Name: **Dr JBO**

Student ID Number: **Model Answer**

Section: 01/02 A/B

Lecturer: Dr. Jamaludin Bin Omar

EEEB273/EEEB2014 - Quiz 4 .

SEMESTER 2, ACADEMIC YEAR 2018/2019

Date: 10 January 2019 Time: 15 minutes

Question:

For the **Class-AB** output stage given in **Figure 1**, V_{CC} **= 10 V**, V_{BB} **= 1.4 V**, R_L **= 100 Ω**, and saturation current is $I_S = 10^{-13}$ **A**. For an output voltage v_O **= 4.2 V**, **calculate** V_{BEn} and V_{EBp}.

[10 marks]

Answer:

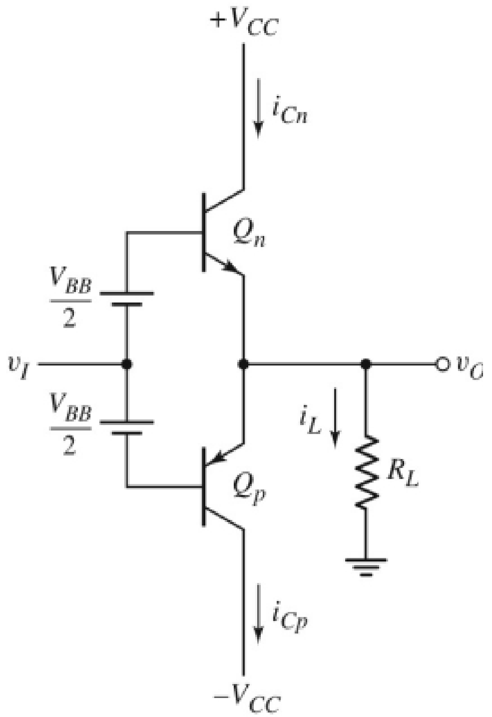

Figure 1

$$i_C = I_S e^{v_{BE}/V_T} \text{ ; npn}$$

$$i_C = I_S e^{v_{EB}/V_T} \text{ ; pnp}$$

$$i_C = \alpha i_E = \beta i_B$$

$$i_E = i_B + i_C$$

$$\alpha = \frac{\beta}{\beta + 1}$$

; Small signal

$$\beta = g_m r_\pi$$

$$g_m = \frac{I_{CQ}}{V_T}$$

$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$

$$i_L = \frac{V_O}{R_L} = \frac{4.2}{100} = 42\ mA \quad [1]$$

Approximate: $i_{cn} = |i_L| = 42\ mA$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{42m}{10^{-13}}\right) = 0.6959\ V \quad [1]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.6959 = 0.7041\ \text{V} \quad [1]$$

$$i_{cp} = I_S exp^{V_{EBp}/V_T} = 10^{-13} exp^{0.7041/26m} = 57.7881\ mA \quad [1]$$

Recalculate: $i_{cn} = i_L + i_{cp} = 42m + 57.7881\text{m} = 99.7881\ \text{mA}$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{99.7881m}{10^{-13}}\right) = 0.7184\ V \quad [2]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.7184 = 0.6816\ \text{V} \quad [2]$$

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	Lecturer: Dr. Jamaludin Bin Omar

Question:

For the **Class-AB** output stage given in **Figure 1**, $\boldsymbol{V_{CC}}$ **= 10 V**, $\boldsymbol{V_{BB}}$ **= 1.4 V**, $\boldsymbol{R_L}$ **= 110 Ω**, and saturation current is $\boldsymbol{I_S = 10^{-13}}$ **A**. For an output voltage $\boldsymbol{v_O}$ **= 4.4 V**, **calculate** $\boldsymbol{V_{BEn}}$ and $\boldsymbol{V_{EBp}}$.

[10 marks]

Answer:

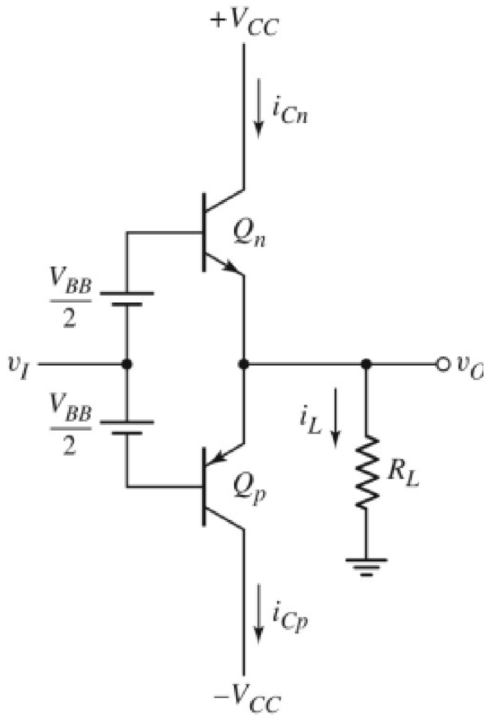

Figure 1

$$i_C = I_S e^{v_{BE}/V_T} \text{; npn}$$

$$i_C = I_S e^{v_{EB}/V_T} \text{; pnp}$$

$$i_C = \alpha i_E = \beta i_B$$

$$i_E = i_B + i_C$$

$$\alpha = \frac{\beta}{\beta + 1}$$

;Small signal

$$\beta = g_m r_\pi$$

$$g_m = \frac{I_{CQ}}{V_T}$$

$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$

$$i_L = \frac{v_O}{R_L} = \frac{4.4}{110} = 40\ mA \quad [1]$$

Approximate: $i_{cn} = |i_L| = 40\ mA$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{40m}{10^{-13}}\right) = 0.6946\ V \quad [1]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.6946 = 0.7054\ \text{V} \quad [1]$$

$$i_{cp} = I_S exp^{V_{EBp}/V_T} = 10^{-13} exp^{0.7054/26m} = 60.6775\ mA \quad [1]$$

Recalculate: $i_{cn} = i_L + i_{cp} = 40m + 60.6775\text{m} = 100.6775\ \text{mA}$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{100.6775m}{10^{-13}}\right) = 0.7186\ V \quad [2]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.7186 = 0.6814\ \text{V} \quad [2]$$

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Date: 10 January 2019 Time: 15 minutes

Question:
For the **Class-AB** output stage given in **Figure 1**, V_{CC} **= 10 V**, V_{BB} **= 1.4 V**, R_L **= 120 Ω**, and saturation current is $I_S = 10^{-13}$ **A**. For an output voltage v_O **= 4.6 V**, **calculate** V_{BEn} and V_{EBp}.
[10 marks]

Answer:

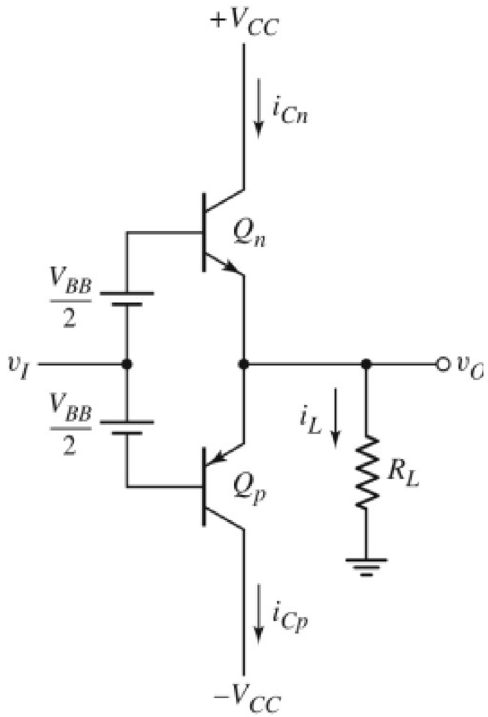

Figure 1

$$i_C = I_S e^{v_{BE}/V_T} \text{; npn}$$
$$i_C = I_S e^{v_{EB}/V_T} \text{; pnp}$$
$$i_C = \alpha i_E = \beta i_B$$
$$i_E = i_B + i_C$$
$$\alpha = \frac{\beta}{\beta+1}$$

;Small signal
$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$

$$i_L = \frac{V_O}{R_L} = \frac{4.6}{120} = 38.3333\ mA \quad [1]$$

Approximate: $i_{cn} = |i_L| = 38.3333\ mA$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{38.3333m}{10^{-13}}\right) = 0.6935\ V \quad [1]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.6935 = 0.7065\ \text{V} \quad [1]$$

$$i_{cp} = I_S exp^{V_{EBp}/V_T} = 10^{-13} exp^{0.7065/26m} = 63.3156\ mA \quad [1]$$

Recalculate: $i_{cn} = i_L + i_{cp} = 38.3333m + 63.3156\text{m} = 101.649\ \text{mA}$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{101.649m}{10^{-13}}\right) = 0.7188\ V \quad [2]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.7188 = 0.6812\ \text{V} \quad [2]$$

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Date: 10 January 2019 Time: 15 minutes

Question:

For the **Class-AB** output stage given in **Figure 1**, $\boldsymbol{V_{CC}}$ **= 10 V**, $\boldsymbol{V_{BB}}$ **= 1.4 V**, $\boldsymbol{R_L}$ **= 130 Ω**, and saturation current is $\boldsymbol{I_S = 10^{-13}}$ **A**. For an output voltage $\boldsymbol{v_O}$ **= 4.8 V**, **calculate** $\boldsymbol{V_{BEn}}$ and $\boldsymbol{V_{EBp}}$.

[10 marks]

Answer:

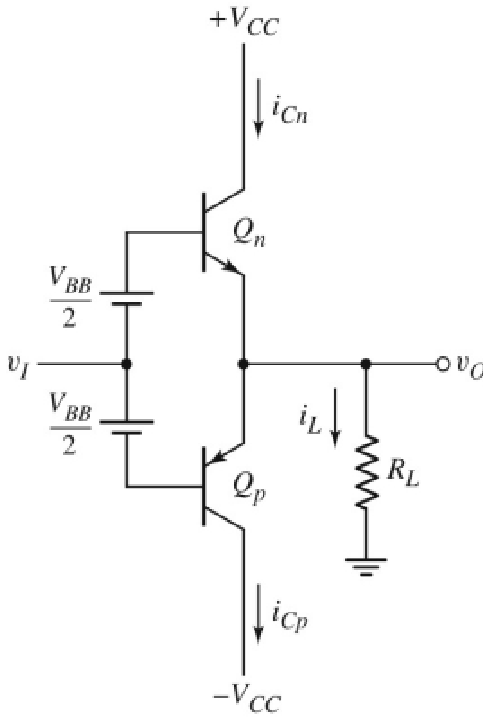

Figure 1

$$i_C = I_S e^{v_{BE}/V_T} \text{ ; npn}$$
$$i_C = I_S e^{v_{EB}/V_T} \text{ ; pnp}$$
$$i_C = \alpha i_E = \beta i_B$$
$$i_E = i_B + i_C$$
$$\alpha = \frac{\beta}{\beta+1}$$

; Small signal

$$\beta = g_m r_\pi$$
$$g_m = \frac{I_{CQ}}{V_T}$$
$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$

$$i_L = \frac{v_O}{R_L} = \frac{4.8}{130} = 36.9231\ mA \quad [1]$$

Approximate: $i_{cn} = |i_L| = 36.9231\ mA$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{36.9231m}{10^{-13}}\right) = 0.6925\ V \quad [1]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.6925 = 0.7075\text{ V} \quad [1]$$

$$i_{cp} = I_S exp^{V_{EBp}/V_T} = 10^{-13} exp^{0.7075/26m} = 65.7339\ mA \quad [1]$$

Recalculate: $i_{cn} = i_L + i_{cp} = 36.9231m + 65.7339\text{m} = 102.657\text{ mA}$ [1]

$$V_{BEn} = V_T \ln\left(\frac{I_{Cn}}{I_S}\right) = (26m)\ln\left(\frac{102.657m}{10^{-13}}\right) = 0.7191\ V \quad [2]$$

$$V_{EBp} = V_{BB} - V_{BEn} = 1.4 - 0.7191 = 0.6809\text{ V} \quad [2]$$