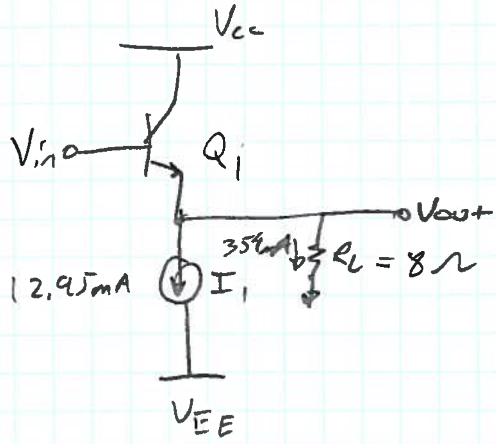
1.



Power = 0.5W

a. $A_V = \dfrac{R_L}{r_{e1} + R_L} \simeq \dfrac{R_L}{\frac{1}{g_{m1}} + R_L} = 0.8$

$g_{m1} = \dfrac{4}{R_L} = \dfrac{4}{8} = 0.5\,mA/V$

$g_{m1} = \dfrac{I_C}{V_T} \Rightarrow I_C = g_{m1} V_T = (0.5\,mA/V)(25.9\,mV) = 12.95\,mA$

$I_1 = 12.95\,mA$

b. $P_{avg} = \dfrac{V_p^2}{2R_L} \Rightarrow V_p = \sqrt{2 R_L P_{avg}} = \sqrt{2(8\Omega)(0.5W)}$

$V_p = 2.83\,V$

$I_p = \dfrac{V_p}{R_L} = \dfrac{2.83V}{8\Omega} = 354\,mA$

During the positive peak

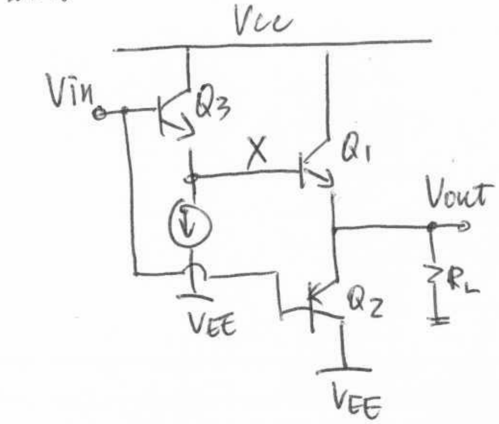
$I_{C1} = I_1 + I_p = 12.95\,mA + 354\,mA = 367\,mA$

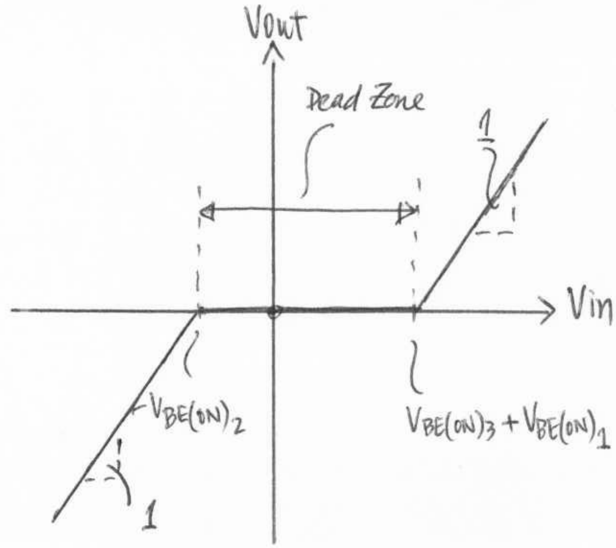
$g_{m1} = \dfrac{I_{C1}}{V_T} = 14.2\,A/V$

$A_V = \dfrac{8\Omega}{\frac{1}{14.2\,A/V} + 8\Omega} = 0.991$

$A_V = 0.991$

11.





Dead Zone
$= |V_{BE(ON)_2}| + V_{BE(ON)_3} + V_{BE(ON)_1}$

Analysis

- $(0 < V_{in} < V_{BE(ON)_3} + V_{BE(ON)_1})$:
  - Q_1 is OFF $(V_{in} < V_{BE(ON)_1})$
  - Q_2 is OFF (V_{BE_2} reverse-biased)
  - $\Rightarrow V_{out} = 0$

- $(-|V_{BE(ON)_2}| < V_{in} < 0)$:
  - Q_1, Q_2 OFF.
  - $V_{out} = 0$

- $(V_{BE(ON)_3} + V_{BE(ON)_1} < V_{in} < V_{CC})$
  - Q_1 ON
  - Q_2 OFF
  - $V_{out} = V_{in} - V_{BE(ON)_3} - V_{BE(ON)_1}$

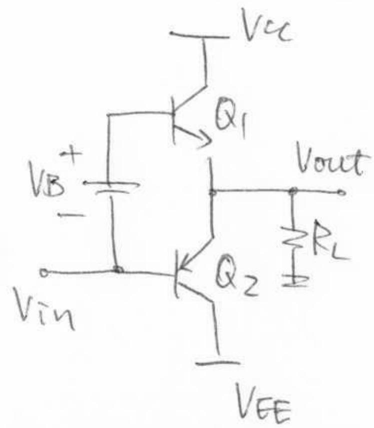
- $(-|V_{EE}| < V_{in} < -|V_{BE(ON)_2}|)$
  - Q_2 ON
  - Q_1 OFF
  - $V_{out} = V_{in} + |V_{BE(ON)_2}|$

17.

- $V_{out} = 0$:

$\Rightarrow I_{C_1} = I_{C2} = I_{BIAS}$

$\Rightarrow I_{S_1} \exp\left(\frac{V_{in}+V_B-V_{out}}{V_T}\right) = I_{S2} \exp\left(\frac{|V_{out}-V_{in}|}{V_T}\right)$



$\ln\left(\frac{I_{S1}}{I_{S2}}\right) + \frac{V_{in}+V_B-V_{out}}{V_T} = \frac{|V_{out}-V_{in}|}{V_T}$

$I_{S_1} = 5 \cdot 10^{-17} A$

$I_{S2} = 8 \cdot 10^{-17} A$

$I_{BIAS} = 5 mA$ ($V_{out} = 0$)

- For $V_{out} = 0$, $V_T = 0.026\ V$:

$\Rightarrow \ln\left(\frac{5}{8}\right) + \frac{V_{in}+V_B}{0.026} = +\frac{V_{in}}{0.026}$

- Given $I_{C2} = 5 mA$

$\Rightarrow I_{S2} \exp\left(\frac{-V_{in}}{0.026}\right) = 5mA \Rightarrow V_{in} = -0.83\ V$

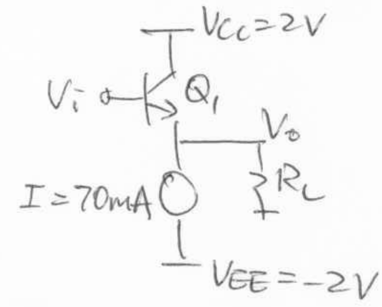
$I_{C_1} = I_{S_1} \exp\left(\frac{V_{in}+V_B-V_{out}}{V_T}\right) = (5 \cdot 10^{-17} A) \exp \frac{-0.83+V_B}{V_T}$

$\Rightarrow V_B = 0.83 + 0.026 \ln\left(\frac{5mA}{5 \cdot 10^{-17} A}\right)$

$\approx 1.67\ V$.

44. $V_P = 0.5\,V$

$R_L = 8\,\Omega$.



$$P_{R_L} = \frac{V_P^2}{2R_L} = \frac{0.25}{16} = 0.0156\,W$$

$$P_I = -I \times V_{EE} = 0.14\,W$$

$$P_{Q_1} = I_1\left(V_{CC} - \frac{V_P}{2}\right) = 0.1225\,W$$

$$\therefore \eta = \frac{P_{R_L}}{P_{R_L} + P_I + P_{Q_1}} = \frac{0.0156}{0.2781} = 5.6\%$$

47. $V_{CC} = 3V$ $\quad P_{R_L} = 0.2W$ $\quad R_L = 8\Omega$.

$$P_{R_L} = \frac{1}{2}\frac{V_p^2}{R_L} \Rightarrow V_p = \sqrt{2P_{R_L} \times R_L} = 1.8\,V$$

$$\therefore \eta = \frac{P_{R_L}}{P_{R_L} + \frac{2V_p}{R_L}\left(\frac{V_{CC}}{\pi} - \frac{V_p}{4}\right)} = \frac{0.2}{0.2 + \frac{3.6}{8}\left(\frac{3}{\pi} - \frac{1.8}{4}\right)}$$

= 46.8%