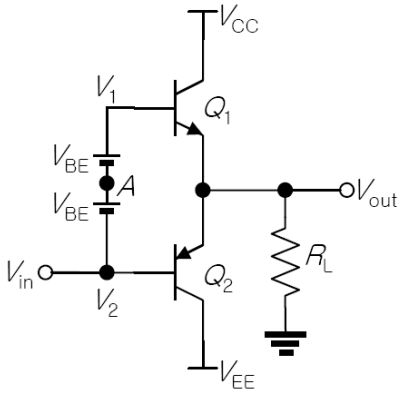
Quiz 8	Subject	Professor	Student ID#	Student Name	Score
Date: 2009.11.04	Microelectronics 2	Jong-Ho Lee			

1. Following figure depicts improved push-pull stage to reduce crossover distortion. Turn-on voltages of Q_1 and Q_2 are V_{BE1} and V_{BE2}, respectively. Answer for the following questions.

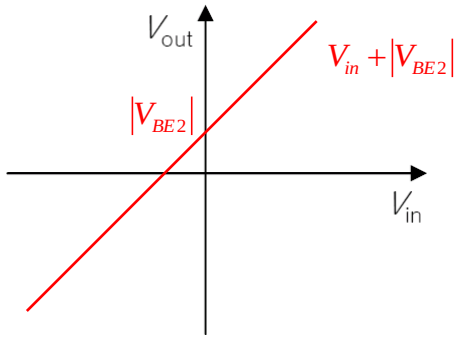


(a) Derive input-output relation and plot schematically the relation on given figure below. (3)

Answer)

Assuming $V_{BE1} \cong |V_{BE2}| \cong V_{BE}$,

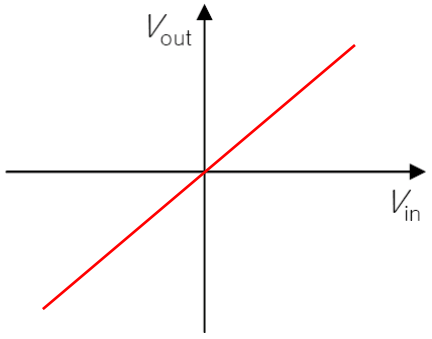
$$V_{out} = V_{in} + |V_{BE2}| = V_{in} + 2V_{BE} - V_{BE1} \cong V_{in} + V_{BE}$$



(b) Repeat (a) when V_{in} is applied to node A. (2)

Answer)

$$V_{out} = V_{in} - V_{BE} + |V_{BE2}|$$
$$= V_{in} + V_{BE} - V_{BE1} \cong V_{in}$$



(c) Calculate voltage gain A_v. Assume $r_\pi = r_{\pi 1} = r_{\pi 2}$ and $g_m = g_{m1} = g_{m2}$. Assume $r_\pi g_m >> 1$. (3)

Answer)

$$\frac{v_{out}}{R_L} = \frac{v_{in} - v_{out}}{r_\pi \| r_\pi} + (g_m + g_m)(v_{in} - v_{out})$$

$$\frac{v_{out}}{v_{in}} = \frac{1 + 2g_m \cdot \frac{r_\pi}{2}}{\frac{r_\pi}{2R_L} + 1 + 2g_m \cdot \frac{r_\pi}{2}} = \frac{1 + g_m r_\pi}{\frac{r_\pi}{2R_L} + 1 + g_m r_\pi}$$

$$\cong \frac{g_m}{\frac{1}{2R_L} + g_m} = \frac{R_L}{R_L + \frac{1}{2g_m}}$$

(d) Although the push-pull stage solves the crossover distortion, there is still a non-linearity when V_{out} increases. Explain briefly the reason of the non-linearity. (2)

Answer)

The voltage division relationship from the result of (c) shows an **input-dependant** behavior. As V_{out} becomes more positive, g_{m1} rises and A_v comes closer to unity. As a result, the voltage gain is not constant. Thus, the circuit experiences nonlinearity.

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