PROBLEM SET #2

Issued: Tuesday, Jan.31, 2012

Due: Tuesday, Feb.7, 2012, 6:00 p.m. in the EE 140 homework box in 240 Cory

1. Use inspection analysis to write expressions for the input resistance R_i, output resistance R_o, and gain v_o/v_I for each of the amplifiers in Fig PS2.1. For part (d), you need to consider two cases assuming: (1) r_o is very large; (2) r_o is on the same order as $(R_D||R_3)$. 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_π, r_o, β, etc.) for the transistors used. For each circuit, assume that all capacitors shown have infinite values.

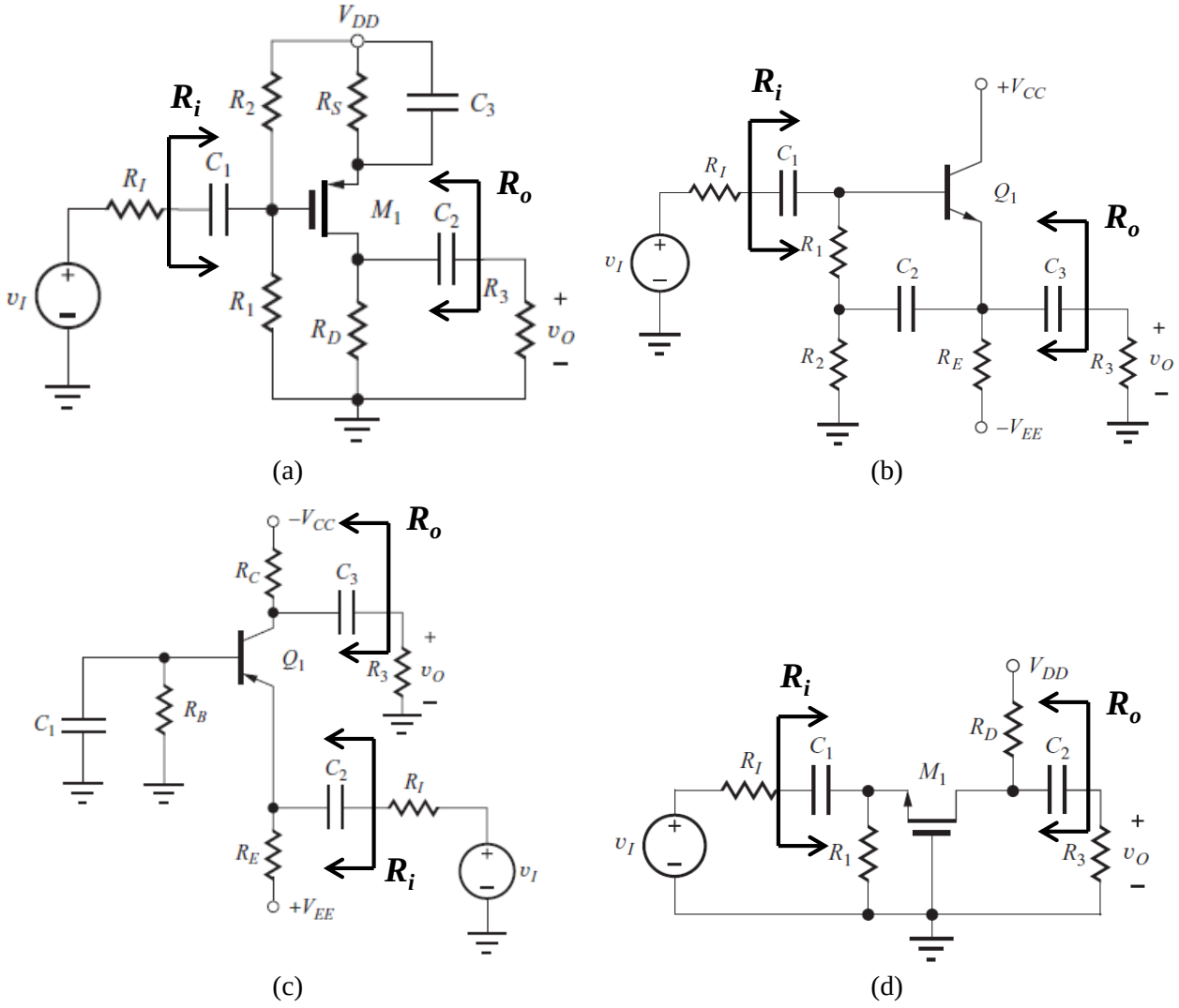

Fig. PS2.1

2. If the emitter resistor R_E in Fig. PS2.2 can be absorbed into the transistor by redefining the small-signal parameters,
   a. What is the redefined g_m', r_π' and r_o'?
   b. What is the common-emitter small-signal current gain β_o'?

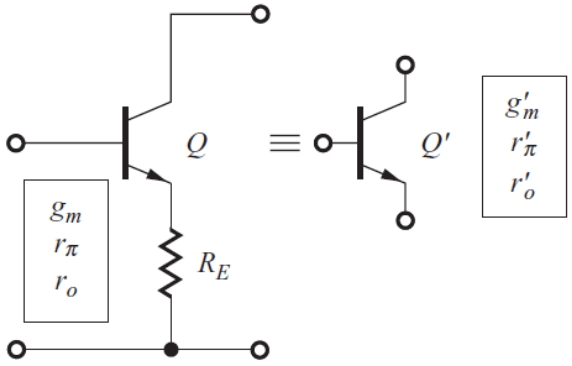

Fig. PS2.2

3. For the circuit in Fig. PS2.3, transistor Q_1 have β = 20 and transistor Q_2 have β = 100. Neglect the effect of r_o. Use V_{BE} = 0.7 V.
   a. Find the DC emitter current of Q_1 and Q_2. Also find the DC voltages V_{B1} and V_{B2}.
   b. If a load resistance R_L = 500 Ω is connected to the output terminal, find the voltage gain from the base to the emitter of Q_2, v_o/v_{b2}, and find the input resistance (R_{ib2}) looking into the base of Q_2.
   c. Analyze the circuit of emitter follower Q_1 to determine its input resistance R_i, and the gain from its base to its emitter, v_{e1}/v_{b1}.
   d. If the circuit is fed with a source having a 100 kΩ resistance, find the overall voltage gain v_o/v_s including the resistances added in parts b.

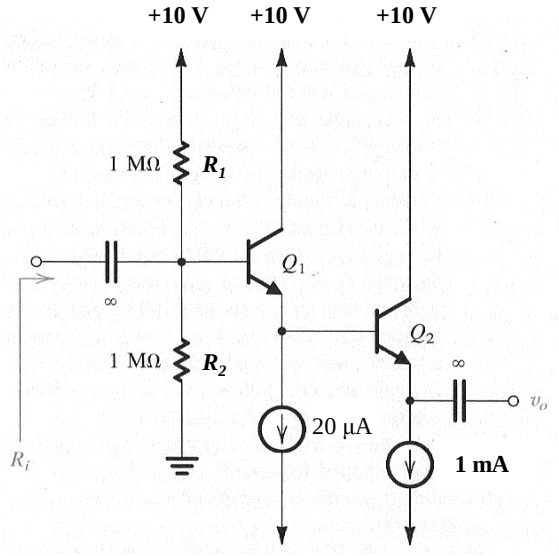

Fig. PS2.3

4. For the common-emitter stage shown schematically in Fig. PS2.4, assume R_I (source resistance) =330Ω, R_G=100kΩ, R_S=150Ω, R_4=16kΩ, R_D=10kΩ, R_3=220kΩ, $+V_{DD}$=5V, $-V_{SS}$=-5V, and C_1, C_2, C_3 are all infinite. For the transistor, assume β_F=65, V_A=50V.
   a. Calculate the DC operating point (I_C, V_{CE}) of the transistor.
   b. Calculate the input resistance and output resistance.
   c. What is the overall voltage gain for this common-emitter amplifier?

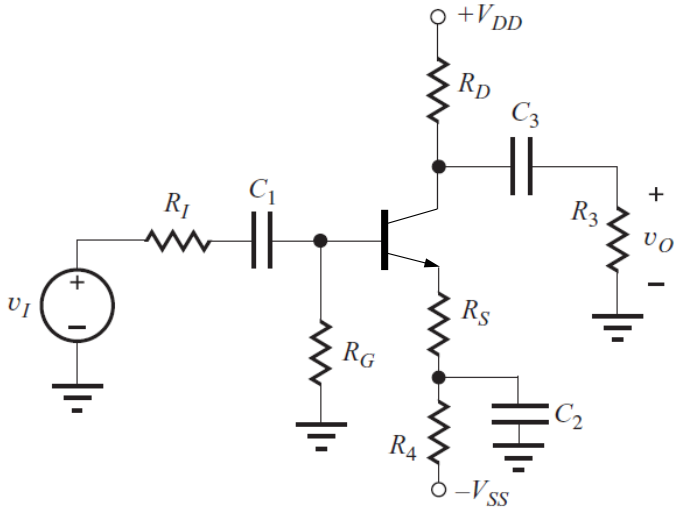

Fig. PS2.4

5. Find the DC operating point, voltage gain, input resistance, and output resistance of the amplifier shown in Fig. PS2.5 if R_F = 1MΩ, R_3 = 100kΩ, k' = 100μA/V^2, V_{TN} = 1V, λ = 0.02, $(W/L)_1$ = 10/1, $(W/L)_2$ = 2/1 and V_{DD} = 5V. Assume C_1 and C_2 infinite.

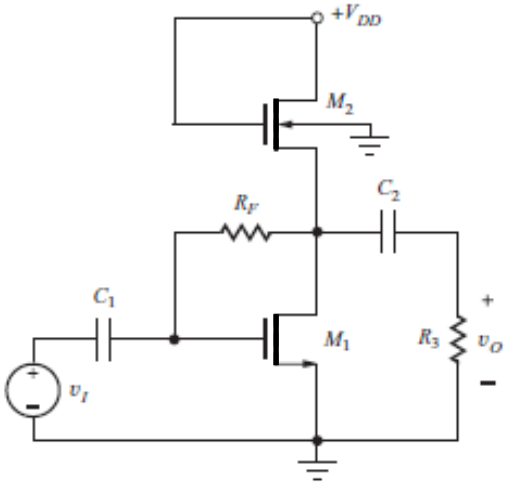

Fig. PS2.5