EECS 311 - HW #8 - fall 2008

1

14.109

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

$I_{C1} = \alpha I_{E1} = \frac{\beta}{\beta+1} I_{E1} = \frac{100}{101}\left(15\frac{180}{180+300} - 0.7\right)/20{,}000 \approx \boxed{243.8\ \mu A}$

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

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

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

c) stage 1:

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

$\approx \boxed{73.577\ k\Omega}$

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

($R_{E1} \uparrow 2000\Omega$)

$R_{out1} = R_{C1}$ (ignore BWM)

$= \boxed{20\ k\Omega}$

stage 2:

$R_{in2} = R_1 // R_2 // r_{\pi 2}$

$\approx \boxed{9.741\ k\Omega}$

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

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

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

A_{v0}: 3,11 — A_{v2}: 156 — R_S: 2kΩ — R_L: 100kΩ

$\approx$ **473 V/V**

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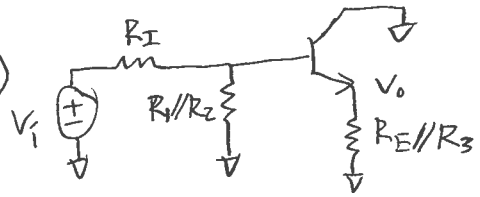
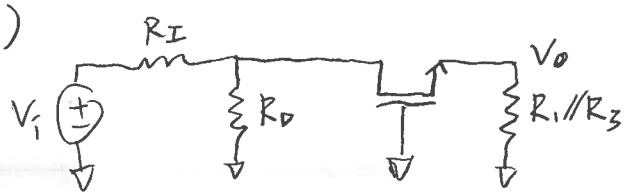
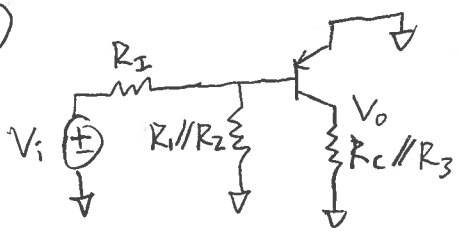
2 | 14.1

a) 

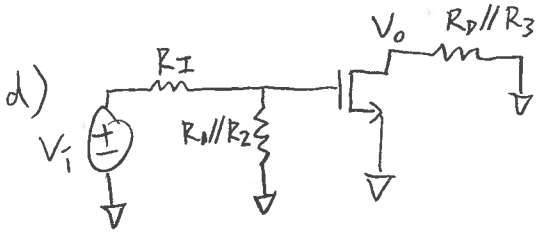
C-C

b) 

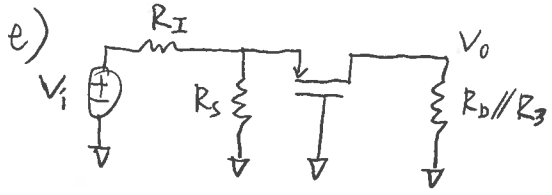
not useful

c) 

C-E

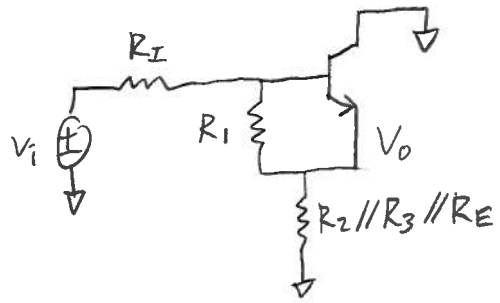
d) 

C-S

e) 

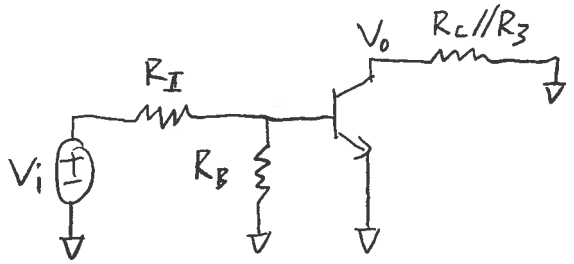
C-G

f)



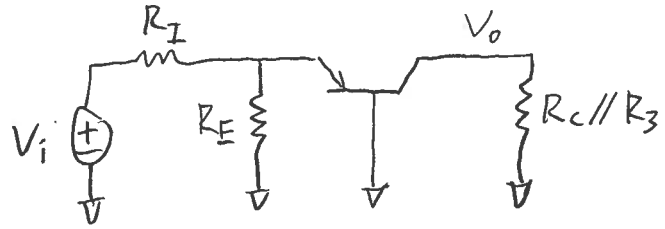
C-C

g)



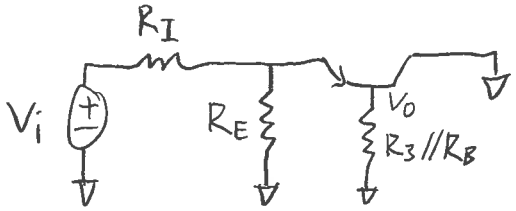
C-E

h)



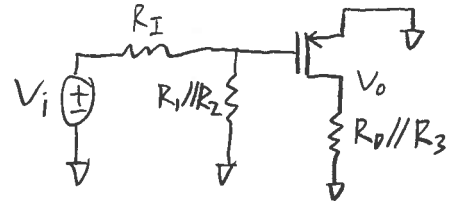
C-B

i)



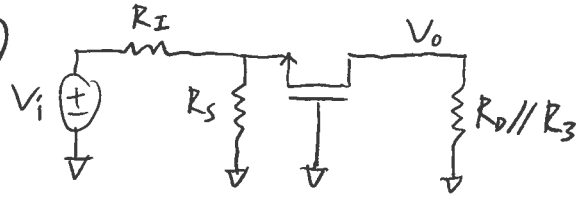
not useful

j)



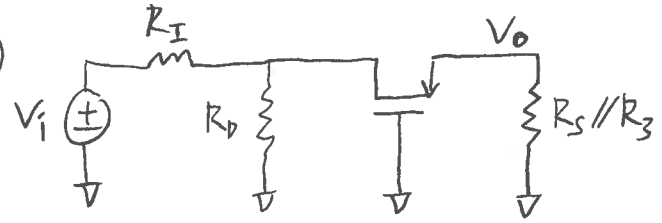
C-S

k)



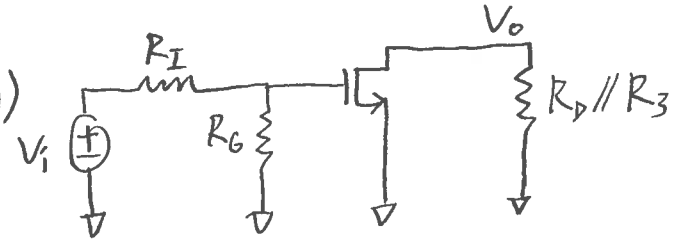
C-G

l)



not useful

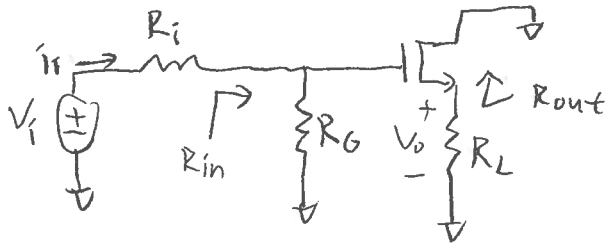
m)



C-S

3

14.21



$R_i = 100 k\Omega$

$R_G = 2 M\Omega$

$R_L = 2 k\Omega$

$g_m = 10 mS$

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

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

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

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

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

4 14.31

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

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

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

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

b) R_I changed to $5\,k\Omega$:

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

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

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

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

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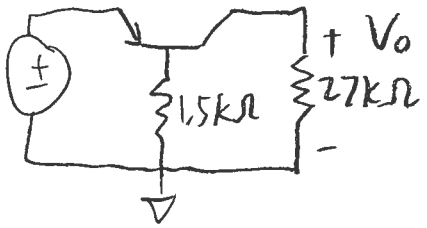
5 14.39



$I_C = 1\,mA$ $\beta_F = 75$

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

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