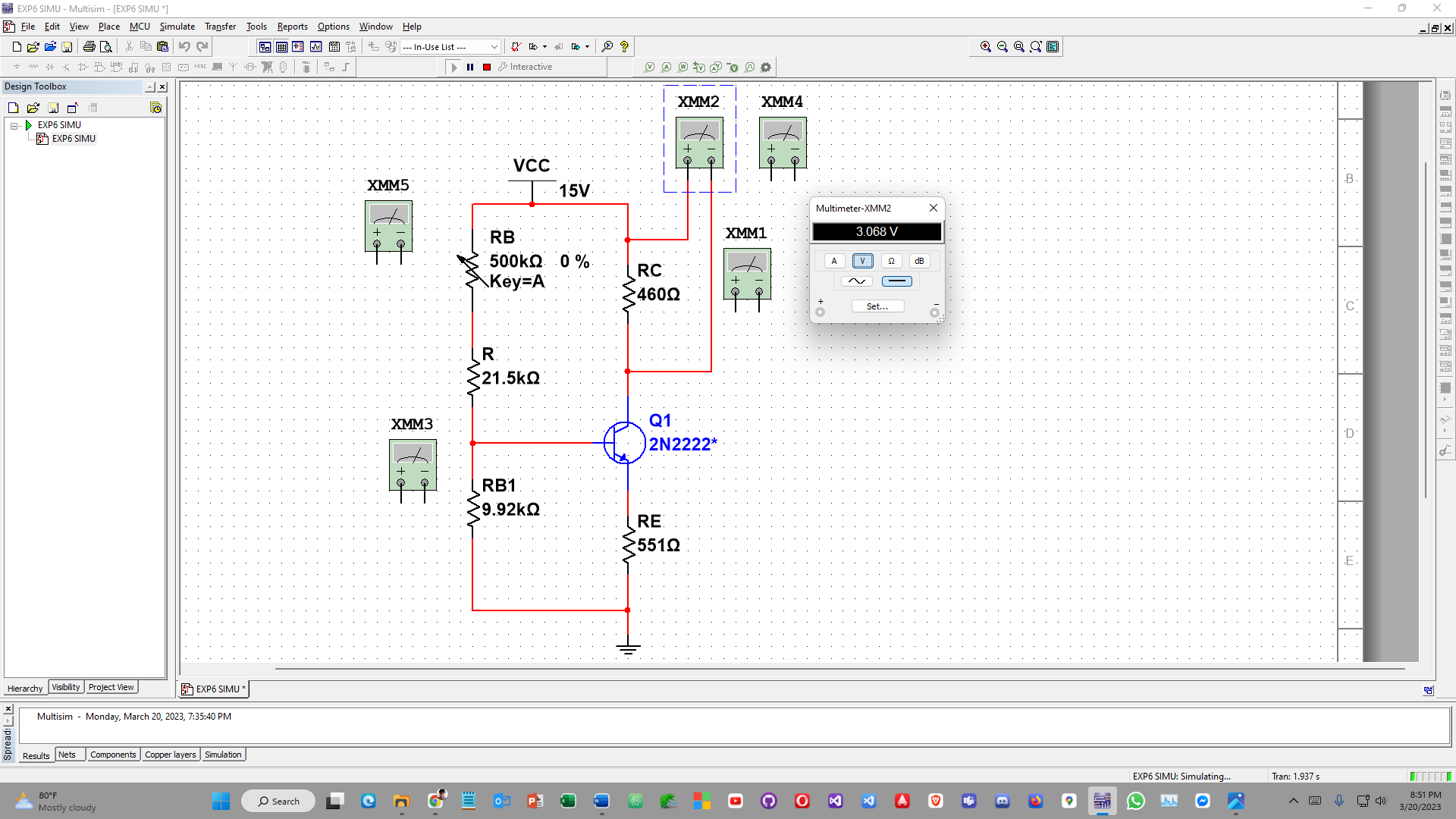
**Emitter bias(beta = 210)**

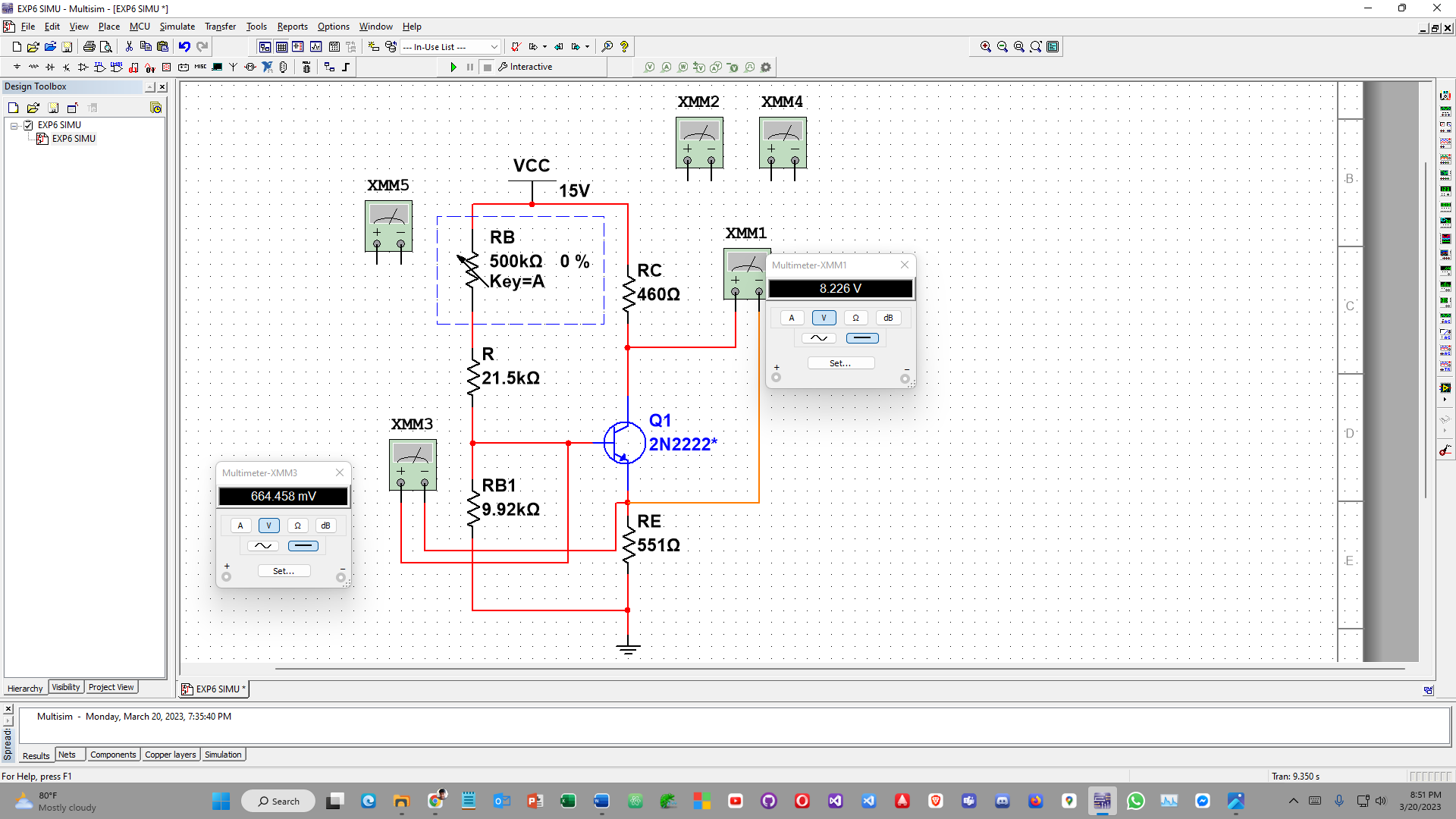






**Voltage divider bias (beta = 92)**





**Voltage divider bias(beta = 210)**

