Sprawozdanie 2

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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 potencjometreem $10k\Omega$ sterowany do 99%:

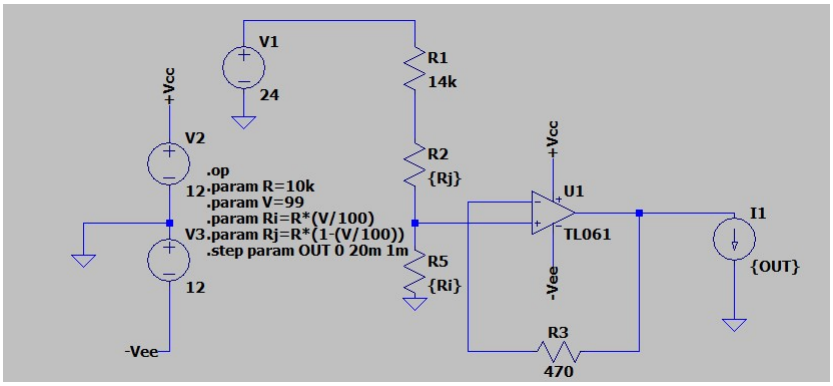
$$U_{wy} = U_{we} \cdot \frac{R_2 + R_5}{R_1 + R_2 + R_5}$$

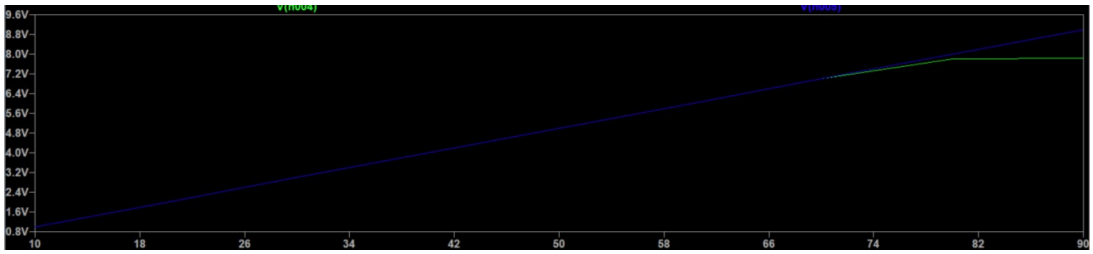
$$10V = 24V \cdot \frac{10\Omega}{R_1 + 10\Omega}, R_1 = 14\Omega$$

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 $U(R)$

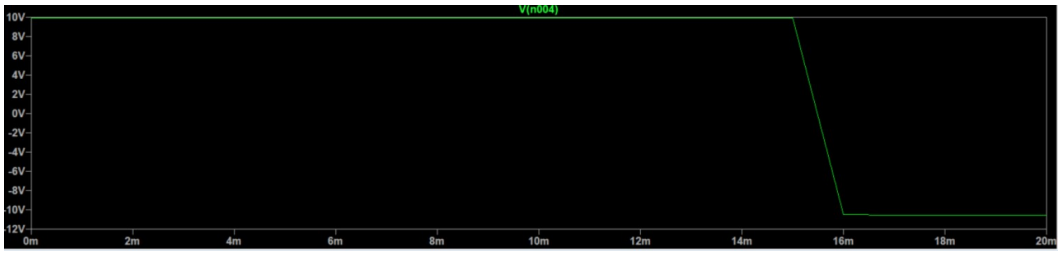
Napięcie stabilizuje sisę przy $R_{ob} > 620\Omega$:

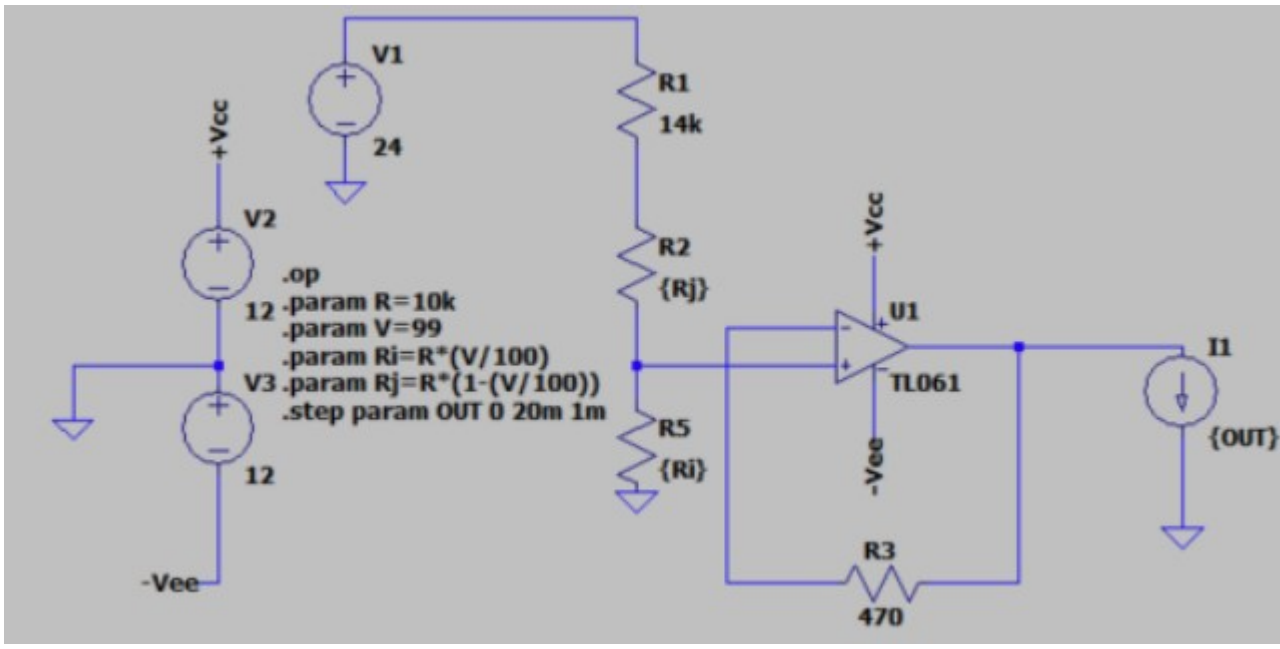
$$I_{wy} = \frac{U_{wy}}{R_{ob}}$$

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

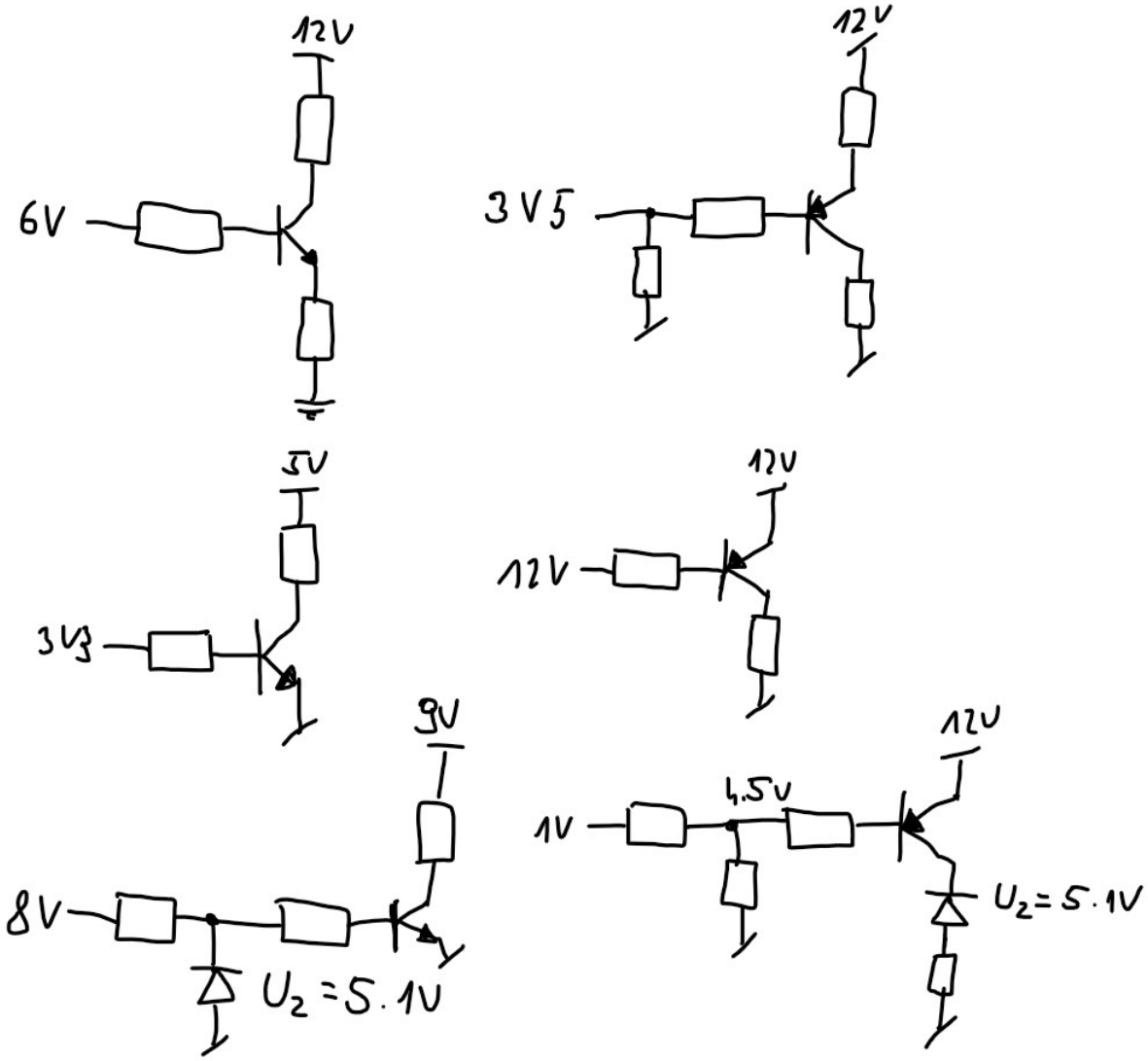
2.3 $U(I)$

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




V1
24
R1
14k
+Vcc
V2
12
.op
.param R=10k
.param V=99
.param Ri=R*(V/100)
V3
.param Rj=R*(1-(V/100))
.step param OUT 0 20m 1m
R2
{Rj}
+Vcc
U1
TL061
I1
{OUT}
R5
{Ri}
-Vee
12
-Vee
R3
470

3 NPN i PNP

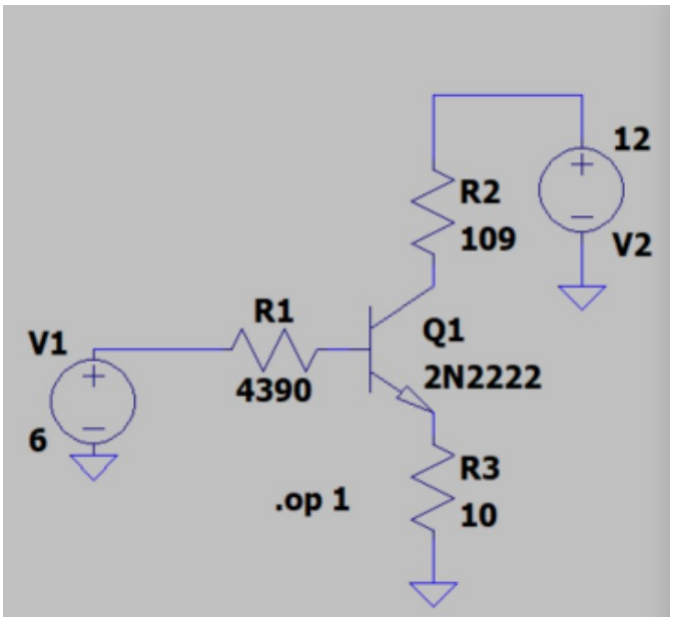


3.1 a)

$U_{ce} = 0.1V,\ U_{be} = 0.6V,\ \beta = 100,\ I_b = 1mA,\ R_3 = 10\Omega$
$I_c\beta \cdot I_b 100mA$
$I_c + I_b = 101mA$
$U_{R_3} = R_3 \cdot I_c = 1.01V$

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

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



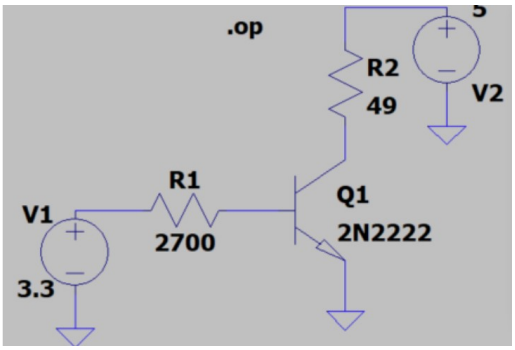
V(n003):	6	voltage
V(n001):	12	voltage
V(n004):	1.81343	voltage
V(n002):	1.18301	voltage
V(n005):	1.00192	voltage
Ic(Q1):	0.0992384	device_current
Ib(Q1):	0.000953662	device_current
Ie(Q1):	-0.100192	device_current
I(R3):	0.100192	device_current
I(R2):	0.0992384	device_current
I(R1):	-0.000953662	device_current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

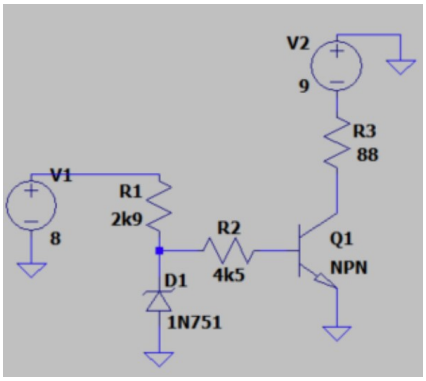
3.3 c)

$\beta = 100,\ I_b = 1mA$
$I_c = \beta \cdot I_b = 100mA$
$I_e = I_c + I_b = 101mA$

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

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

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



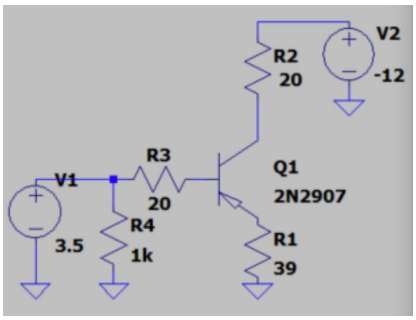
V(n004):	1.79071	voltage
V(n002):	8	voltage
V(n005):	-7.82985	voltage
V(n001):	-9	voltage
V(n003):	-8.62373	voltage
Ic(Q1):	-0.0042758	device_current
Ib(Q1):	0.0021379	device_current
Ie(Q1):	0.0021379	device_current
I(D1):	-3.23529e-006	device_current
I(R3):	-0.0042758	device_current
I(R2):	-0.0021379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

$U_{ce} = 0.1V,\ U_{be} = -0.6V,\ \beta = 100,\ I_b = 2mA$
$I_c = \beta \cdot I_b = 200mA$
$I_e = I_c + I_b = 202mA$

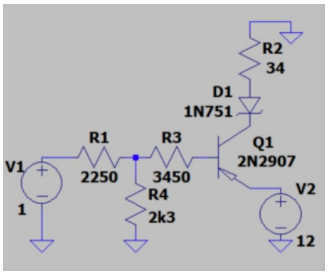
$$R_3 = \frac{12V - 4.5V - 0.6V}{I_b} = 3450\Omega$$

R_2 liczymy z dzielnika napięcia:

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

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

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



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