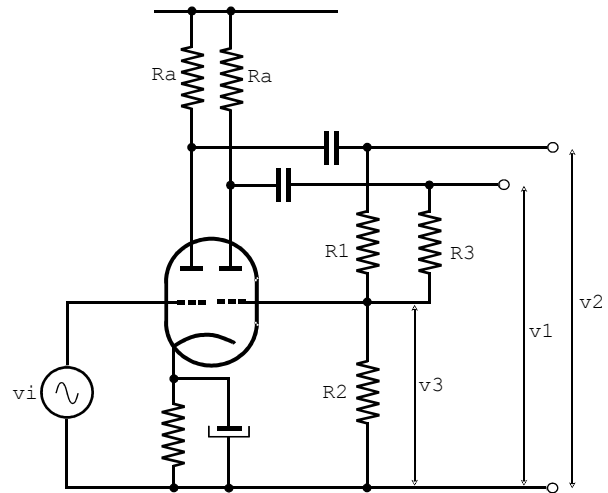


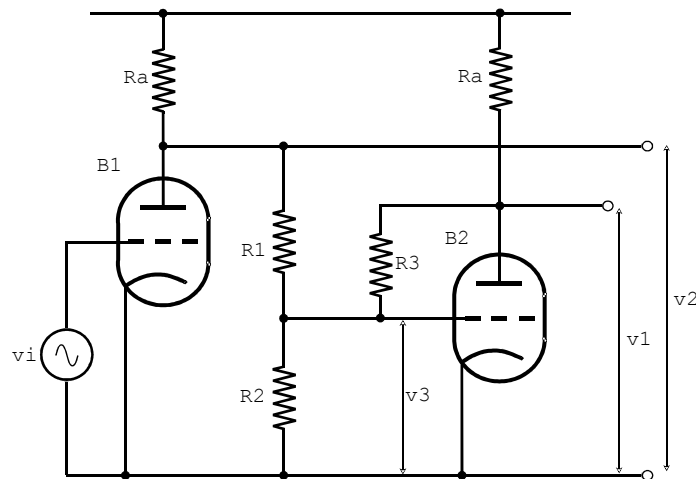
$\mu = 100;$
 $R_i = 20\text{k}\Omega;$
 $R_a = 80\text{k}\Omega;$
 $R_1 = 400\text{k}\Omega;$
 $R_3 = 20\text{k}\Omega;$
 $v_2 = -v_1.$



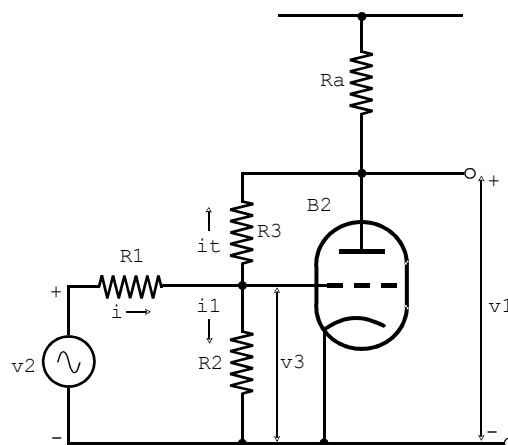
Calculate the value of R2.

1.

For the calculation I draw an AC schematic leaving out the capacitors and using two (equal) triodes:



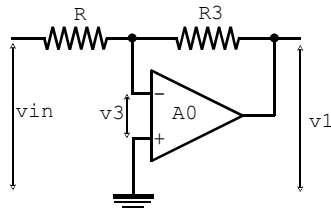
I draw again the AC diagram of the second triode from the anode of the first via the voltage divider R1-R2 to the second triode:



In the digagram: $i=i_l+i_t$ so:

$$v_3+v_3 \cdot \frac{R_1}{R_2} + \frac{v_3-v_1}{R_3} \cdot R_1 = v_2 \quad (1)$$

To caculate the open loop gain remember opamp theory:



In op-amps the open loop gain is very high so the value of v_3 is always neglected when calculating the transfer function, but with the triode this can be maximum μ theoretically.

$$v_3 = \frac{v_1}{A_0} \quad \text{where } A_0 \text{ is the open loop gain of the triode:}$$

The equation is then:

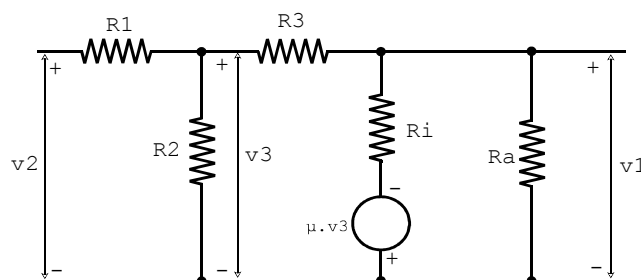
$$\frac{v_1}{A_0} + \frac{v_1}{A_0} \cdot \frac{R_1}{R_2} + \frac{\frac{v_1}{A_0} - v_1}{R_3} \cdot R_1 = v_2$$

$$\frac{v_1}{A_0} + \frac{v_1}{A_0} \cdot \frac{R_1}{R_2} + \frac{v_1}{A_0} \cdot \frac{R_1}{R_3} - v_1 \cdot \frac{R_1}{R_3} = v_2$$

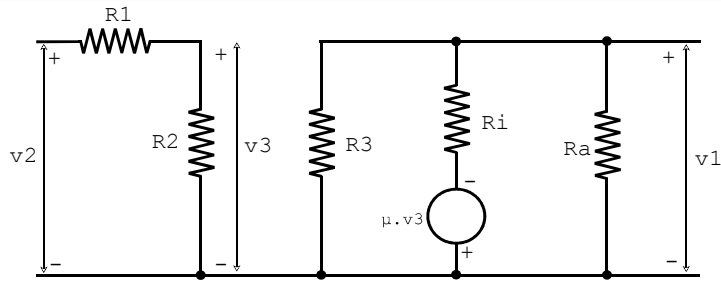
$$\frac{v_1}{A_0} \left(1 + \frac{R_1}{R_2} + \frac{R_1}{R_3} - A_0 \cdot \frac{R_1}{R_3} \right) = v_2$$

$$\frac{v_1}{v_2} \left(1 + \frac{R_1}{R_2} + \frac{R_1}{R_3} \right) - A_0 \cdot \frac{R_1}{R_3} = A_0 \quad (2)$$

Now I draw the equivalent 'pi' circuit:



And disconnect the feedback resistor R_3 and connect it to the common:



And calculate the open loop gain:

$$vI = \frac{Rv}{Ri + Rv} \cdot \mu \cdot v3$$

Where Rv is the equivalent of Ra // R3

$$\frac{vI}{v3} = Ao = \frac{\mu \cdot Rv}{Ri + Rv}$$

Substituting the values:

$$Ao = \frac{100 \cdot 16}{20 + 16} = 44,4$$

Then substituting the values in equation (2):

$$\frac{vI}{v2} = -1 \quad ; \quad \frac{RI}{R2} = \frac{400}{R2} \quad ; \quad \frac{RI}{R3} = 20 \quad ; \quad Ao \cdot \frac{RI}{R3} = 44,4 \cdot 20 = 888 \quad ; \quad Ao = 44,4$$

$$\frac{vI}{v2} \left(1 + \frac{RI}{R2} + \frac{RI}{R3} - Ao \cdot \frac{RI}{R3} \right) = Ao$$

$$-(1 + \frac{400}{R2} + 20 - 888) = 44,4$$

$$-1 - \frac{400}{R2} - 20 + 888 = 44,4$$

$$\frac{400}{R2} = 823$$

$$R2 = \frac{400}{823} = 0,486 \text{ k } \Omega = 486 \Omega$$