ECE 115A

Fall 2020

Midterm 2 Exam

Tuesday, 11/24/2020

Instructor: Prof. M.-C. Frank Chang

Name:

UID:

Problem 1:

Problem 2:

Problem 3:

Problem 4:

Bonus Problem:

Total:

Problem 1 (25 points)

For the amplifier shown, the transistor has $\beta = 100$ and early voltage $V_A = 100$ V. Assume $V_{BE,on} = 0.7$ V and $V_{CE,sat} = 0.2$ V.

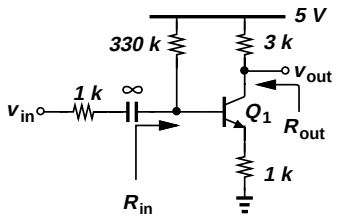
(a) Find the value of dc collector current I_C. (5 points)

(b) Find g_m, r_π, r_o and draw the small-signal model for the entire amplifier. (5 points)

(c) Find the value of input resistance R_{in}. (5 points)

(d) Find the small-signal voltage gain v_{out}/v_{in}. (5 points)

(e) Find the output resistance R_{out}. (5 points)



Problem 2 (25 points)

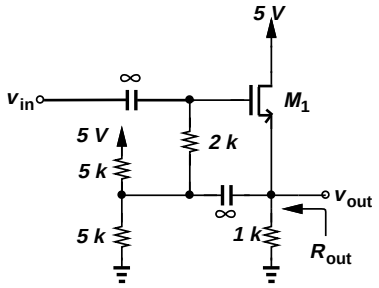
For the amplifier circuit below, M1 has $\mu_n C_{ox}$=200μA/V^2, W/L=10, V_{TH}=0.4V, λ=0.

(a) Determine DC drain current I_D and DC gate voltage V_G. (7 points)

(b) Compute M1's small-signal parameters g_m and r_o and draw the small-signal equivalent model for the amplifier. (6 points)

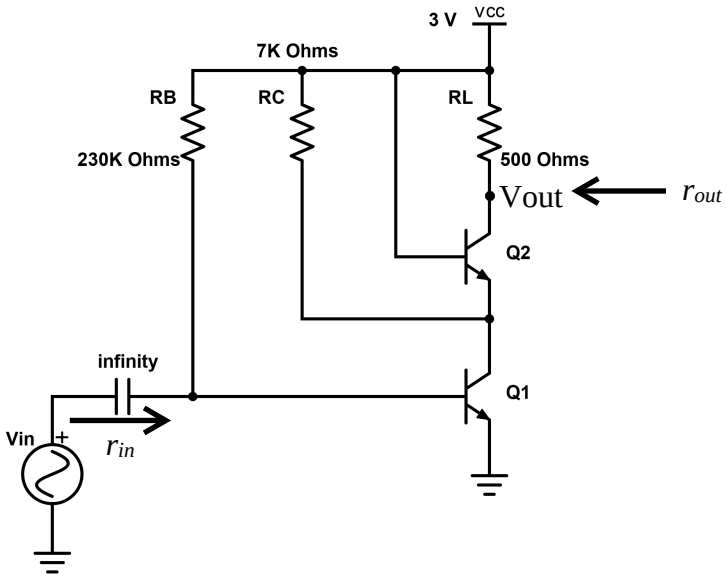
(c) Determine the small-signal voltage gain v_{out}/v_{in}. (6 points)

(d) Determine the output resistance R_{out}. (6 points)



Problem 3 (25 points)

For the below circuit, $V_{BE,ON}$ = 0.7 V, VA = +∞, $V_{CE,SAT}$ = 0.2 V, β = 100
(a) Find DC collector currents I_{C1} and I_{C2}. (4 points)
(b) Find the value of g_m and r_π for both transistors, and draw the small signal model for the entire circuit. (5 points)
(c) Compute the small-signal voltage gain v_{out}/v_{in}. (8 points)
(d) Find output resistance r_{out}. (4 points)
(e) Find input resistance r_{in}. (4 points)



Problem 4 (25 points)

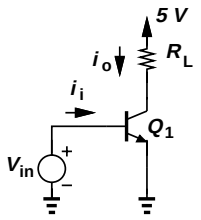
Consider the common-emitter amplifier shown. Assume that the transistor is properly biased in the forwared-active region.

(a) Draw the small-signal model of the amplifier incorporating the high frequency effects. (Hint: It should include C_π and C_μ.) (8 points)

(b) Derive an expression for the current gain i_o/i_i. Assume $g_m \gg sC_\mu$ and $R_L = 0$. (10 points)

(c) At which input frequency is the current gain unity? (This frequency is also called the unity gain frequency.) (5 points)

(d) If $I_C = 1$ mA, $C_\pi = 10$ pF, and $C_\mu = 2$ pF, compute the value of unity-gain frequency? (2 points)



Bonus Problem (25 points)

For the amplifier shown below, the transistors have $\beta = 100$ and $V_A = \infty$. Assume $V_{BE,on} = 0.7$ V and $V_{CE,on} = 0.2$ V.

(a) Find the dc collector currents I_{C1} and I_{C2}. (3 points)

(b) Find the small-signal voltage gain v_{out}/v_{in}. (4 points)

(c) Determine the input resistance (R_{in}) of the amplifier. (3 points)