

**PROBLEM SET #2**

Issued: Tuesday, Feb. 3, 2009

Due: Tuesday, Feb. 10, 2009, 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  $v_o/v_s$  for each of the amplifiers below. The expressions should be in terms of the given elements and parameters of the small-signal equivalent circuits (i.e.,  $g_m$ ,  $r_p$ ,  $r_o$ ,  $\beta$ , etc.) for the transistors used. For each circuit, assume that all capacitors shown have infinite values.

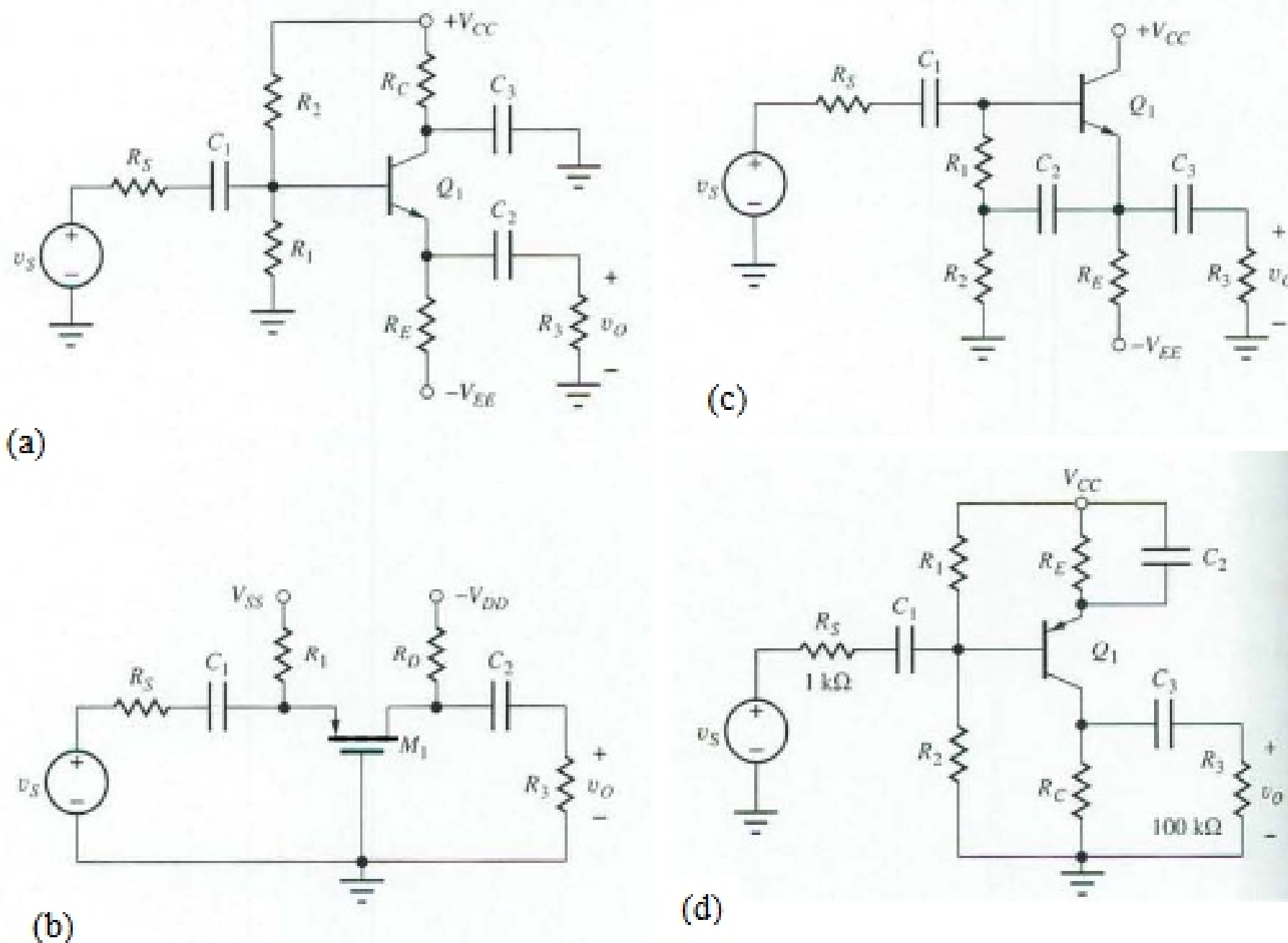


Fig. PS2.1

2. Calculate numerical values for the input resistance  $R_i$ , output resistance  $R_o$ , gain  $v_o/v_s$ , and maximum amplitude of the signal source that still provides linear operation, for the circuit in Fig. PS2.1(d) if  $R_1 = 20\text{k}\Omega$ ,  $R_2 = 62\text{k}\Omega$ ,  $R_E = 3.9\text{k}\Omega$ ,  $R_C = 8.2\text{k}\Omega$ , and  $V_{CC} = 12\text{V}$ . Use  $\beta = 75$  and an Early voltage  $V_A = 60\text{V}$ .
3. Determine expressions for the small-signal input resistance, output resistance, and gain, for each of the circuits in Razavi, Fig. 3.67, except for (b). Use inspection analysis where possible, but resort to the full small-signal model if you deem it necessary.

4. For the Darlington emitter follower of Fig. PS2.2.

- (a) Determine the dc collector currents in  $Q_1$  and  $Q_2$ , and then the small-signal input resistance and voltage gain. Neglect  $r_{\mu}$ ,  $r_b$  and  $r_o$ , and assume that  $V_{BE(on)} = 0.7V$ ,  $\beta=200$ ,  $V_T=26mV(300k)$ . Use inspection analysis wherever possible.
- (b) Determine the -3dB corner frequency ( $f_H$ ) of the gain using open circuit time-constant methods. Assume  $V_{BE(on)} = 0.7V$ ,  $\beta=200$ ,  $V_T=26mV(300k)$ ,  $f_T=500MHz$  at  $I_C=1mA$ ,  $C_{\mu}=0.4pF$ ,  $C_{j\epsilon}=2pF$ ,  $C_{CS}=1pF$ , and neglect  $r_{\mu}$ ,  $r_b$  and  $r_o$ . (Note: use the DC operating point found in (a) and assume zero source impedance.)

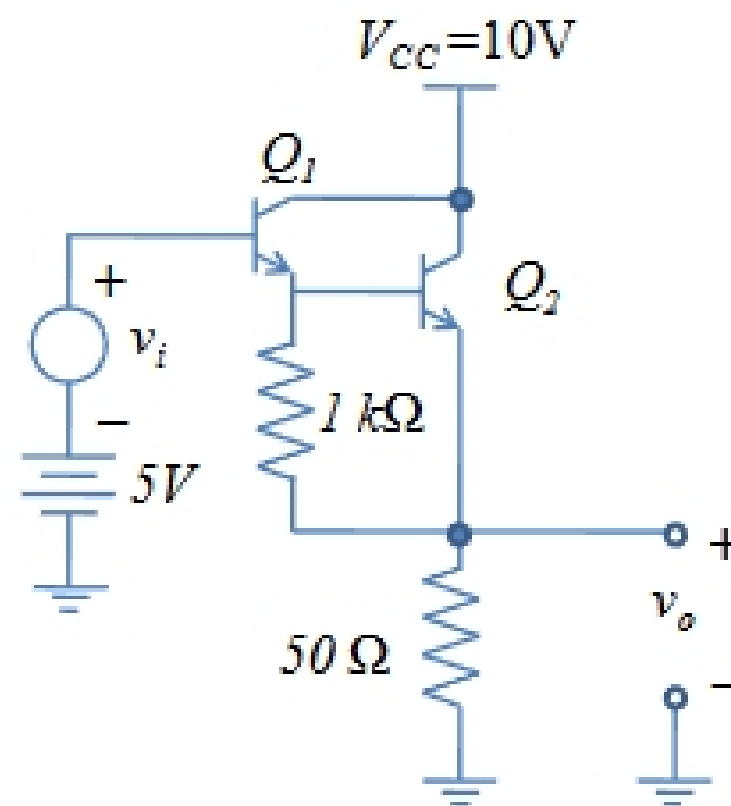


Fig. PS2.2