King Fahd University of Petroleum & Minerals
Electrical Engineering Department

ELECTRONICS I

Exam II

EE 203 – (081)

Saturday, January 10, 2009

5:30–7:00 PM (1 hour and 30 minutes)

Instructors: M. Alsunaidi & S. Al-Shahrani

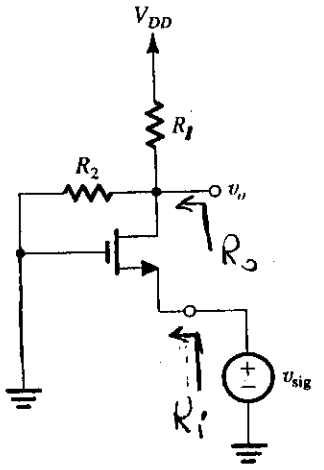
Student Name: Key

Student ID: _____

Problem 1	20	
Problem 2	20	
Problem 3	20	
TOTAL	60	

Problem 1: [2+3+4+4+4+3 : Marks]

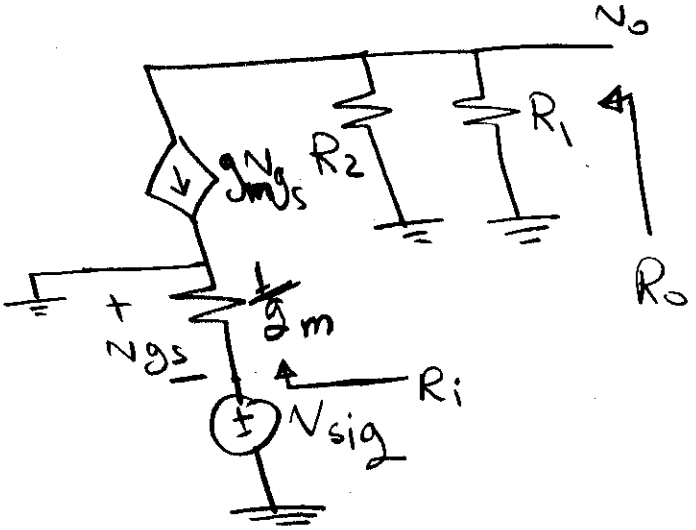
Consider the FET amplifier circuit shown in the figure. Assume the transistor is biased such that g_m=1 mA/V (neglect r_o).



(a) Identify the amplifier type.
(b) Draw the small signal equivalent circuit of the amplifier using the T model.
(c) Derive a general expression for the overall voltage gain (v_o/v_{sig}).
(d) Derive a general expression for the input resistance of the amplifier (R_i).
(e) Derive a general expression for the output resistance of the amplifier (R_o).
(f) For R_1=10 kΩ, R_2=1 MΩ, Find numerical values for parts c, d and e.

a) Common Gate (CG)

b) T-model



c) $\frac{V_o}{V_{sig}} = ??$

$V_o = -g_m V_{gs} (R_2 // R_1)$

$V_{gs} = -V_{sig}$

$\frac{V_o}{V_{sig}} = g_m (R_2 // R_1)$

d) $R_i = \frac{1}{g_m}$; e) $R_o = R_1 // R_2$

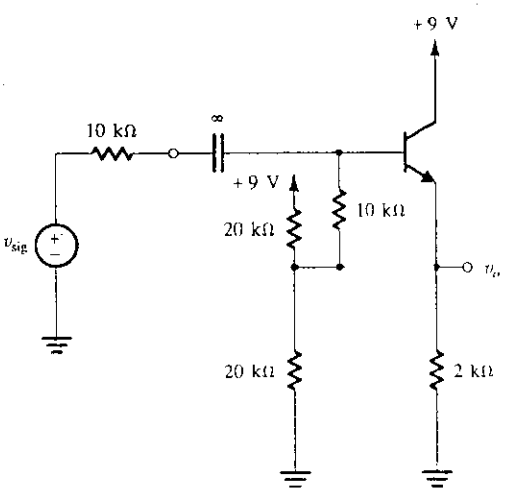
f) $\text{Gain} = \frac{V_o}{V_{sig}} = +1m \times (10K // 1M) \simeq +10\ V/V$

$R_i = \frac{1}{1m} = 1K\Omega$; $R_o = 10K // 1M \simeq 10K\Omega$

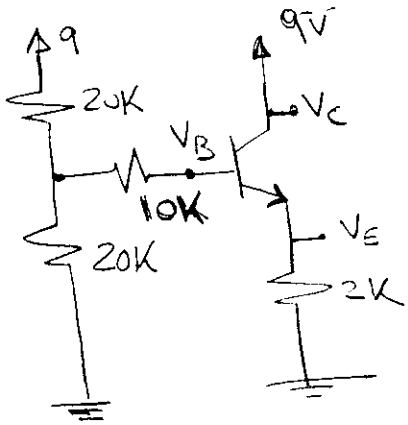
Problem 2:

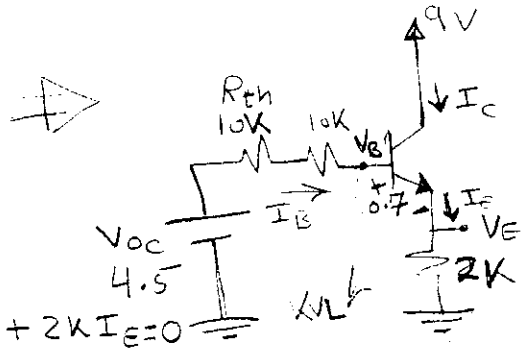
For the BJT transistor circuit shown in the figure, β=100 and V_A=50 V.

(a) Calculate all DC currents and voltages (I_B, I_C, I_E, V_B, V_C, V_E).
(b) What is the mode of operation?
(c) Calculate the small-signal parameters (g_m, r_π, r_e and r_o)



a)





By KVL: $-4.5 + (10K+10K)\,I_B + 0.7 + 2K\,I_E = 0$

$-4.5 + 20K\,I_B + 0.7 + 2K(\beta+1)\,I_B = 0 \Rightarrow I_B = \frac{3.8}{222K} = 17.1\mu A$

$I_C = \beta I_B = 1.71mA$; $I_E = I_C + I_B = 1.73mA$

$V_B = 0.7 + 2K\,I_E = 4.16\,V$

$V_E = 2K\,I_E = 3.46\,V$

$V_C = 9\,V$

b) $V_{BC} < 0.5$ & $V_{BE} = 0.7 \Rightarrow$ Active Mode

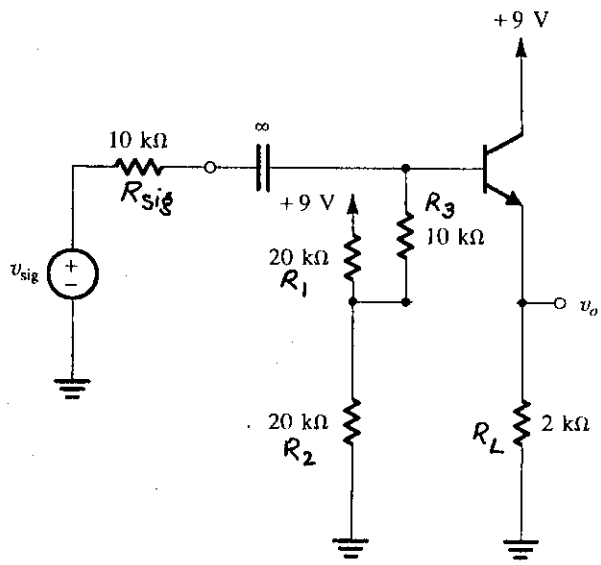
c) $g_m = \frac{I_C}{V_T} = 40 I_C = 68.4 mA/V$; $r_e = \frac{\alpha}{g_m} = 14.6\,\Omega$

$r_\pi = (\beta+1) r_e = 1.46\,K\Omega$; $r_o = \frac{V_A}{} = 29\,K\Omega$

Problem 3 [2+3+4+4+4+3 Marks]

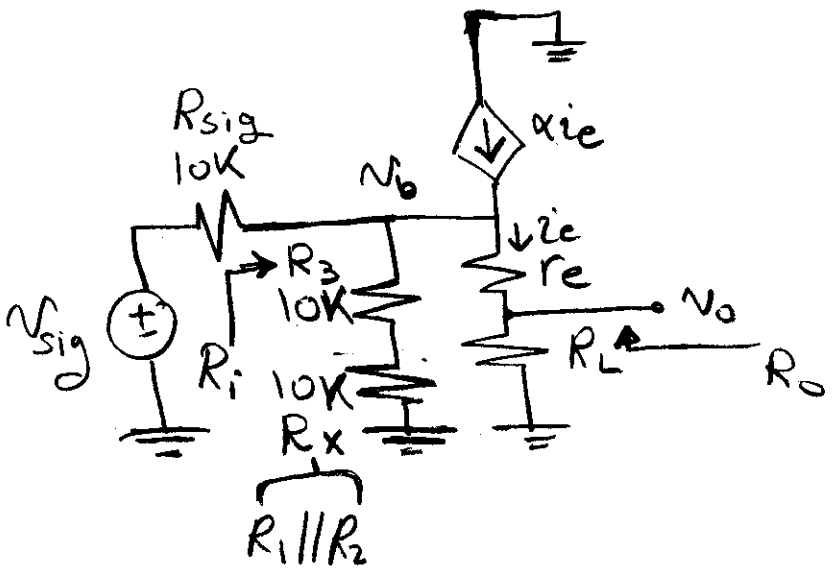
Consider the BJT amplifier circuit shown in the figure (neglect r_o).

(a) Identify the amplifier type.
(b) Draw the small signal equivalent circuit of the amplifier
(c) Derive a general expression for the overall voltage gain ($\upsilon_o/\upsilon_{sig}$).
(d) Derive a general expression for the input resistance of the amplifier (R_i).
(e) Derive a general expression for the output resistance of the amplifier (R_o).
(f) Find numerical values for parts c, d and e.



a) Common Collector CC

b)



c) $\frac{V_o}{V_{sig}} = \frac{V_b}{V_{sig}} \frac{V_o}{V_b} = \frac{R_i}{R_i + R_{sig}} \frac{R_L}{R_L + r_e}$

d) $R_i = (R_3 + R_x) // (\beta+1)(r_e + R_L) = 18.21\ K\Omega$

e) $R_o = r_e + \frac{R_{sig} // (R_3 + R_x)}{(\beta+1)} = 80.5\ \Omega$

f) $\frac{V_o}{V_{sig}} = 0.646 \times 0.992 = 0.641\ V/V$