Electronic Circuits I – Laboratory 06

Transistors as Amplifier

#	Student ID	Student Name	Grade (10)	Instructor signature
1				
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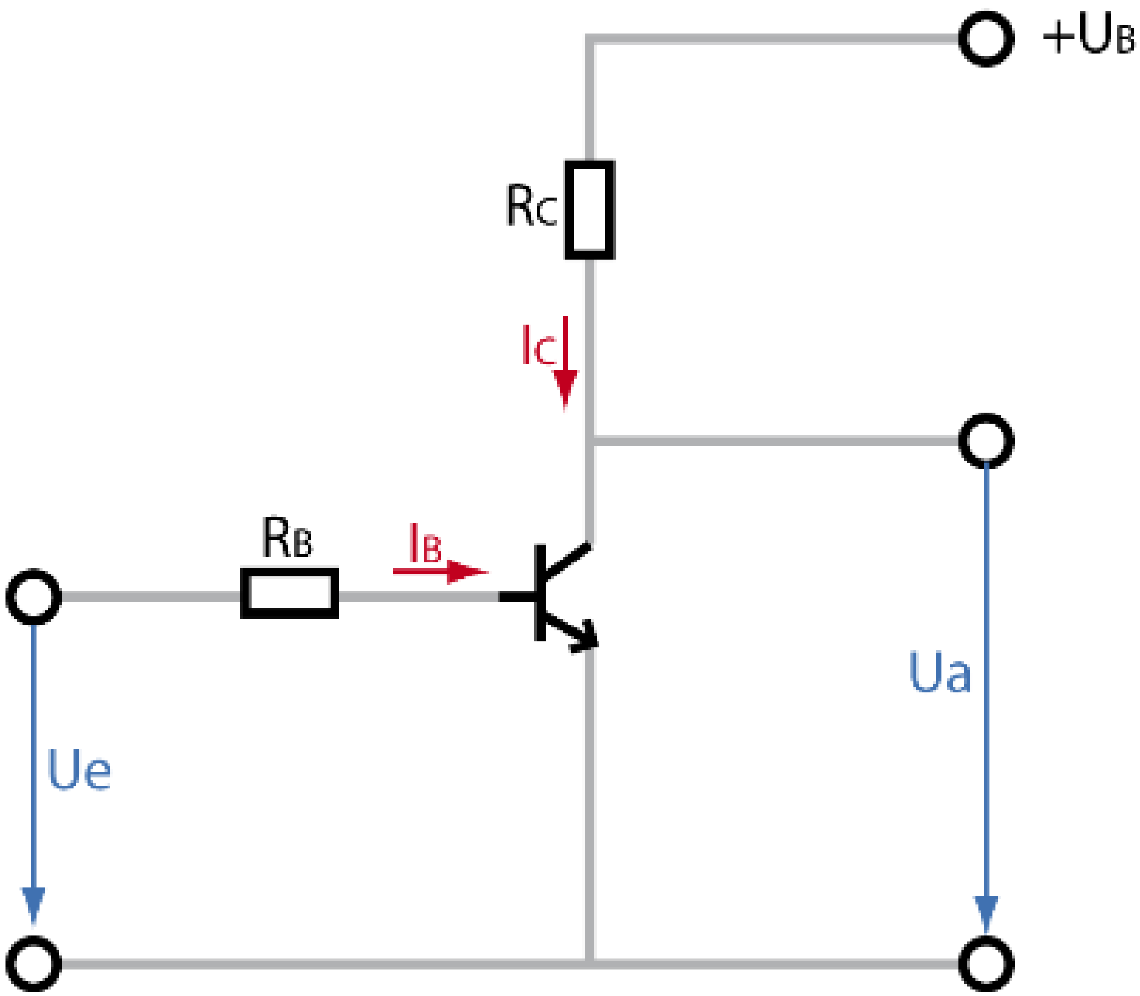
Delivery Date	

One of the main applications for transistors is transistor switching stages. They are used for contactless, fast switching of small and medium loads. When used in this manner, the transistor is simply shifted between two states. Switching between these two states happens within a few microseconds.



Transistor switched off

In this state, the input base current I_B = 0 A. In this case, the transistor is switched off and no collector current is able to flow. Because there is no voltage drop across the resistor R_C, the output voltage V_{out} corresponds to the supply voltage V_B.

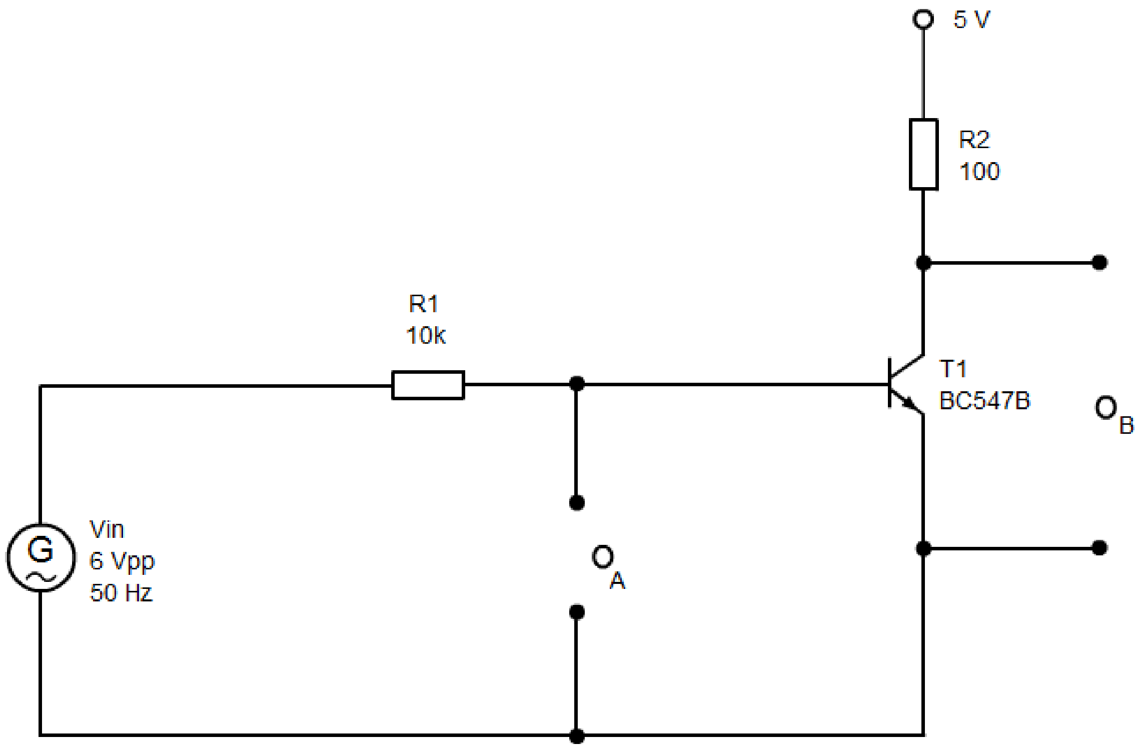
Transistor switched on

In this state, a base current is fed to the transistor via R_B by applying an input voltage. This causes a collector current to flow, which must be sufficiently large that most of the supply voltage V_B drops across the collector resistor R_C. The output voltage V_{out} therefore sinks almost to 0 V. The voltage does not fall all the way to 0 V due to the fact that the resistance between the collector and the emitter of the transistor is not exactly 0 Ω. This residual voltage is also called the saturation voltage V_{CEsat}.

In order to ensure that this saturation level is achieved, a base current is supplied, which is not just the amount required for a collector current, but several times that current. As a consequence, the base is overdriven. This multiple is also referred to as the overdrive factor and, in practice, commonly has a value of between 2 and 10.

Part 1: AC response

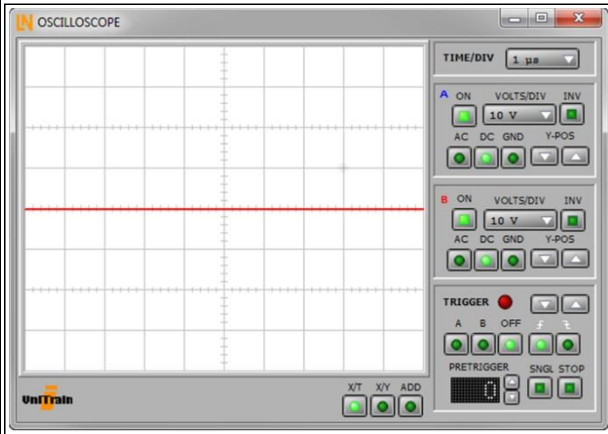
Circuit diagram



This experiment is based on the following circuit

Equipment

The following equipment is needed for this experiment and should be configured as shown:

<table>
<tr><th>Equipment</th><th>Settings</th></tr>
<tr><td>
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	Channel A	Channel B
Sensitivity	1 V/div	2 V/div
Coupling	DC	DC
Polarity	Normal	Normal
Y position	0	0
Time base	5ms/div	
Mode	X/T	
Trigger channel	-	
Trigger edge	-	

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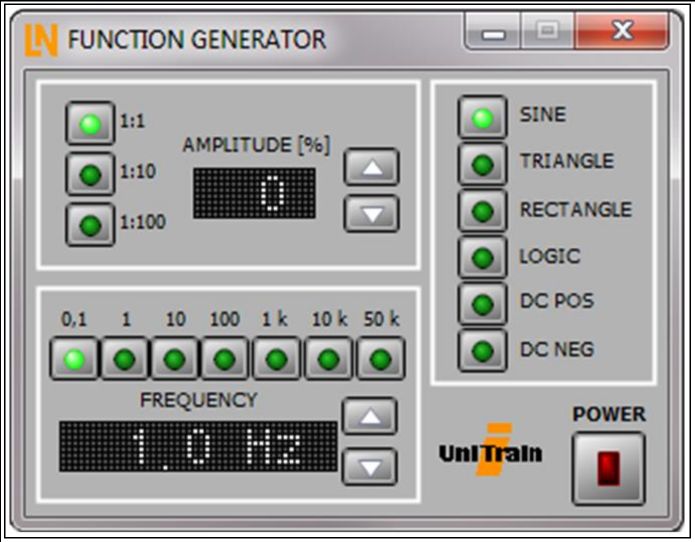
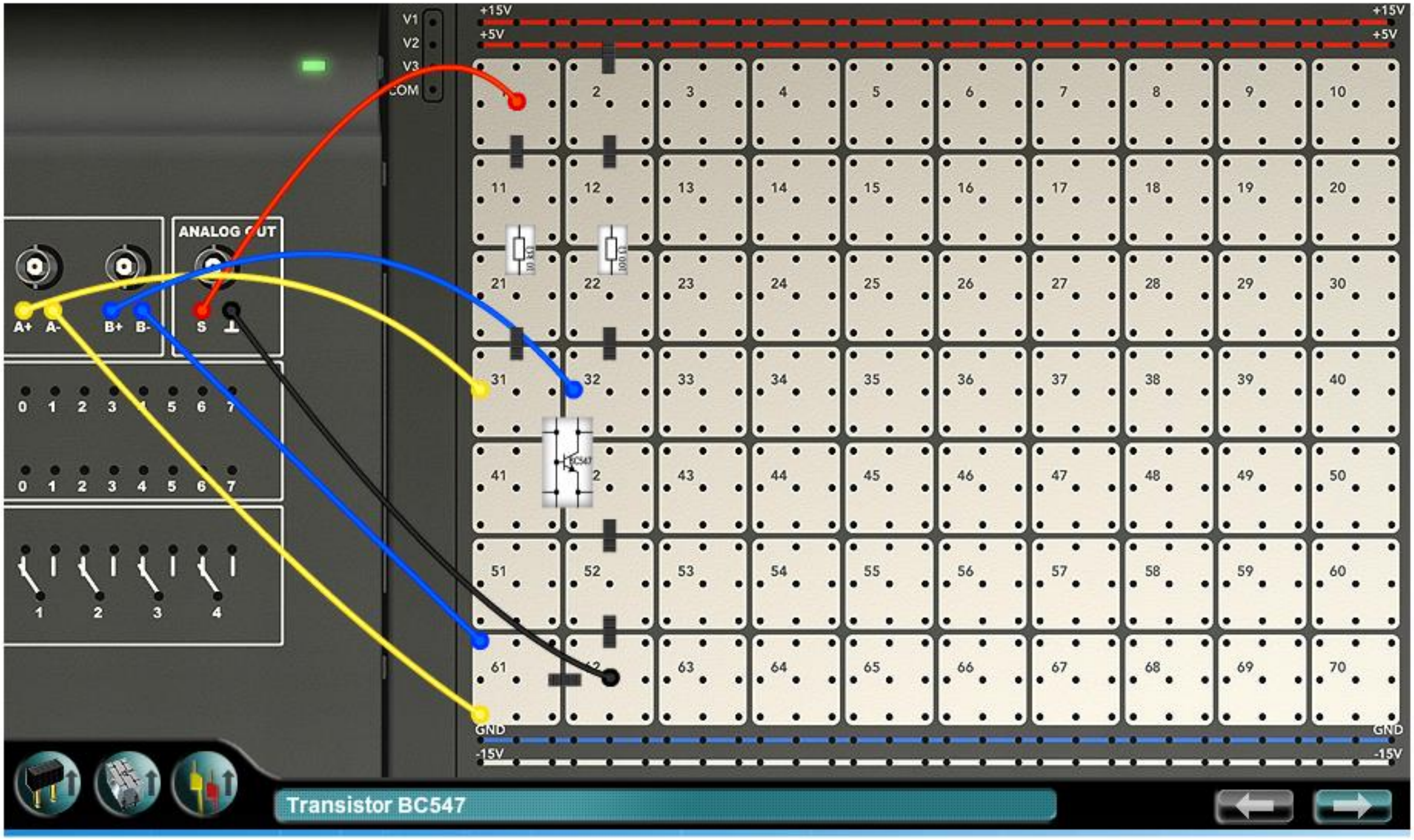
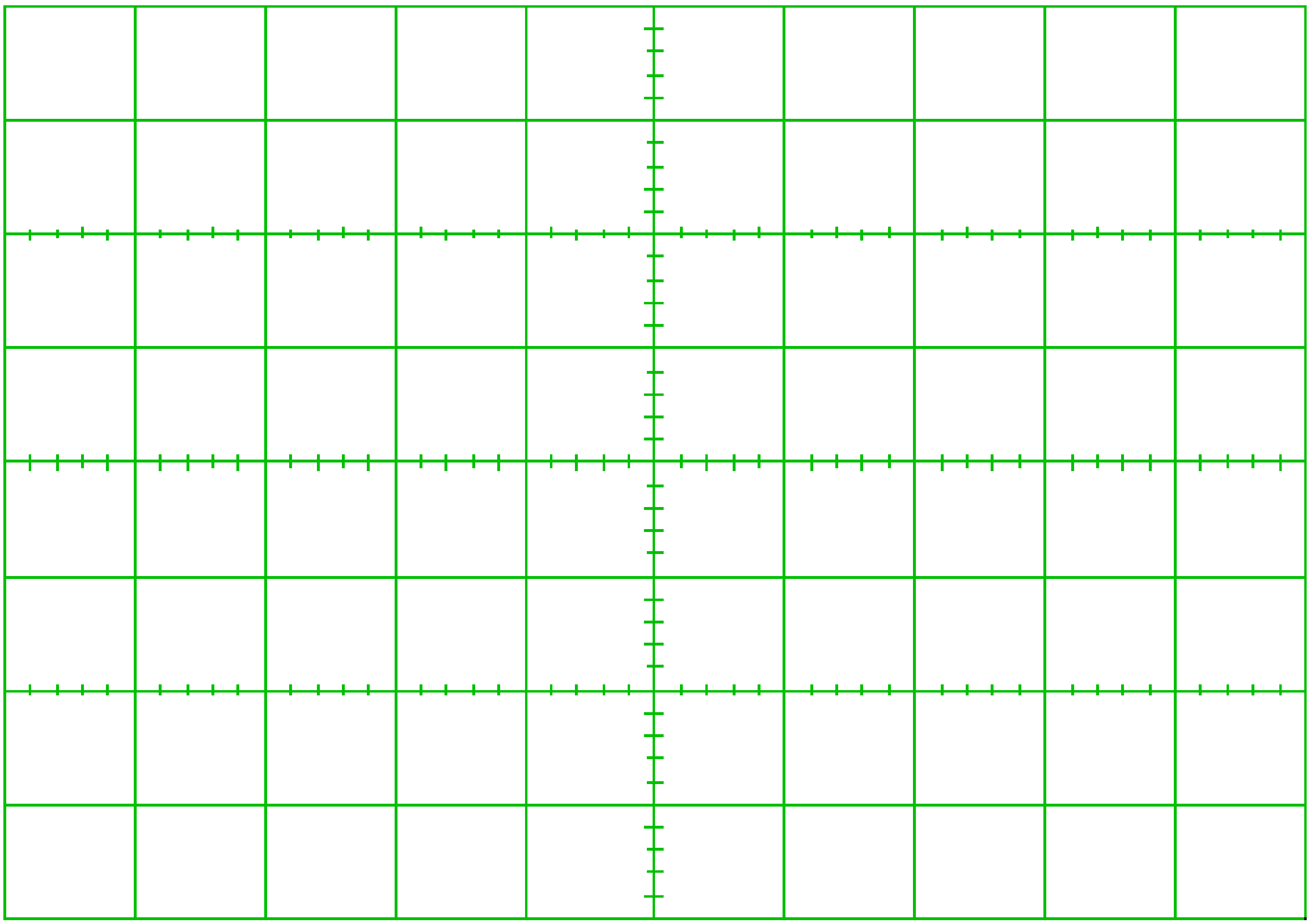


Waveform	Sine
Amplitude	6 Vpp (30%, 1:1)
Frequency factor	10
Frequency	50 Hz


ANALOG OUT
A+ A- B+ B- S
V1
V2
V3
COM
+15V
+5V
GND
-15V
Transistor BC547

Experiment procedure and exercises

Configure the oscilloscope and function generator with the values given above. Record the voltages VBE and VCE and copy the oscilloscope trace into the space below

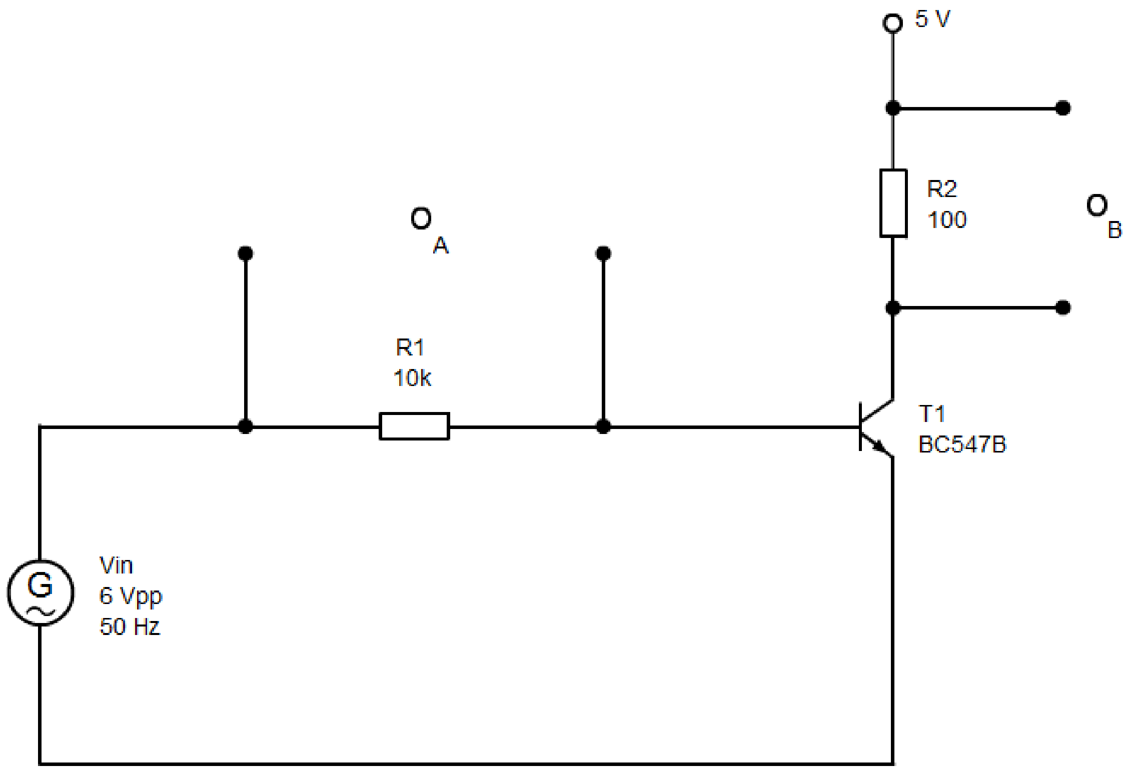


Which of the following statements are correct?	
	The transistor does not conduct when the input voltage is negative.
	The transistor does not conduct when no control voltage is present.
	The transistor conducts more current as the control voltage increases.
	The transistor consists of four semiconductor layers.

	What kind of transistor is this?
	A bipolar PNP transistor
	A bipolar NPN transistor

Part 2: Current gain calculation

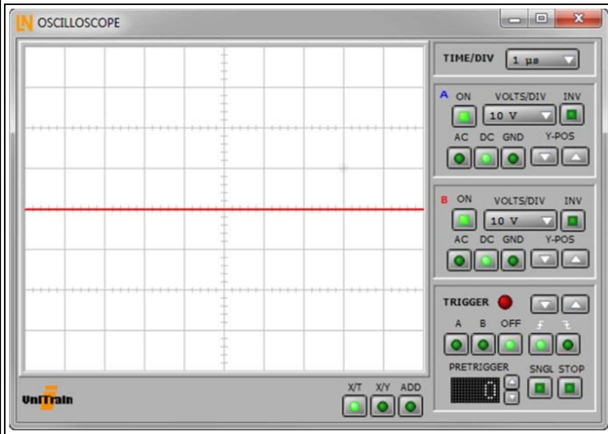
Circuit diagram



Equipment

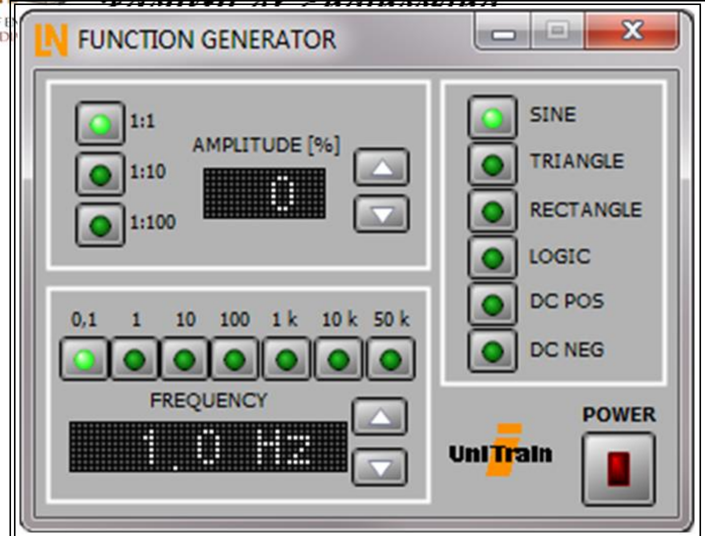
The following equipment is needed for this experiment and should be configured as shown:

Equipment

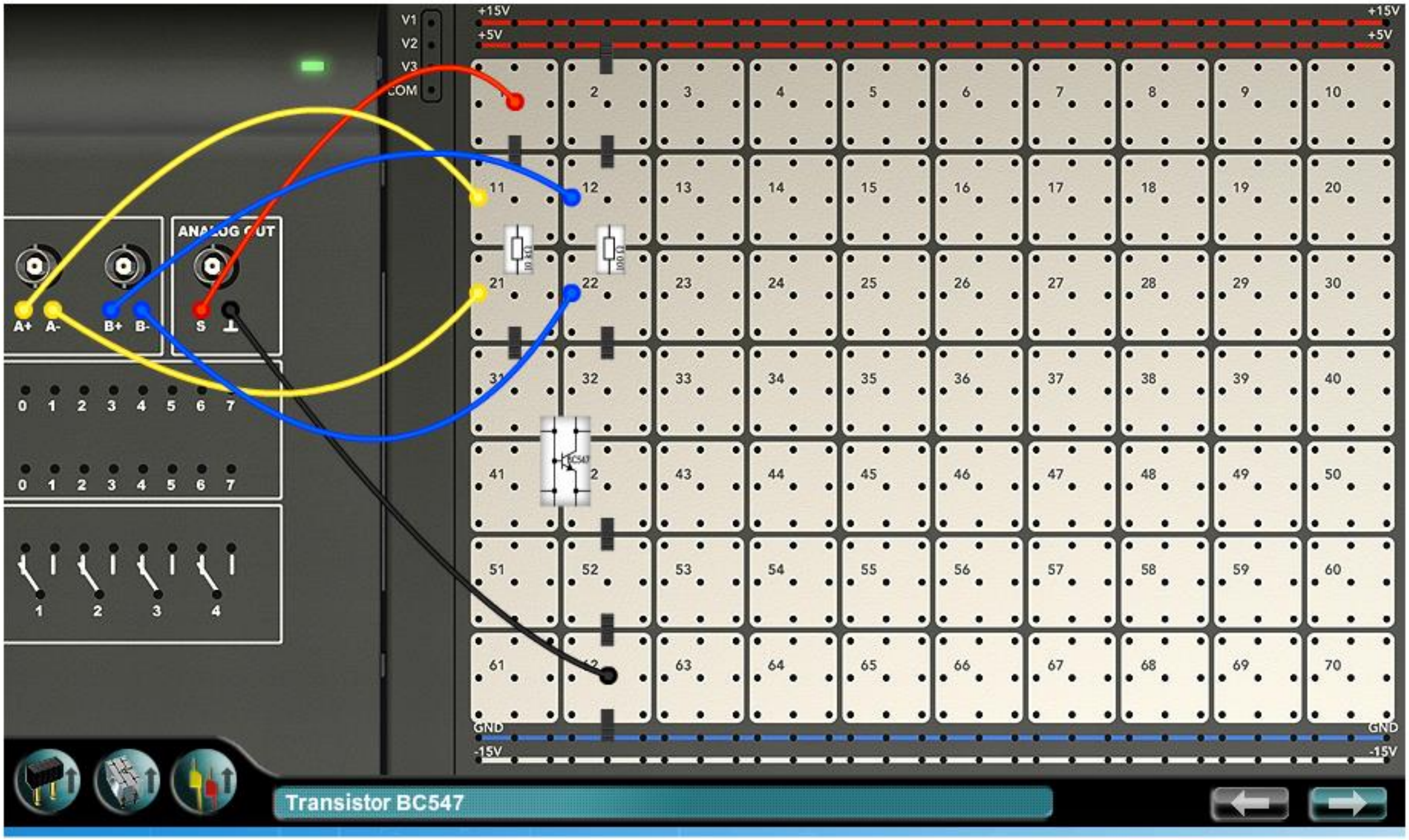


Settings

	Channel A	Channel B
Sensitivity	2 V/div	2 V/div
Coupling	DC	DC
Polarity	Normal	Normal
Y position	0	0
Time base	2ms/div	
Mode	X/Y	
Trigger channel	-	
Trigger edge	-	



Waveform	Sine
Amplitude	6 Vpp (30%, 1:1)
Frequency factor	10
Frequency	50 Hz


V1
V2
V3
COM
+15V
+5V
ANALOG OUT
A+ A- B+ B- S
GND
-15V
Transistor BC547

Experiment procedure and exercises

Record the currents I_B and I_C and copy the oscilloscope trace into the space below.

Now calculate the current gain of the transistor. This is given by the ratio of the collector current to the base current.

$$\text{Gain} = \frac{I_{CE}}{I_{BE}}$$

Calculate the current gain.	
IBE = mA	
ICE = mA	
Gain	

Now replace resistor R2 with one of 330 ohms. Calculate the current gain once again.	
IBE = mA	
ICE = mA	
Gain	