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Answers for Tutorial 1: Single Ended Amplifiers

1. Problem 3.20 in the course book

a) $A_v = -\frac{g_{m1}-\frac{1}{R_F}}{\frac{1}{R_F}+\frac{1}{R_D}+\frac{1}{r_{o1}}}$

b) $A_v = \frac{g_{m1}+\frac{1}{R_1}+\frac{1}{r_{o1}}}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{r_{o1}}}$

c) $A_v = -\frac{g_{m1}-g_{m2}}{g_{m2}+\frac{1}{r_{o1}}+\frac{1}{r_{o2}}}$

d) $A_v = \frac{g_{m1}(g_{m2}R_D-1)}{g_{m2}+\frac{1}{r_{o1}}+\frac{1}{r_{o2}}\left(1+\frac{R_D}{r_{o1}}\right)}$

e) $A_v = -\frac{g_{m1}\left(g_{m2}+\frac{1}{R_S}\right)r_{o2}}{g_{m1}+\frac{1}{R_S}+\frac{1}{r_{o1}}\left(1+r_{o2}\left(g_{m2}+\frac{1}{R_S}\right)\right)}$

2. Problem 3.21(h) in the course book

$$A_v = -\frac{g_{m1}g_{m2}r_{o1}r_{o2}r_{o3}}{(r_{o1}+r_{o3})(1+g_{m2}r_{o2})+g_{m2}g_{m3}r_{o1}r_{o2}r_{o3}}$$

3. Problem 3.27 in the course book. Assume $\mu_n C_{ox} = 200\,\mu A/V^2$, $V_{t0,n} = 0.5\,V$, $|2\Phi_f| = 0.9\,V$ and $V_{DD} = 3\,V$. Also assume that in part (a) both transistors are in saturation region.

a) $\left(W/L\right)_1 = 20$ and $\left(W/L\right)_2 = 5$

b) $\left(W/L\right)_1 = 94.5$ and $\left(W/L\right)_2 = 5$ and $V_{in,m} = 1.92\ V$

4. A two-stage single-ended amplifier is shown in Figure 1. Calculate the small-signal voltage gain and the output resistance. Assume $g_m \gg 1/r_{o1}$ and $R_D \ll r_{o2}$. ($\lambda \neq 0$ and $\gamma = 0$).

$$A_V = -g_{m2}R_D \text{ and } R_o = R_D$$

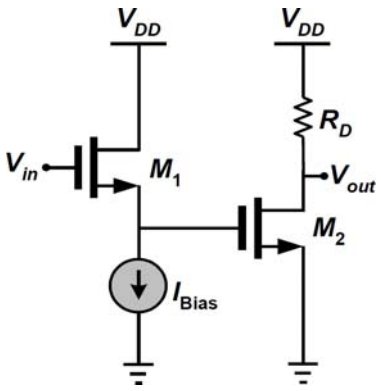

Figure 1 A two-stage amplifier

5. Using the small-signal model, calculate the voltage gain of the cascade stage shown in Figure 2 For both transistors we assume $g_m \gg g_{mb}$ and $r_o \to \infty$.

$$A_v = -\frac{g_{m1}g_{m2}R_1R_2}{1+g_{m2}R_1}$$

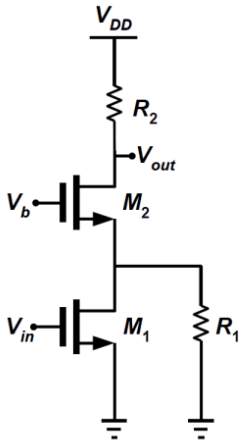

Figure 2 A cascode amplifier stage