PROBLEM SET #2

Issued: Thursday, Jan.31, 2013

Due (at 8 a.m.): Friday, Feb. 8, 2013, 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 expression should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e., g_m, r_π, r_o, etc) for the transistor used. For each circuit, assume that all the capacitors shown have infinite values.

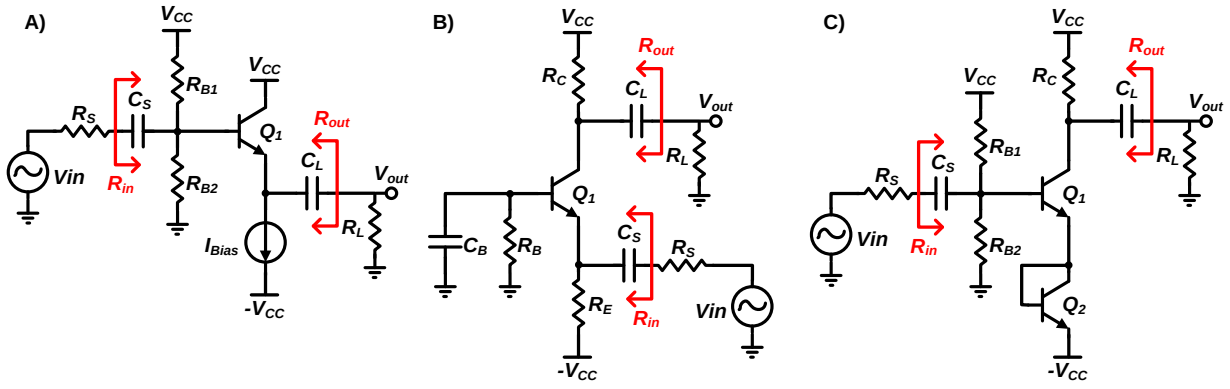
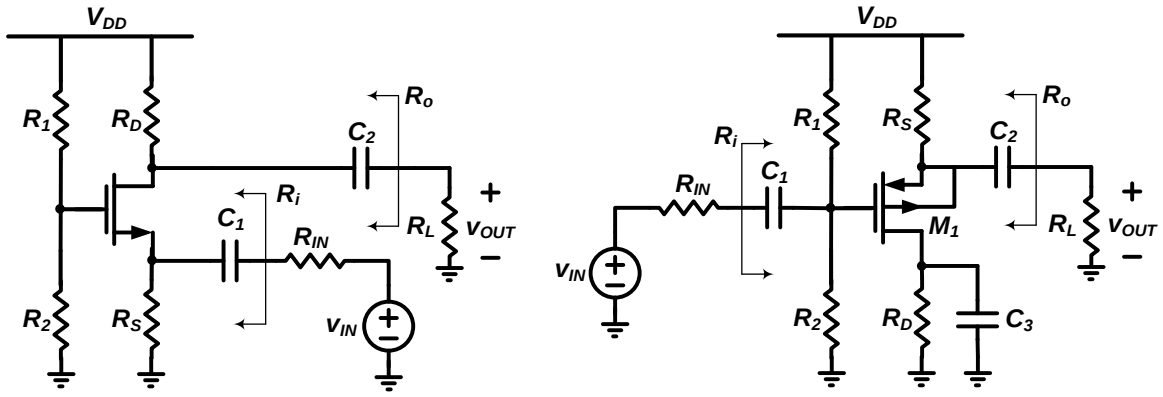


Fig. PS2.1

2. Use inspection analysis to write expressions for the input resistance R_i, output resistance R_o, and gain v_{out}/v_{in} for each of the amplifiers in Fig. PS2.2. The expressions should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e., g_m, g_{mb}, r_o, etc.) for the transistors used. For each circuit, assume that all capacitors shown have infinite values. Assume bulks are connected to ground and V_{DD} for NMOS and PMOS, respectively, unless otherwise specified in the circuit diagram.



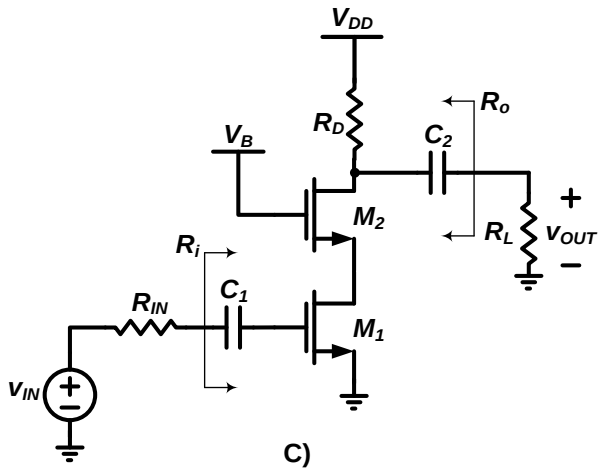


Fig. PS2.2

3. Referring to the circuit shown in Fig. PS2.3, provide expressions in terms of given elements and transistor small-signal model parameters for:

(a) The equivalent small-signal resistance looking into the collector of Q_1, R_{eq1}; equivalent small-signal resistance looking into the emitter of Q_2, R_{eq2}; input resistance, R_{in}; and output resistance, R_{out}.

(b) First stage gain, v_{o1}/v_{in}; second stage gain, v_{out}/v_{o1}; and total gain, v_{out}/v_{in}.

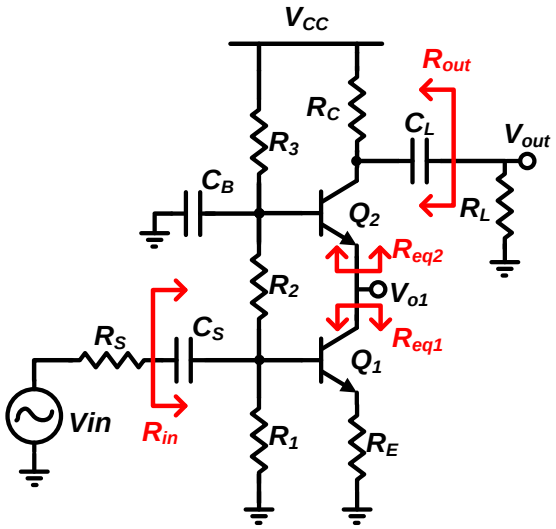


Fig. PS2.3

4. Fig. PS2.5 depicts a "Darlington pair," where M_1 plays a role somewhat similar to a source follower driving Q_2. In this problem do not neglect r_{o1} or r_{o2}.

(a) Determine the impedance seen looking into each terminal when all other terminals are tied to small-signal ground.

(b) Compute the transconductance of the pair, defined as $(i_{d1} + i_{c2})/v_{g1}$ when terminals 2 and 3 are tied to small-signal ground.

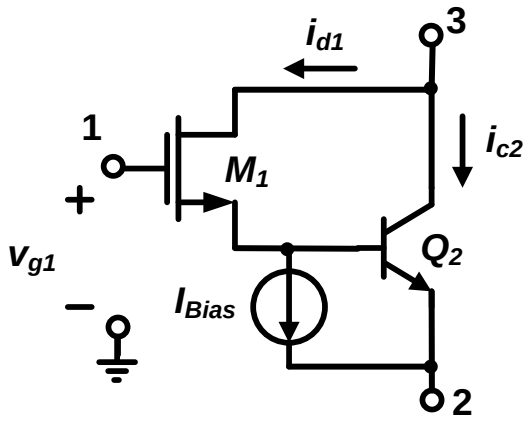


Fig. PS2.4