EE3019 - Integrated Electronics Tutorial 8 – **Revision**

If you have difficulty with this tutorial, please revise EE2002

1. The BJT-based Wilson Current Mirror is depicted in Figure 8.1.

(a) Show that the current gain is given by $\frac{I_o}{I_{REF}} = \frac{\beta^2 + 2\beta}{\beta^2 + 2\beta + 2}$

and discuss the implication of this current gain (with respect to the simple current mirror).

(b) Design an equivalent CMOS Wilson Current Mirror circuit with an output current of 0.2 mA. Assume that V_{DD} = 9V, and the MOSFET parameters are $\mu_n C_{ox} W/L$ = 1.0 x 10^{-4} A/V^2, V_t = 0.4 V.

(c) Determine the minimum output voltage of your Current Mirror design.

[(b) R = 21 kΩ; (c) $V_{out} \geq$ 4.4 V]

2. The transistor in Figure 8.2 has the following parameters: β =100, $r_o = \infty$, V_{BE} = 0.7V and V_{CEQ} = 2V. Assume that V_T = 25mV. The input source has an internal impedance R_S.

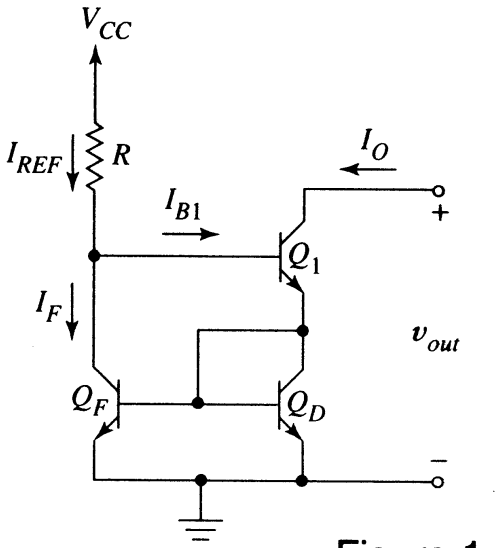
(a) Determine the value of R_C. [1.05 k Ω]

(b) Determine the transconductance g_m and r_π. [334mA/V, 299.5Ω]

(c) Determine the voltage gain as a common collector amplifier and as a common emitter amplifier. [0.975V/V, -2.05V/V]

(d) Determine the input resistance seen by the input signal source (this includes R_S). [51.8 kΩ]

(f) Determine the output resistances taken at the common collector amplifier output and at the common emitter amplifier output. [12.54 Ω, 1.05 kΩ]



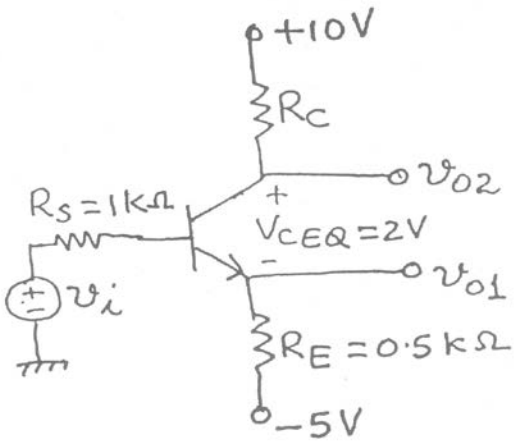


Figure 8.1 **Figure 8.2**

3. A BJT differential amplifier is depicted in Figure 8.3. The current source I = 100μA and the transistor parameters are: npn: V_A = 200V, β = 100; pnp: V_A = 100V, β = 50. Assume V_T = 26mV. Determine (or by inspection, state) the following:

(a) differential input resistance (assume that the current source is ideal),

(b) output resistance,

(c) equivalent transconductance,

(d) differential voltage gain, and

(e) differential voltage gain when the output is connected to a subsequent stage with an input resistance of 1 MΩ.

[(a) 104 kΩ; (b) 1.33 MΩ; (c) 1.92 mA/V; (d) 2554 V/V; 1096 V/V]

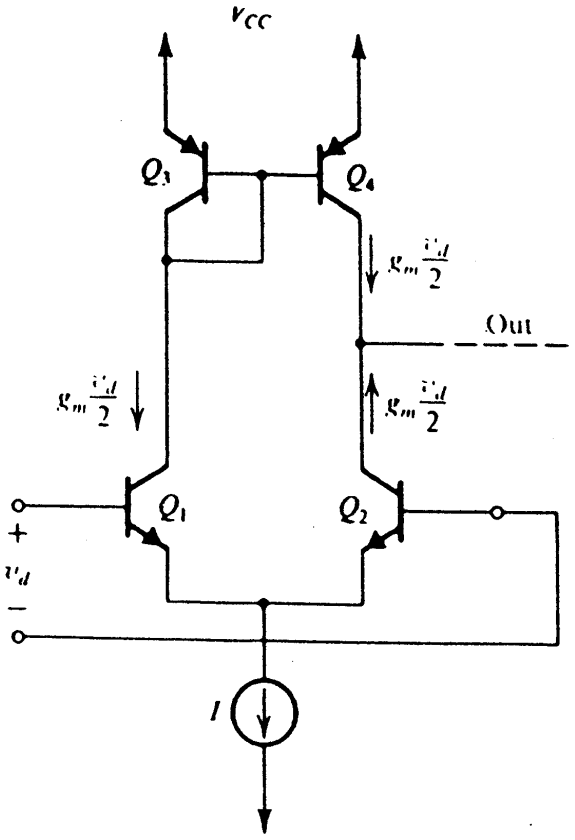


Figure 8.3