Department of Electrical and Computer Engineering, Cornell University

ECE 3150: Microelectronics

Spring 2015

Homework 10 **Due on April 23, 2015 at 5:00 PM**

Suggested Readings:

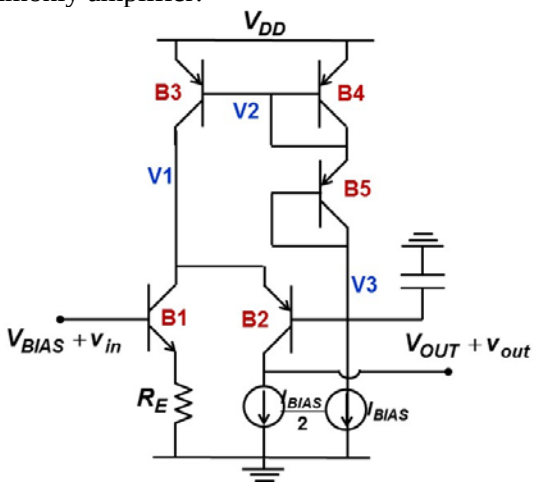
a) Lecture notes

Important Notes:

1) MAKE SURE THAT YOU INDICATE THE UNITS ASSOCIATED WITH YOUR NUMERICAL ANSWERS. OTHERWISE NO POINTS WILL BE AWARDED.
2) Unless noted otherwise, always assume room temperature.

Problem 10.1: (A Mystery Amplifier)

Consider the following commonly amplifier:



$V_{BE-ON} = 0.7\,V$
$V_{CE-SAT} = 0.2\,V$
$\beta_F = 100$
$I_{BIAS} = 400\ \mu A$
$R_E = 500\ \Omega$
$V_{DD} = 5.0\,V$

a) The amplifier is really a cascade of two familiar stages. Identify these two stages?

b) What is the function of the BJTs B3 and B4?

c) What is the function of the BJT B5?

d) What is the function of B1?

e) What is the function of B2?

f) What are the voltages V1, V2, and V3?

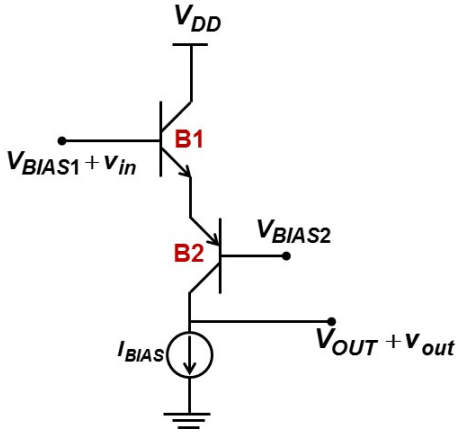
g) What ought to be the value of V_{BIAS} to make the circuit function properly?

h) Find an expression for the output resistance R_{out} ?

i) Find an expression for the open circuit voltage gain $A_v = v_{out}/v_{in}$?

Problem 10.2: (A Mystery Amplifier Again)

Consider the following amplifier



$V_{BE-ON} = 0.7\,V$
$V_{CE-SAT} = 0.2\,V$
$\beta_F = 200$
$I_{BIAS} = 400\ \mu A$
$V_{DD} = 5.0\,V$

a) The amplifier is really a cascade of two familiar stages. Identify these two stages?

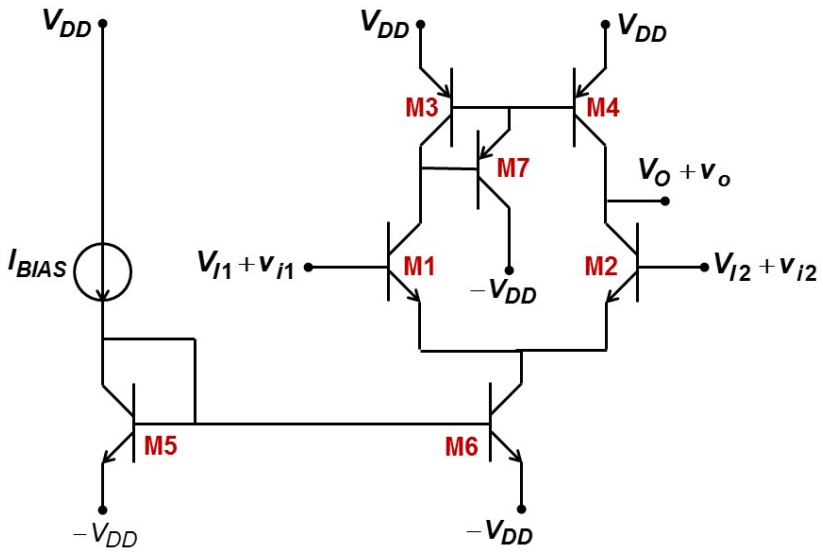
b) Suppose one wants the maximum and minimum voltage values at the output to be 3.0 and 2.0 Volts, respectively. What ought to be the value of V_{BIAS1} and V_{BIAS2} to make the circuit function properly?

c) Find an expression for the output resistance R_{out} ?

d) Find an expression for the open circuit voltage gain $A_v = v_{out}/v_{in}$?

Problem 10.3: (A BJT Differential Amplifier with a Current Mirror)

Consider the following BJT differential amplifier.



Assume:

$V_{BE-ON} = 0.7\,V$

$V_{CE-SAT} = 0.2\,V$

$\beta_F = 200$

$I_{BIAS} = 400\ \mu A$

$V_{DD} = 5.0\,V$

The NPN's are all identical and the PNP's are all identical.

a) What is the function of M7?

b) Find an expression for the input resistance at each of the two input ends as seen by a purely difference-mode input source.

c) Find an expression for input resistance at each of the two input ends as seen by a purely common-mode input source.

d) Find an expression for the output resistance.

e) Find an expression for the open circuit difference-mode voltage gain $A_{vd} = v_o / v_{id}$.

f) Find an expression for the open circuit common-mode voltage gain $A_{vc} = v_o / v_{ic}$.