

MOSS

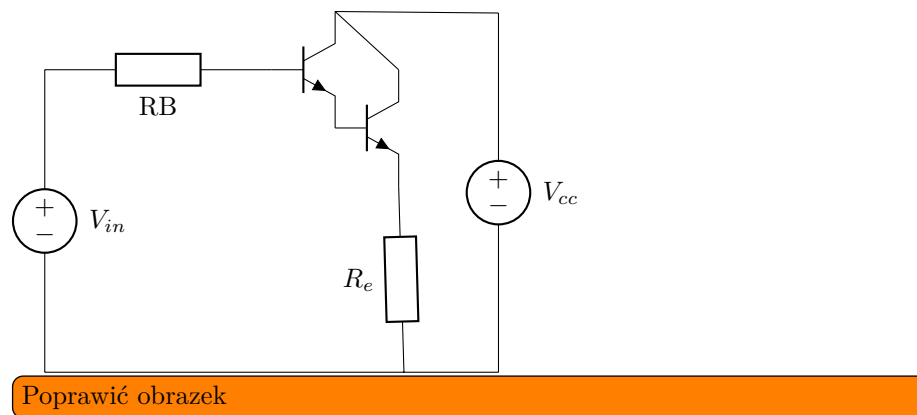
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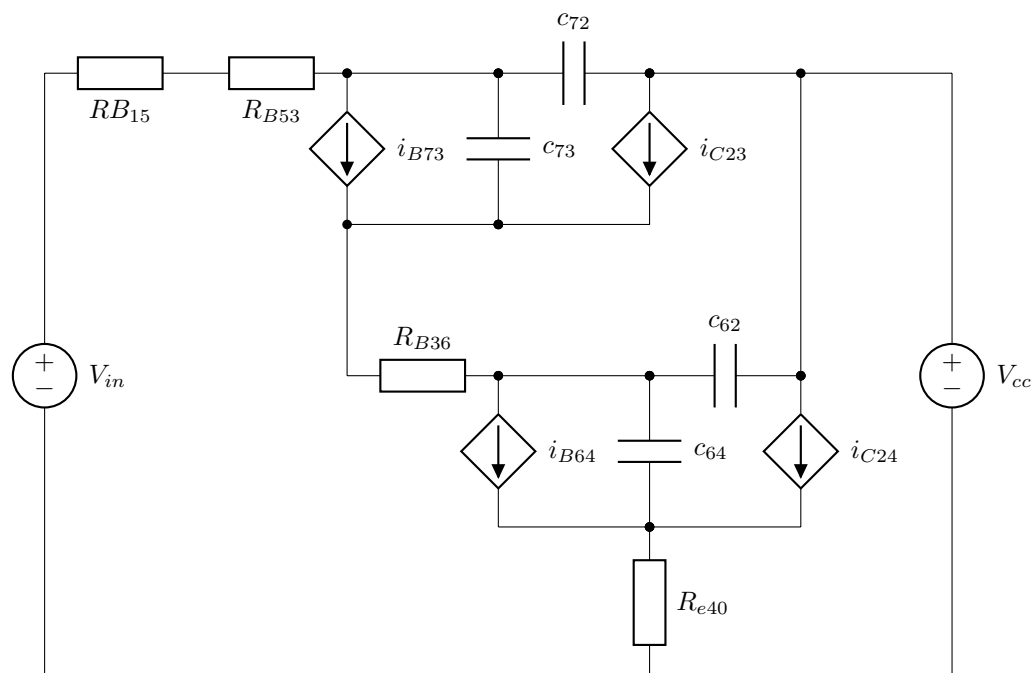
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1 Projekt



$$V_{in} = \begin{cases} 1.5V, & \text{OP} \\ 1, & \text{AC} \end{cases} \quad (1)$$



Wstawić schematy zastępcze

1.1 Parametry tranzystora

$$i_B = \frac{I_S}{BF} \left(\exp\left(\frac{u_{BE}}{NFU_T}\right) - 1 \right) + \frac{I_S}{BR} \left(\exp\left(\frac{u_{BC}}{NRU_T}\right) - 1 \right)$$

$$i_C = I_S \left(\exp\left(\frac{u_{BE}}{NFU_T}\right) - \exp\left(\frac{u_{BC}}{NRU_T}\right) \right) - \frac{I_S}{BR} \left(\exp\left(\frac{u_{BC}}{NRU_T}\right) - 1 \right)$$

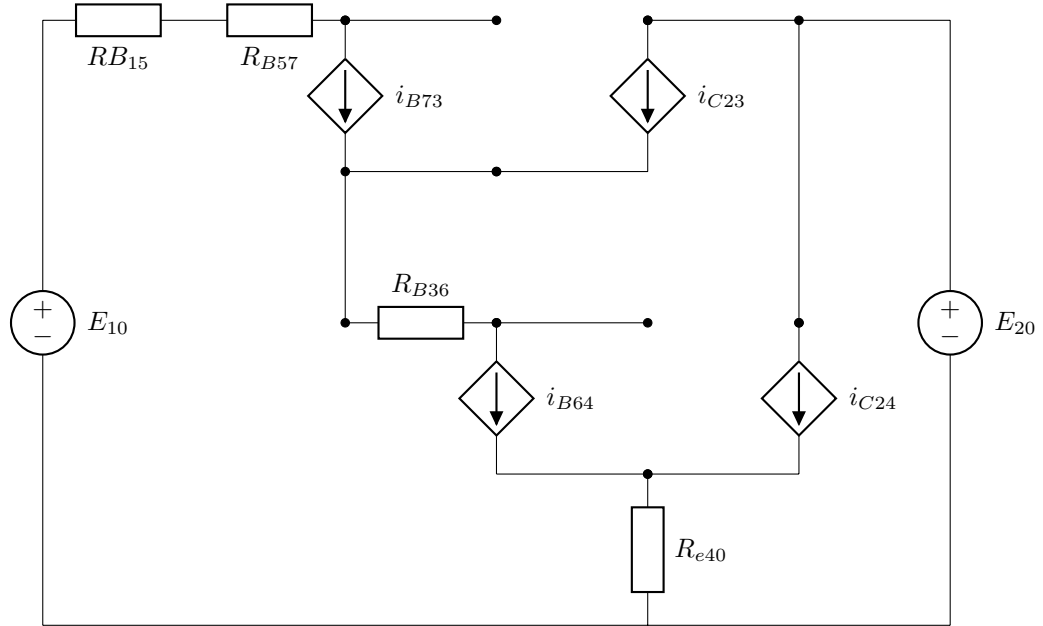
$$C_{BE} = \frac{TF \left(1 + \frac{1}{BF} \right) I_S}{NFU_T} \exp\left(\frac{u_{BE}}{NFU_T}\right) + \frac{C_{jE0}}{\left(1 - \frac{BE}{V_{JE}} \right)^{M_{JE}}}$$

$$C_{BC} = TR \frac{I_S}{NRU_T} \exp\left(\frac{u_{BC}}{NRU_T}\right) + \frac{C_{jC0}}{\left(1 - \frac{BC}{V_{JC}} \right)^{M_{JC}}}$$

Dodać parametry tranzystora podane przez prowadzącego

2 Analiza OP

2.1 Schemat zastępczy dla analizy OP



Wstawić schemat

$$E_{10} = 1.5V$$

$$E_{20} = 12V$$

$$G_{15} = \frac{1}{RB}$$

$$G_{57} = \frac{1}{R_{B57}}$$

$$G_{36} = \frac{1}{R_{B36}}$$

$$G_{40} = \frac{1}{R_{e40}}$$

Dla gałęzi ic:

$$i_{23}^{(p+1)} = g_{be23}^{(p)} \left(v_7^{(p+1)} - v_3^{(p+1)} \right) + g_{bc23}^{(p)} \left(v_7^{(p+1)} - v_2^{(p+1)} \right) + j_{23}^{(p)}$$

$$g_{be23}^{(p)} = \frac{I_S}{NF \cdot U_T} \cdot \exp \left(\frac{v_7^{(p)} - v_3^{(p)}}{NF \cdot U_T} \right)$$

$$g_{bc23}^{(p)} = -\frac{I_S}{NR \cdot U_T} \cdot \exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right) - \frac{I_S}{BR \cdot NR \cdot U_T} \cdot \exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right)$$

$$j_{23}^{(p)} = I_S \left(\exp \left(\frac{v_7^{(p)} - v_3^{(p)}}{NF \cdot U_T} \right) - \exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right) \right) - \frac{I_S}{BR} \left(\exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right) - 1 \right) - g_{be23}^{(p)} (v_7^{(p)} - v_3^{(p)}) - g_{be73}^{(p)} (v_7^{(p)} - v_2^{(p)})$$

Dla gałęzi ib

$$i_{73}^{(p+1)} = g_{be73}^{(p)} (v_7^{(p+1)} - v_3^{(p+1)}) + g_{bc73}^{(p)} (v_7^{(p+1)} - v_2^{(p+1)}) + j_{73}^{(p)}$$

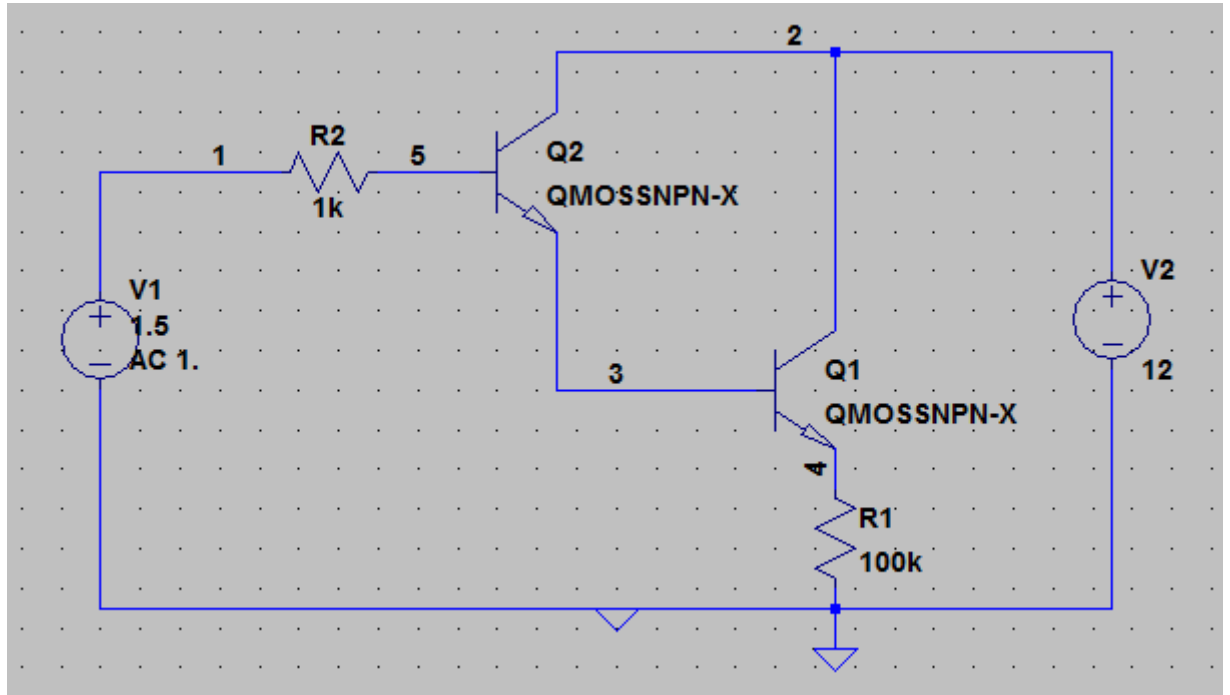
$$g_{be73}^{(p)} = \frac{I_S}{BF \cdot NF \cdot U_T} \cdot \exp \left(\frac{v_7^{(p)} - v_3^{(p)}}{NF \cdot U_T} \right)$$

$$G_{bc73}^{(p)} = -\frac{I_S}{BR \cdot NR \cdot U_T} \cdot \exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right)$$

$$j_{73}^{(p)} = \frac{I_S}{BF} \left(\exp \left(\frac{v_7^{(p)} - v_3^{(p)}}{NF \cdot U_T} \right) - 1 \right) + \frac{I_S}{BR} \left(\exp \left(\frac{v_7^{(p)} - v_2^{(p)}}{NR \cdot U_T} \right) - 1 \right) - g_{be73}^{(p)} (v_7^{(p)} - v_3^{(p)}) - G_{bc73}^{(p)} (v_7^{(p)} - v_2^{(p)})$$

Powielić dla drugiego NPN

2.2 Wyniki symulacji LT Spice



— Operating Point —

V(2): 12 voltage

V(5):	1.49996	voltage
V(3):	1.00103	voltage
V(4):	0.432637	voltage
V(1):	1.5	voltage
Ic(Q1):	4.01568e-006	device_current
Ib(Q1):	3.10684e-007	device_current
Ie(Q1):	-4.32637e-006	device_current
Ic(Q2):	2.72276e-007	device_current
Ib(Q2):	3.84079e-008	device_current
Ie(Q2):	-3.10686e-007	device_current
I(R2):	-3.84079e-008	device_current
I(R1):	4.32637e-006	device_current
I(V2):	-4.28796e-006	device_current
I(V1):	-3.84079e-008	device_current

2.3 Wyniki symulacji Matlab

3 Analiza AC