# PROBLEM SET #2

*Issued: Tuesday, Sep. 9, 2015*

*Due (at 8 a.m.): Wednesday, Sep. 16, 2015*, in the EE 140/240A HW box near 125 Cory.

**1.** Use inspection analysis to write expressions for the input resistance $R_{in}$, output resistance $R_{out}$, and gain $v_{out}/v_{in}$ for each of the amplifiers in Fig PS2.1. The expressions should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e., $g_m$, $r_\pi$, $r_o$, $\beta$, etc.) for the transistors used. For each circuit, assume that all capacitors shown have infinite values.

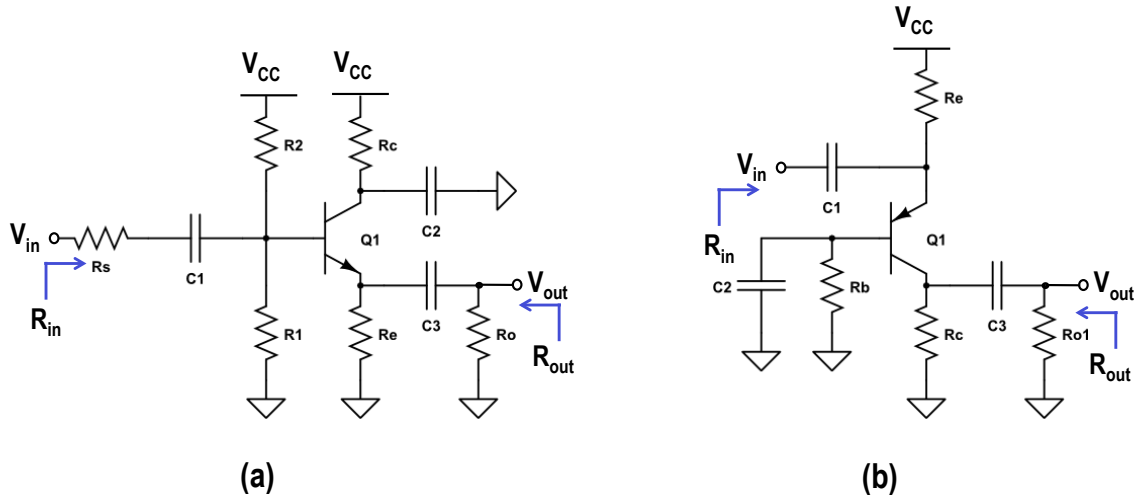


**Fig. PS1**

**2.** Use inspection analysis to write expressions for the input resistance $R_{in}$, output resistance $R_{out}$, and gain $v_{out}/v_{in}$ for each the amplifiers in Fig. PS2. The expressions should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e., $g_m$, $r_o$, etc.) for the transistors used. For each circuit, assume that all the capacitors shown have infinite values. Ignore body-effect. For amplifier (c), assume $R_s$ is much smaller than $r_o$.

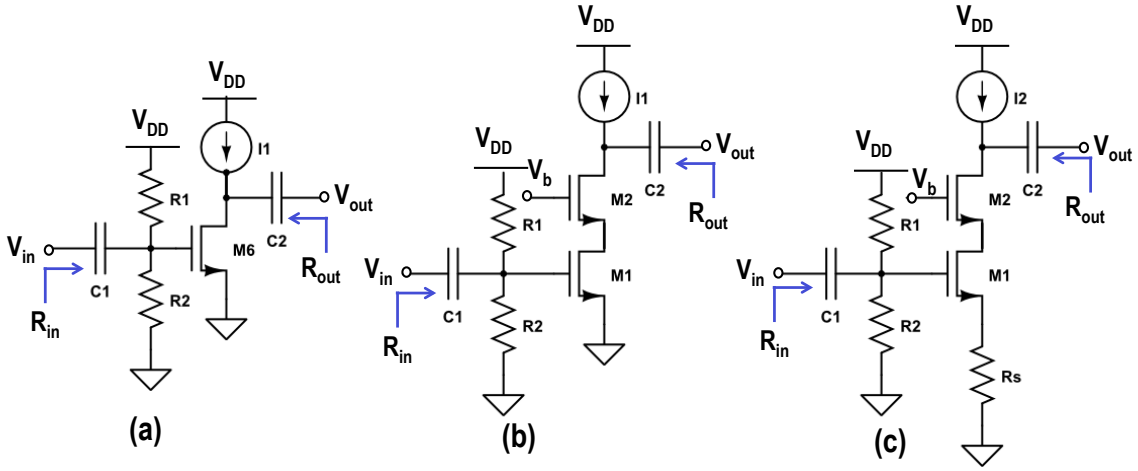


**Fig. PS2**

**3.** Consider the following questions using the parameter value list in Table PS.3. Assume all MOSFET share the same parameters except for the one specified. Ignore body-effect.

(a) Provide expressions for the input resistance $R_{in}$, output resistance $R_{out}$, and gain $v_{out}/v_{in}$ for the amplifier in Fig. PS3. Assume $V_b$ biases all the transistors properly in saturation region.

(b) Redo Problem (a) with the amplifier shown in Fig. PS2-(b). Assume $V_b$ biases all the transistors properly in saturation region.

(c) Briefly compare the results you get from part (a) and (b) and identify advantages or disadvantages between the two amplifiers.

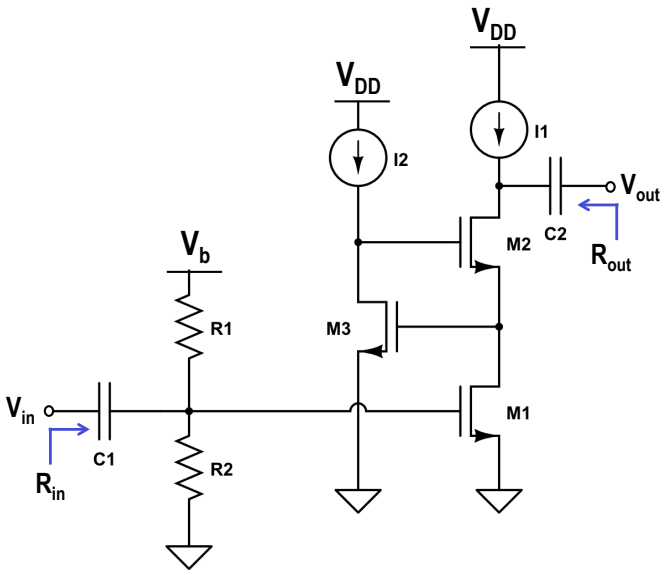


**Fig. PS3**

| Parameter | Value | Parameter | Value |
|---|---|---|---|
| **M1 Width ($W$)** | 16$\mu$m | Oxide relative permittivity ($\varepsilon_r$) | 3.9 |
| **M2 Width ($W$)** | 8$\mu$m | Channel Length Modulation Coeff. ($\lambda$) | 0.2 $V^{-1}$ |
| **M3 Width ($W$)** | 8$\mu$m | $R_1$ | 10kΩ |
| **Channel Length ($L$)** | 0.8$\mu$m | $R_2$ | 20kΩ |
| **Gate Dielectric Thickness ($t_{ox}$)** | 60Å | $I_1$ | 1mA |
| **Threshold Voltage ($V_{TH}$)** | 0.6V | $I_2$ | 0.1mA |
| **Electron Mobility ($\mu_n$)** | 1400$cm^2/Vs$ | $V_{DD}$ | 3.3V |

**Table. PS3**

**4.** Suppose the BJTs in the two amplifiers of Fig. PS4 have the same $\beta = 100$ and that they are properly biased by $V_{b1}$ and $V_{b2}$ such that the nominal bias current $I_{C1} = I_{C2} = 0.5$mA. Assume also that $V_{b1}$ and $V_{b2}$ are unstable, such that $I_C$ varies by ±20%. Ignore Early effect.

(a) For both amplifiers, calculate the corresponding ranges of the input resistance $R_{in}$, output resistance $R_{out}$, and gain $v_{out}/v_{in}$

(b) Based on the result of problem 4-(a), briefly compare the two amplifiers, stating advantages and disadvantages of one over the other.

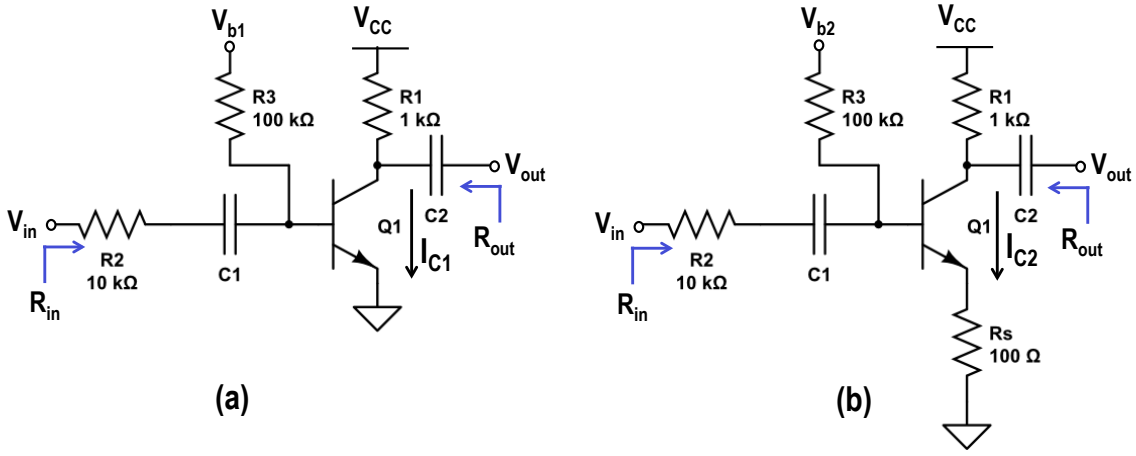


**Fig. PS4**