

EECS 311 - HW #8 - fall 2008

11
14,109

a) $I_{E1} \approx (V_{th} - V_{be,on}) / R_{E,tot}$

$$I_u = \alpha I_{E1} = \frac{\beta}{\beta + 1} I_{E1} = \frac{100}{101} \left(15 \frac{180}{180 + 300} - 0.7 \right) / 20,000 \approx \boxed{243.8 \mu A}$$

$$\boxed{I_{C2} = I_{C1}}$$

b) $g_{m1} = g_{m2} \approx \frac{I_C}{V_T} \approx \boxed{9.377 \text{ mS}}$

$$r_{\pi 1,2} = \frac{\beta_F}{g_{m1,2}} \approx \boxed{10.664 \text{ k}\Omega}$$

c) stage 1:

$$R_{in1} = R_1 // R_2 // [r_{\pi 1} + (1 + \beta_F) R_{E1}] = 180 \text{ k} // 300 \text{ k} // [r_{\pi 1} + (1 + 100) 2000]$$
$$\approx \boxed{73.577 \text{ k}\Omega}$$

$$G_{m1} = \frac{g_{m1}}{1 + g_{m1} R_{E1}} \approx \boxed{0.475 \text{ mS}}$$

$\uparrow$
 2000Ω

$$R_{out1} = R_{C1} \text{ (ignore BWM)}$$
$$= \boxed{20 \text{ k}\Omega}$$

stage 2:

$$R_{in2} = R_1 // R_2 // r_{\pi 2} \leftarrow$$
$$\approx \boxed{9.741 \text{ k}\Omega}$$

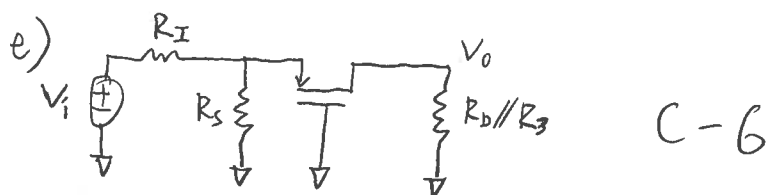
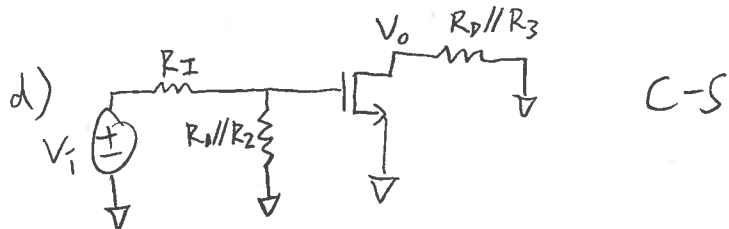
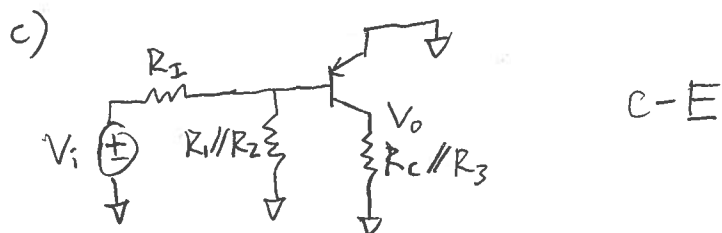
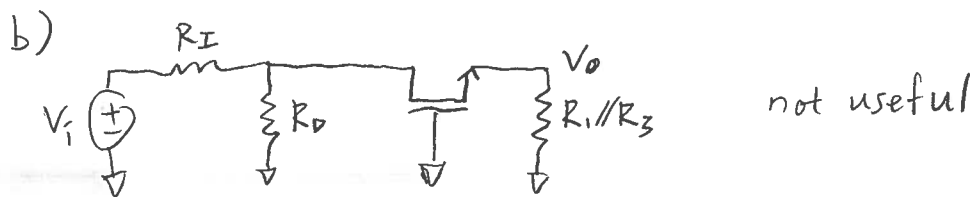
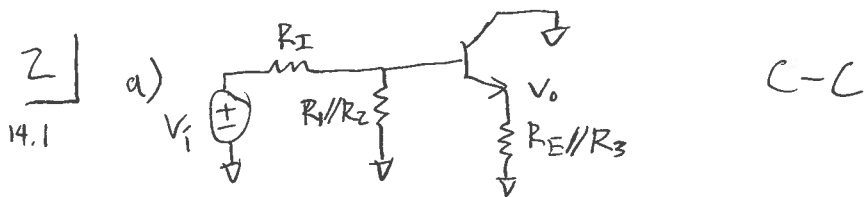
$$G_{m2} = g_{m2} \approx \boxed{9.377 \text{ mS}}$$

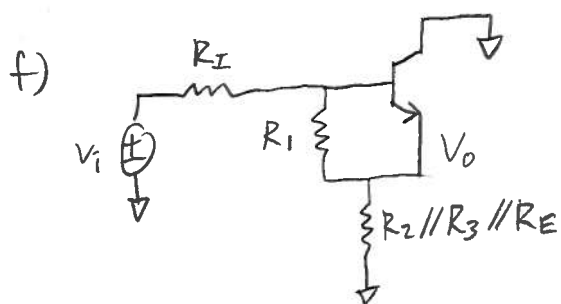
$$R_{out2} = R_{C2} = \boxed{20 \text{ k}\Omega}$$

$$d) A_v = A_{v0} A_{v1} A_{v2} = \frac{R_{in1}}{R_{in1} + R_s} G_{m1} (R_{out1} // R_{in2}) G_{m2} (R_{out2} // R_L)$$

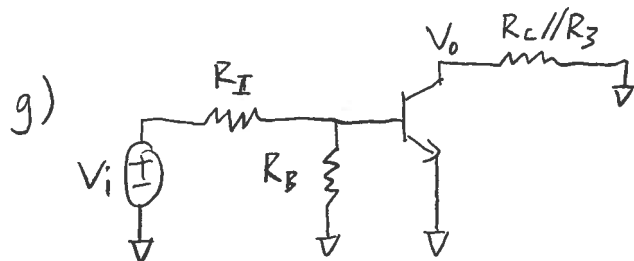
$\uparrow$ 3.11 $\uparrow$ 156 $\uparrow$ 2k Ω $\uparrow$ 100k Ω

$$\approx \boxed{473 \text{ V/V}}$$

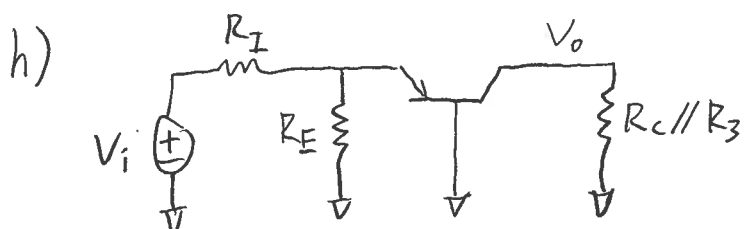




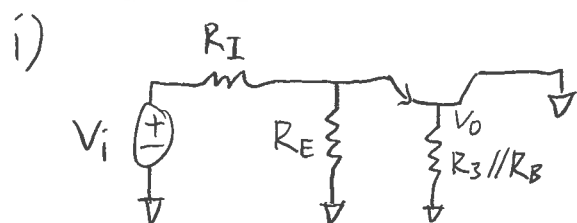
C-C



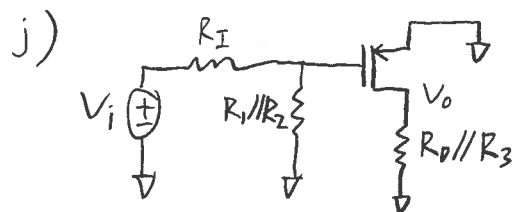
C-E



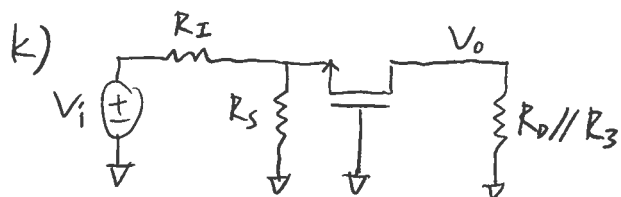
C-B



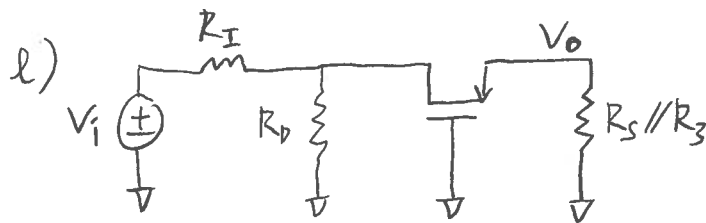
not useful



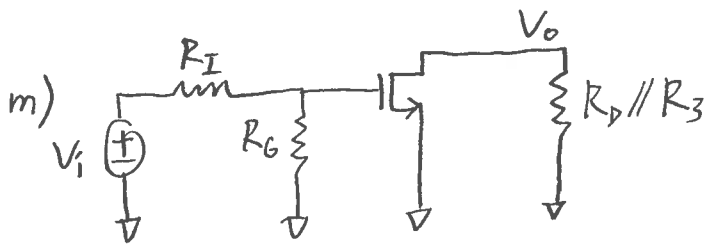
C-S



C-G

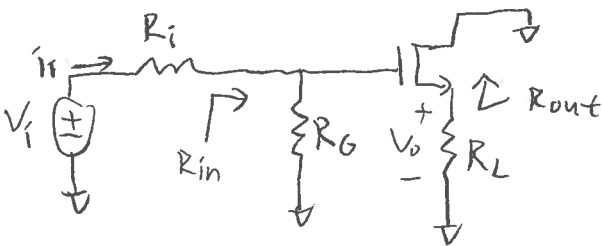


not useful



C-S

3
14.21



$$\begin{aligned} R_i &= 100 \text{ k}\Omega \\ R_G &= 2 \text{ M}\Omega \\ R_L &= 2 \text{ k}\Omega \\ g_m &= 10 \text{ mS} \end{aligned}$$

$$R_{in} = R_G = \boxed{2 \text{ M}\Omega}$$

$$R_{out} = \frac{1}{g_m} = \boxed{100 \Omega}$$

$$A_v = \frac{R_G}{R_i + R_G} \cdot \frac{g_m R_L}{1 + g_m R_L} = \boxed{0.907 \text{ V/V}}$$

$$A_i = \frac{i_o}{i_i} = \frac{V_o / R_L}{V_i / (R_i + R_G)} = A_v \cdot \frac{R_i + R_G}{R_L} \approx \boxed{952 \text{ A/A}}$$

$$R_4 = 3 \text{ k}\Omega, R_I = 50 \Omega, R_L = 60 \text{ k}\Omega, g_m = 0.5 \text{ mS}$$

4
14.31

$$a) R_{in} = R_4 // \frac{1}{g_m} \approx \boxed{1.20 \text{ k}\Omega}$$

$$R_{out} = \boxed{\infty}$$

$$A_v = \frac{R_{in}}{R_{in} + R_I} \cdot g_m R_L \approx \boxed{28.8 \text{ V/V}}$$

$$A_i = \frac{V_o / R_L}{V_{in} / (R_I + R_4 // \frac{1}{g_m})} = A_v \frac{R_I + (R_4 // \frac{1}{g_m})}{R_L} \approx \boxed{0.60 \text{ A/A}}$$

b) R_I changed to $5 \text{ k}\Omega$:

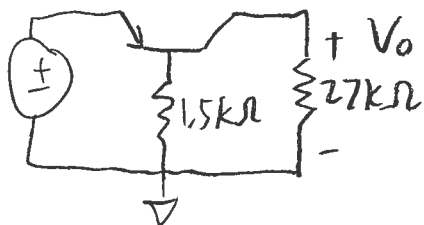
$$R_{in} \approx \boxed{1.20 \text{ k}\Omega} \text{ same}$$

$$R_{out} \approx \boxed{\infty} \text{ same}$$

$$A_v \approx \boxed{5.81 \text{ V/V}}$$

$$A_i \approx \boxed{0.60 \text{ A/A}}$$

S
14.39



$$I_C = 1 \text{ mA} \quad \beta_F = 75$$

$$R_{in} \approx \frac{1}{g_m} + \frac{R_S}{\beta_F}$$

$$\approx \frac{V_T}{I_C} + \frac{1.5 \text{ k}}{\beta_F} \approx \boxed{46 \Omega}$$