

# Sprawozdanie 2

Jan Bronicki 249011

## 1 Cel ćwiczenia

Zapoznanie się z działaniem tranzystorów NPN oraz PNP.

## 2 0-10V

### 2.1 $U(V)$

Dzielnik napięcia z rezystorami  $R_2$  oraz  $R_5$ , jest potencjometrem  $10k\Omega$  sterowany do 99%:

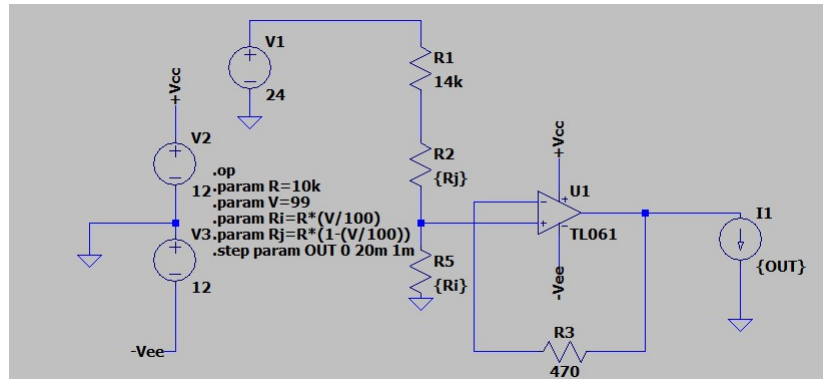
$$U_{wy} = U_{we} \cdot \frac{R_2 + R_5}{R_1 + R_2 + R_5}$$

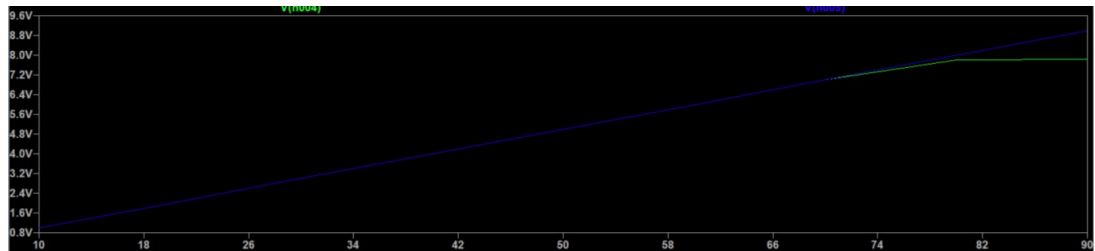
$$10V = 24V \cdot \frac{10\Omega}{R_1 + 10\Omega}, R_1 = 14\Omega$$

Pobierane jest  $20mA$ , tak więc opór to:

$$R_4 = \frac{10V}{20mA}$$

Rezystor  $R_3 = 470\Omega$  stabilizuje wzmacniacz.





Wzmacniacz stabilizuje się na około  $7.2V$ .

## 2.2 $U(R)$

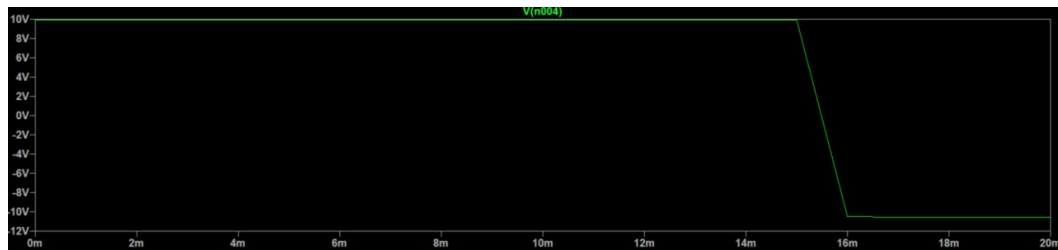
Napięcie stabilizuje się przy  $R_{ob} > 620\Omega$ :

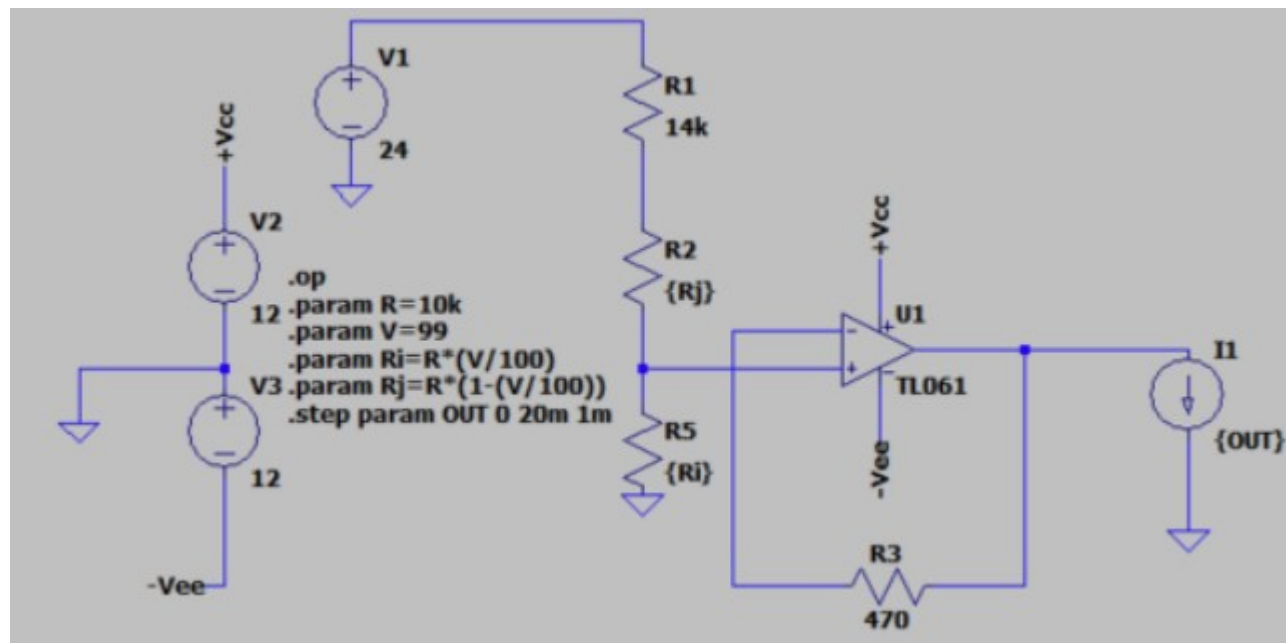
$$I_{wy} = \frac{U_{wy}}{R_{ob}}$$

$$I_{wy} = \frac{10V}{620\Omega} \approx 16mA$$

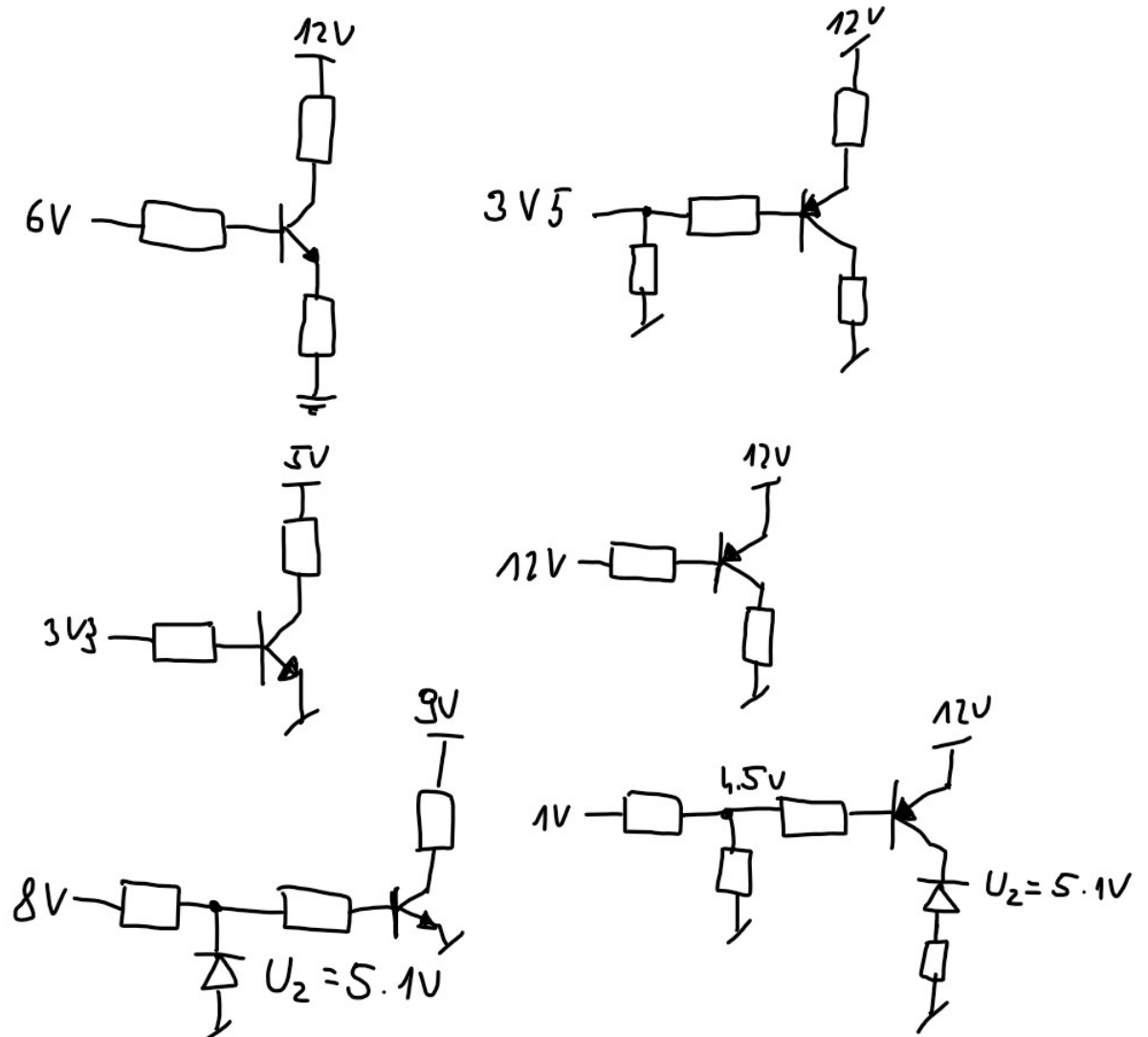
## 2.3 $U(I)$

Układ jest w stanie podać maksymalne natężenie około 16mA, w przybliżeniu zgodne z obliczeniami.





### 3 NPN i PNP



### 3.1 a)

$$U_{ce} = 0.1V, U_{be} = 0.6V, \beta = 100, I_b = 1mA, R_3 = 10\Omega$$

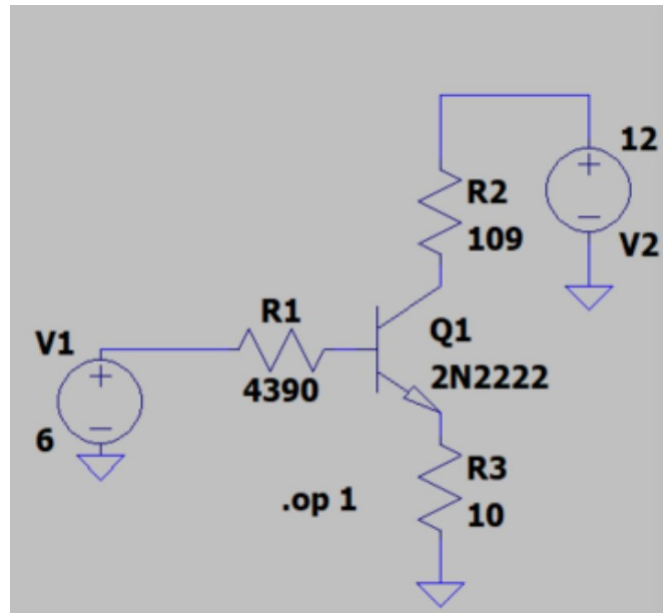
$$I_c \beta \cdot I_b 100mA$$

$$I_c + I_b = 101mA$$

$$U_{R_3} = R_3 \cdot I_c = 1.01V$$

$$R_1 = \frac{6V - U_{R_3} - 0.6V}{I_b} = \frac{6V - 1.01V - 0.6V}{0.001A} = 4390\Omega$$

$$R_2 = \frac{12V - U_{R_3} - 0.1V}{I_c} = \frac{12V - 1.01V - 0.1V}{0.1A} = 4390\Omega$$



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V(n003):      6          voltage
V(n001):      12          voltage
V(n004):      1.81343     voltage
V(n002):      1.18301     voltage
V(n005):      1.00192     voltage
Ic(Q1):       0.0992384    device_current
Ib(Q1):       0.000953662  device_current
Ie(Q1):       -0.100192    device_current
I(R3):        0.100192     device_current
I(R2):        0.0992384    device_current
I(R1):        -0.000953662 device_current
I(V2):        -0.0992384   device_current
I(V1):        -0.000953662 device_current

```

### 3.2 b)

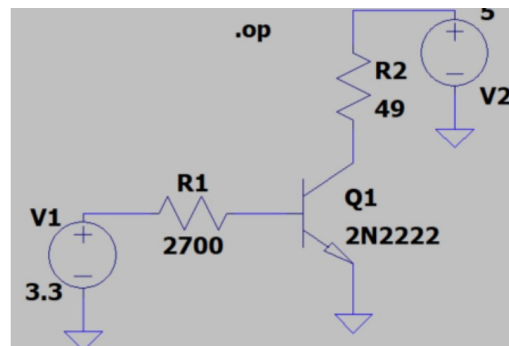
$$U_{ce} = 0.1V, U_{bc} = 0.6V, \beta = 100, I_b = 1mA$$

$$I_c = \beta \cdot I_b = 100mA$$

$$I_e = I_c + I_b = 101mA$$

$$R_1 = \frac{3.3V - 0.6V}{I_b} = \frac{2.7V}{0.001A} = 22700\Omega$$

$$R_2 = \frac{5V - 0.1V}{I_c} = \frac{4.9V}{0.1A} = 49\Omega$$



```

V(n001) :      5          voltage
V(n002) :    0.182553    voltage
V(n004) :    0.810673    voltage
V(n003) :      3.3       voltage
Ic(Q1) :    0.0983152    device_current
Ib(Q1) :    0.000921973  device_current
Ie(Q1) :   -0.0992372    device_current
I(R1) :   -0.000921973    device_current
I(R2) :    0.0983152    device_current
I(V2) :   -0.0983152    device_current
I(V1) :   -0.000921973    device_current

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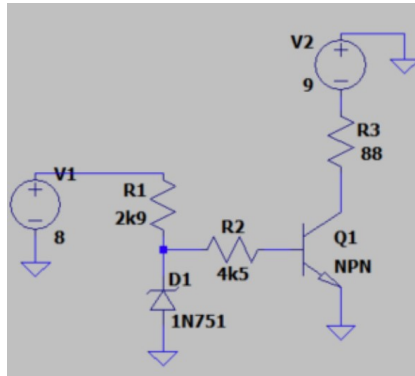
### 3.3 c)

$$\begin{aligned}\beta &= 100, I_b = 1mA \\ I_c &= \beta \cdot I_b = 100mA \\ I_e &= I_c + I_b = 101mA\end{aligned}$$

$$R_1 = \frac{U_{R_1}}{I_b} = \frac{2.9V}{0.001A} = 2900\Omega$$

$$R_2 = \frac{5.1V - 0.6V}{I_b} = 4500\Omega$$

$$R_3 = \frac{9V - 0.2V}{I_c} = 88\Omega$$



V(n004) :	1.79071	voltage
V(n002) :	8	voltage
V(n005) :	-7.82985	voltage
V(n001) :	-9	voltage
V(n003) :	-8.62373	voltage
Ic(Q1) :	-0.0042758	device_current
Ib(Q1) :	0.0021379	device_current
Ie(Q1) :	0.0021379	device_current
I(D1) :	-3.23529e-006	device_current
I(R3) :	-0.0042758	device_current
I(R2) :	-0.0021379	device_current
I(R1) :	-0.00214114	device_current
I(V2) :	-0.0042758	device_current
I(V1) :	-0.00214114	device_current

### 3.4 d)

$$U_{ce} = 0.1V, U_{be} = -0.6V, \beta = 100, I_b = 2mA, R_4 = 20\Omega$$

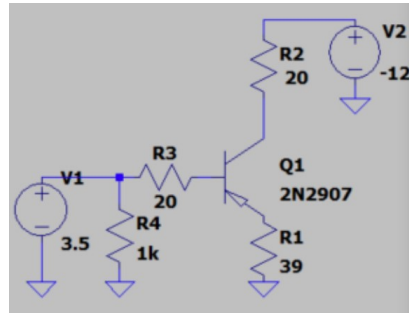
$$I_c \beta \cdot I_b = 200mA$$

$$I_e I_c + I_b = 202mA$$

$$U_{R_4} = R_4 \cdot I_e = 4.04V$$

$$R_3 = \frac{12V - 0.1V - U_{R_4}}{I_c} \approx 39\Omega$$

$$R_2 = \frac{12V - 3.5V - 0.6V - U_{R_3}}{I_b} = 20\Omega$$



```

V(n003):      3.5          voltage
V(n004):      3.5          voltage
V(n001):     -12          voltage
V(n002):     -12          voltage
V(p001):      1.36502e-010 voltage
Ic(Q1):      -1.55076e-011 device_current
Ib(Q1):      1.90034e-011 device_current
Ie(Q1):      -3.50004e-012 device_current
I(R1):       3.50004e-012 device_current
I(R2):      -1.55008e-011 device_current
I(R3):      -1.90034e-011 device_current
I(R4):       0.0035        device_current
I(V2):       1.55008e-011 device_current
I(V1):      -0.0035        device_current

```

### 3.5 e)

Pomiędzy emiterem a bazą nie będzie prądu, taki układ nie zadziała.



### 3.6 f)

$$U_{ce} = 0.1V, U_{be} = -0.6V, \beta = 100, I_b = 2mA$$

$$I_c = \beta \cdot I_b = 200mA$$

$$I_e = I_c + I_b = 202mA$$

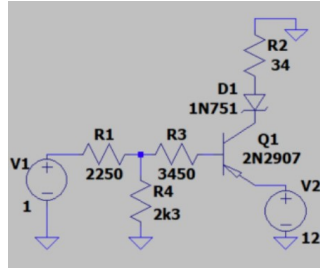
$$R_3 = \frac{12V - 4.5V - 0.6V}{I_b} = 3450\Omega$$

$R_2$  liczymy z dzielnika napięcia:

$$4.5V = \frac{R_2}{R_2 + R_3} \cdot (12V - 0.6V), R_2 = 2300\Omega$$

$$R_4 = \frac{12V - 5.1V - 0.1V}{I_c} \approx 34\Omega$$

$$R_2 = \frac{3.5V}{I_b} 2250\Omega$$



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V(n002):      3.14054      voltage
V(n003):      11.1335      voltage
V(p001):       6.51218      voltage
V(n001):       1           voltage
V(p002):      11.7834      voltage
V(n004):      12           voltage
Ic(Q1):       -0.191535     device_current
Ib(Q1):       -0.0023168    device_current
Ie(Q1):       0.193852      device_current
I(D1):        -0.191535     device_current
I(R1):        0.000951351    device_current
I(R2):        -0.191535     device_current
I(R3):        0.0023168      device_current
I(R4):        0.00136545     device_current
I(V2):        -0.193852      device_current
I(V1):        0.000951351    device_current
```