Dr JBO Name:

Student ID Number: Model Answer

Section:

Lecturer: Dr. Jamaludin Bin Omar

EEEB273 - Quiz 6

SEMESTER 2, ACADEMIC YEAR 2015/2016 Date: 14 January 2016 Time: 15 minutes

### **Question:**

Study the bias circuit and input stage of 741 operational amplifier shown in Figure 1 carefully. Assume  $V_{BE}$  for npn =  $V_{EB}$  for pnp = 0.7 V. Neglect dc base currents.

**Determine** the value of resistor  $R_5$  if bias current for  $Q_6$  is 8  $\mu$ A, and  $V^+ = +12$  V and V = -12 V.

Write your answer using pen, in 4 decimal points, with proper Units for all the parameters.

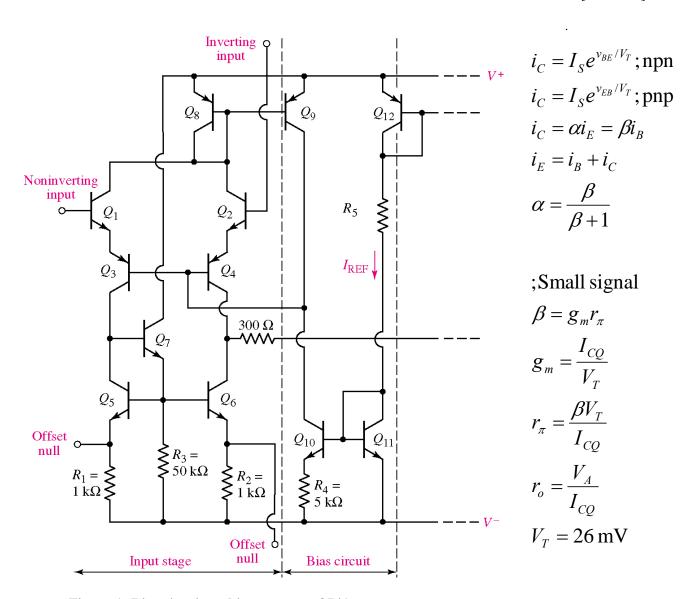


Figure 1: Bias circuit and input stage of 741 op-amp.

$$I_{C6}$$
 = 8  $\mu$ A [1]  
=  $I_{C8}/2 = I_{C9}/2$  =  $I_{C10}/2$  [1]  
 $I_{C10}$  = 2 x  $I_{C6}$  =16  $\mu$ A [1]  
 $I_{C10}R_4$  =  $V_T \ln(I_{REF}/I_{C10})$  [1]  
 $I_{REF}$  =  $I_{C10} \exp[I_{C10}R_4/V_T]$  [1]  
=  $(16\mu) \exp[(16\mu \times 5k)/(26m)]$  [1]  
= 0.347 mA [1]  
 $I_{REF}$  =  $(V^+ - V - V_{EB12} - V_{BE11})/R_5$   
=  $(V^+ - V - V_{EB12} - V_{BE11})/I_{REF}$  [1]  
=  $(12 - (-12) - 0.7 - 0.7)/(0.347m)$  [1]  
=  $65.129 \text{ k}\Omega$  [1]

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**Determine** the value of resistor  $R_5$  if bias current for  $Q_6$  is 8.5  $\mu$ A, and  $V^+ = +12$  V and V = -12 V.

Write your answer using pen, in 4 decimal points, with proper Units for all the parameters.

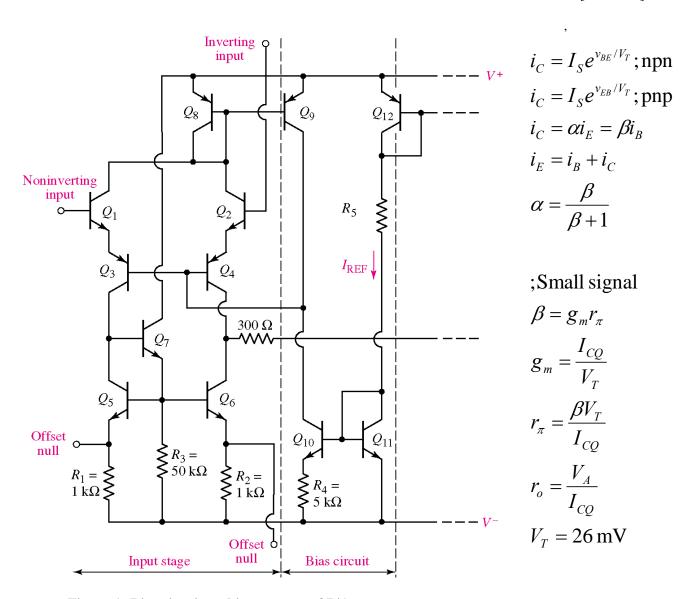


Figure 1: Bias circuit and input stage of 741 op-amp.

$$I_{C6} = 8.5 \, \mu A$$

$$= I_{C8} / 2 = I_{C9} / 2$$

$$= 17 \, \mu A$$

$$I_{C10} = 2 \, x \, I_{C6}$$

$$= 17 \, \mu A$$

$$I_{C10} R_4 = V_T \ln(I_{REF} / I_{C10})$$

$$I_{REF} = I_{C10} \exp[I_{C10} R_4 / V_T]$$

$$= (17 \mu) \exp[(17 \mu \, x \, 5k) / (26m)]$$

$$= 0.4469 \, mA$$

$$I_{REF} = (V^+ - V - V_{EB12} - V_{BE11}) / R_5$$

$$= (V^+ - V - V_{EB12} - V_{BE11}) / I_{REF}$$

$$= (12 - (-12) - 0.7 - 0.7) / (0.4469m)$$

$$= 50.570 \, k\Omega$$

$$I_{I} = 10.4469m$$

$$= 10.4469m$$

$$= 10.4469m$$

$$= 10.4469m$$

$$= 10.4469m$$

$$= 10.4469m$$

$$= 10.4469m$$

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# **Question:**

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**Determine** the value of resistor  $R_5$  if bias current for  $Q_6$  is 8.5  $\mu$ A, and  $V^+ = +10$  V and V = -10 V.

Write your answer using pen, in 4 decimal points, with proper Units for all the parameters.

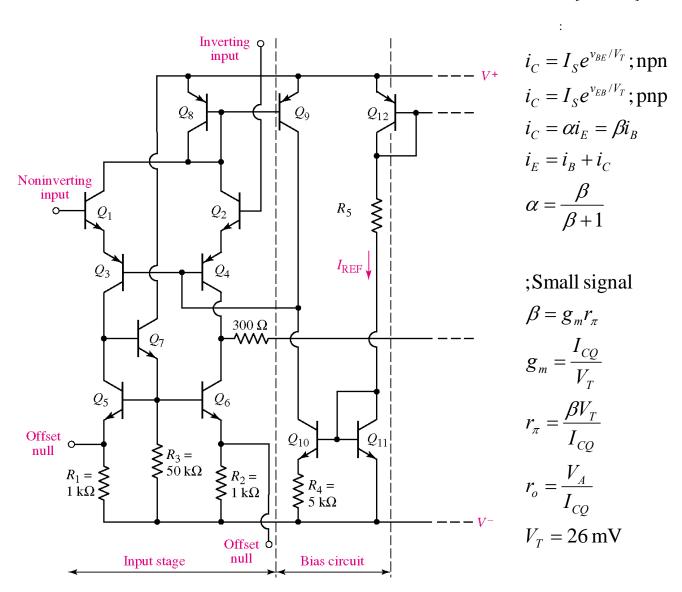


Figure 1: Bias circuit and input stage of 741 op-amp.

$$I_{C6} = 8.5 \,\mu\text{A} \qquad [1]$$

$$= I_{C8} / 2 = I_{C9} / 2 \qquad = I_{C10} / 2 \qquad [1]$$

$$I_{C10} = 2 \,x \,I_{C6} \qquad = 17 \,\mu\text{A} \qquad [1]$$

$$I_{C10} R_4 = V_T \ln(I_{REF} / I_{C10}) \qquad [1]$$

$$I_{REF} = I_{C10} \exp[I_{C10} R_4 / V_T] \qquad [1]$$

$$= (17 \mu) \exp[(17 \mu \times 5 k) / (26 m)] \qquad [1]$$

$$= 0.4469 \,\text{mA} \qquad [1]$$

$$I_{REF} = (V^+ - V - V_{EB12} - V_{BE11}) / R_5$$

$$R_5 = (V^+ - V - V_{EB12} - V_{BE11}) / I_{REF} \qquad [1]$$

$$= (10 - (-10) - 0.7 - 0.7) / (0.4469 m) \qquad [1]$$

$$= 41.620 \,k\Omega \qquad [1]$$

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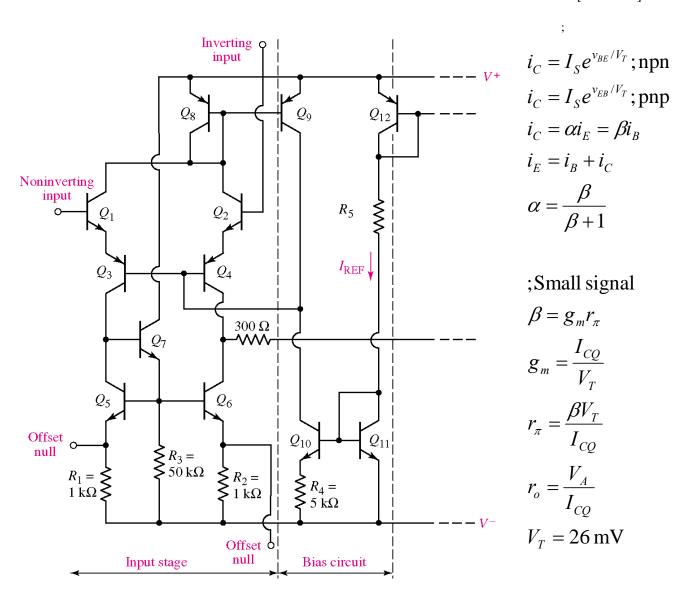


Figure 1: Bias circuit and input stage of 741 op-amp.

$$I_{C6} = 8 \mu A$$

$$= I_{C8} / 2 = I_{C9} / 2$$

$$= 16 \mu A$$

$$I_{C10} = 2 \times I_{C6}$$

$$= 16 \mu A$$

$$I_{C10} R_4 = V_T \ln(I_{REF} / I_{C10})$$

$$I_{REF} = I_{C10} \exp[I_{C10} R_4 / V_T]$$

$$= (16\mu) \exp[(16\mu \times 5k) / (26m)]$$

$$= 0.347 \text{ mA}$$

$$I_{REF} = (V^+ - V - V_{EB12} - V_{BE11}) / R_5$$

$$= (V^+ - V - V_{EB12} - V_{BE11}) / I_{REF}$$

$$= (10 - (-10) - 0.7 - 0.7) / (0.347m)$$

$$= 53.602 \text{ k}\Omega$$

$$[1]$$