EECS140 Midterm 2
Spring 2017

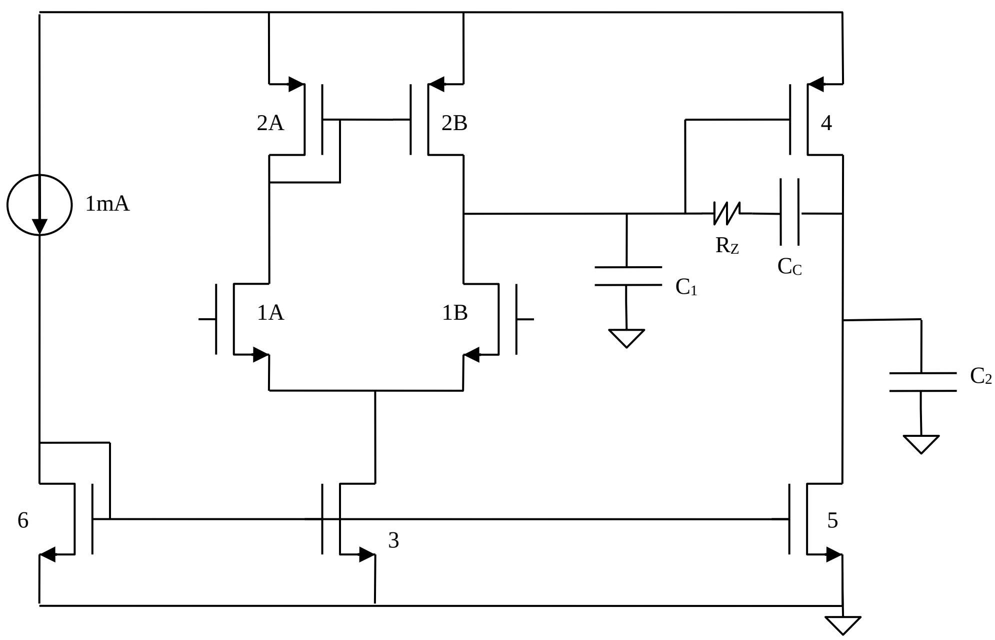
Name______________________________

SID______________________________

Prob.	Score
1a-e	/10
1f-l	/25
2, 3	/30
4	/15
Total	/80

1) Unless otherwise indicated, you may make the following assumptions:

- All transistors are biased in saturation with V_{ov}=0.2V
- V_{DD}=3V, V_{tn}=1V, V_{tp}=-1V
- M3, and M6 are identical, M5 is 10 times wider
- All capacitors are assumed to be zero except C_C, C_1, and C_2 .



a. What is the common mode input range (min and max)?

b. What is the output swing (min and max)?

c. If C_1=0, C_2=1 pF, and C_c=1 pF, what is the positive slew rate?

d. If C_1=0, C_2=2 pF, and C_c=1 pF, what is the negative slew rate?

e. If C_1=0, C_2=1,000 pF, and C_c=1 pF, what is the negative slew rate?

A different amplifier with the same topology has the following parameters. You may ignore the pole/zero doublet from the mirror.

$g_{m1,2}$	R_{o1}	g_{m4}	R_{o2}	C_1	C_C	C_2
1mS	1M	1mS	100k	10p	1p	100p

f. If Cc=0 (magically we will assume no Cgd4 for this part only), what are the uncompensated poles?

$\omega_{p1,u}$=	$\omega_{p2,u}$=

On the following pages,

g. what is the location of the RHZ zero?

ω_z=

h. plot the magnitude of the second stage gain

i. plot the overall impedance seen at the first stage output (including R_{o1}, C_1, C_C, and any effects of Miller multiplication),

j. plot the magnitude of the first stage gain,

k. plot the magnitude and phase of the overall gain. **Label any poles and zeros clearly**.

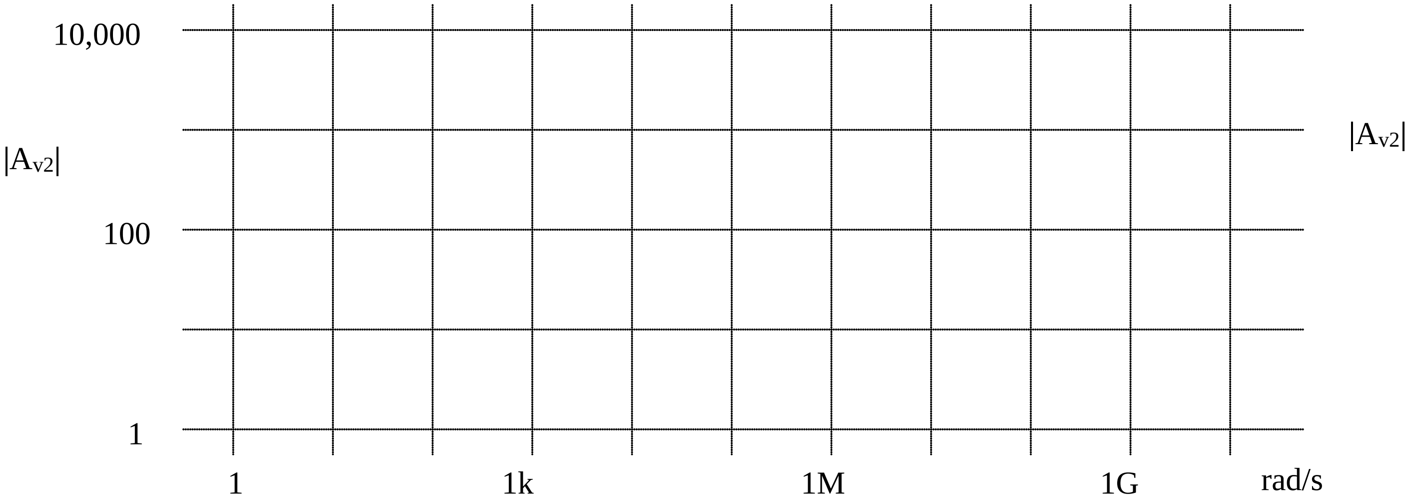
l. Estimate the phase margin for this value of C_C.

PM=

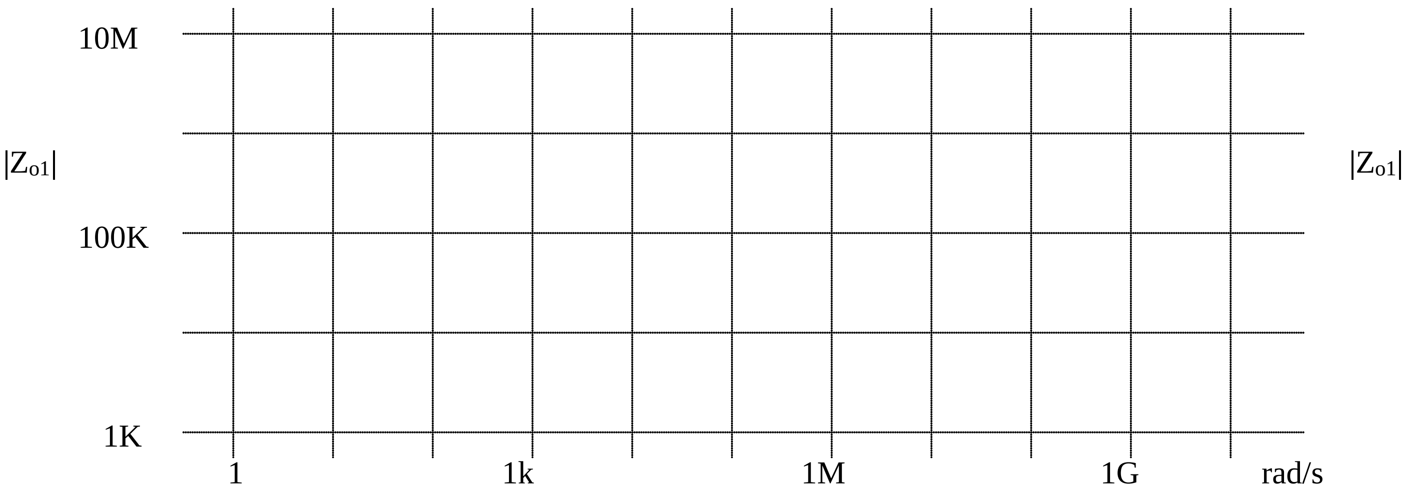
m. What is the maximum feedback factor and closed loop gain for which the amplifier has a 45 degree phase margin?

f=	A_{cl}=

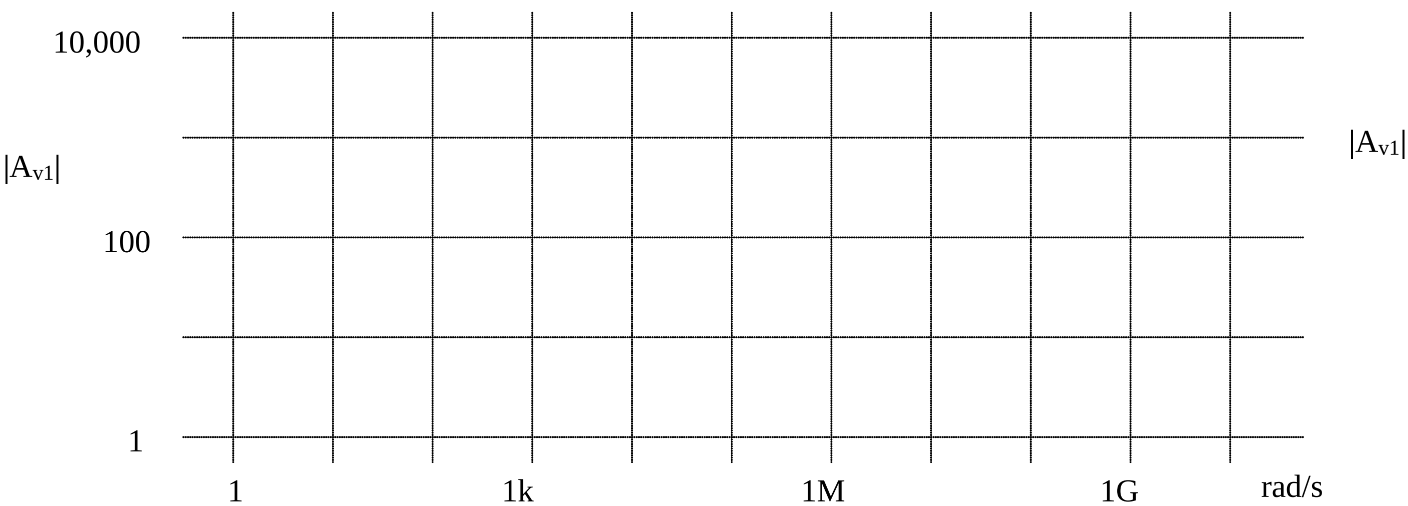
1h) Second stage gain – $|A_{v2,0}|$



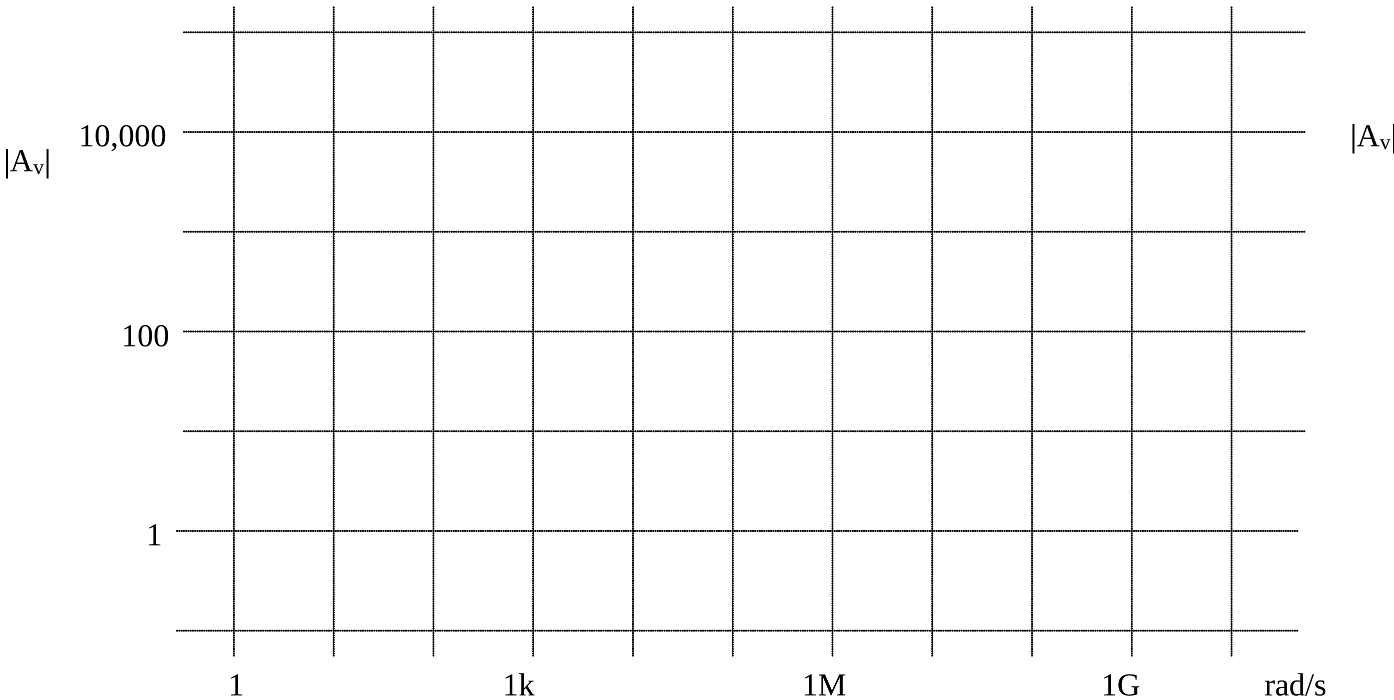
1i) Impedance at first stage output, $|Z_{o1}|$



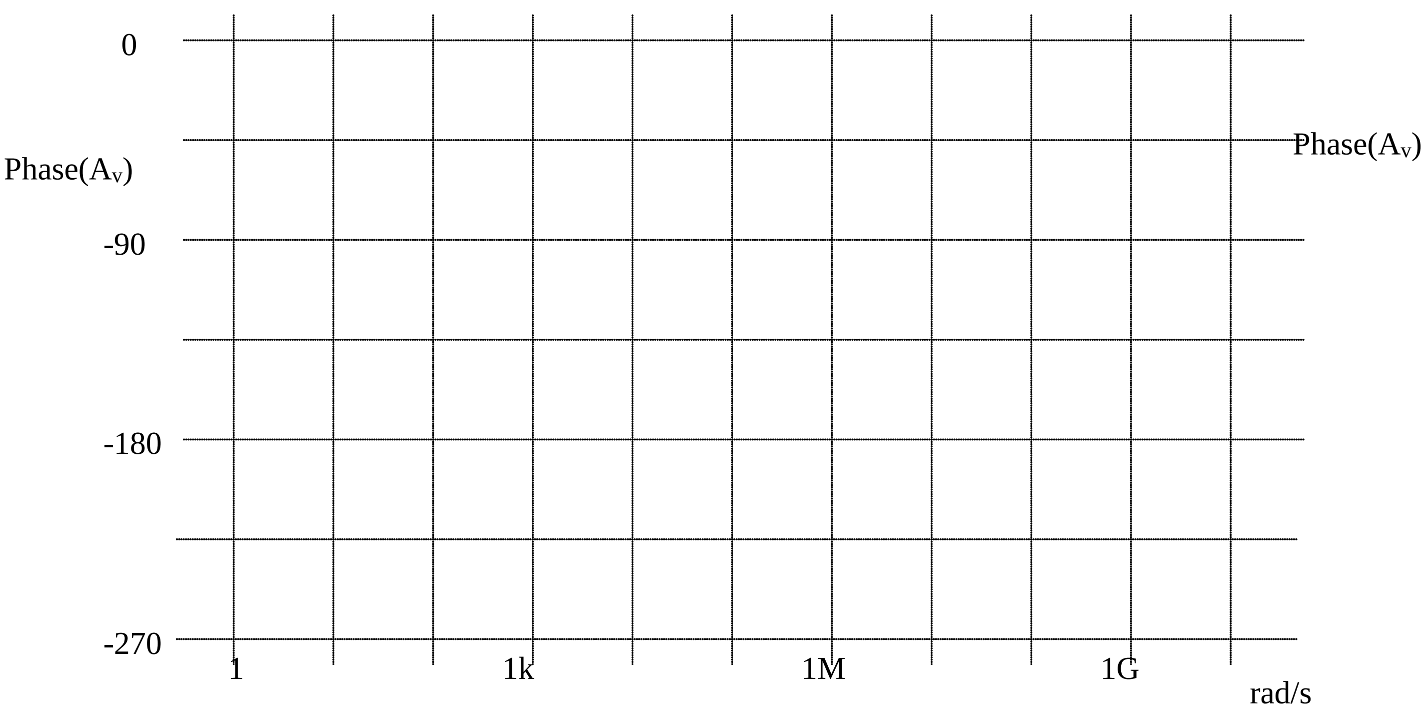
1j) First stage gain, $|A_{v1}|$



1kl) op amp Bode plot



Label any poles and zeros clearly!



2) [8] A single-pole amplifier has a gain of 1,000 and a pole at 1MHz. It is used in feedback with a feedback factor f=0.01 .

a. What is the approximate closed-loop gain,

b. percent gain error,

c. closed-loop pole location,

d. and time constant of the step response?

3) [22] A particular diode D1 has a saturation current of 1pA, and at 1mA current at room temperature the diode voltage has a temperature coefficient of -2mV/K. You are using copies of this diode to make a bandgap reference as in Lab 4, with D2 composed of seven copies of D1. You can use the approximation that ln(7) ~= 2. Assuming that the current in both diodes is maintained at 1mA at room temperature

a. What is the voltage on D1 at room temperature?

b. What is the voltage on D2 at room temperature?

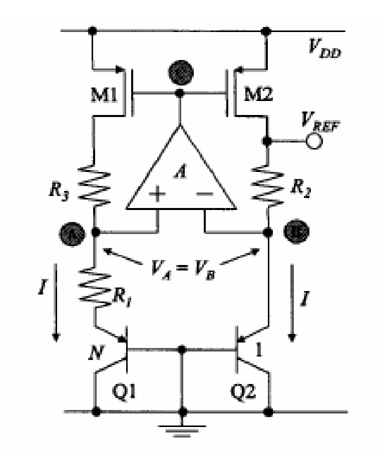
c. What is the different between the two diode voltages at 200K, 300K, and 400K?

d. What is the temperature coefficient of the voltage on D2?

e. Roughly what is the right value for R1?

f. On the following page, carefully sketch by hand the voltage on D1, the voltage on D2, and the difference between them as a function of temperature from 200K to 400K.

g. On the same plot, if $R_3 = R_2 = 10\ R_1$, sketch V_{ref} vs. temperature from 200K to 400K.



It will help your grade if you draw carefully and label the voltage values of any dots that you draw.

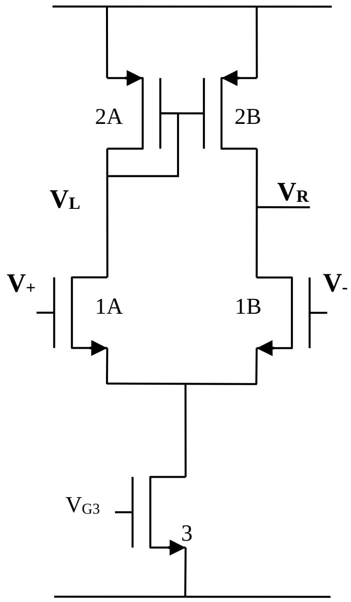
4) [15] For the differential amplifier in the figure below, estimate the change in V_{TAIL}, I_{TAIL}, V_L, and V_R due to

a. An increase of ΔV in both V+ and V-

b. An increase of ΔV in just V+

c. An increase of ΔV in just V-

Give your answers in terms of g_{mi}, r_{oj}, and assume that g_m*r_o >> 1 for all i,j combinations.



	V_{TAIL}	I_{TAIL}	V_L	V_R
ΔV in both V+ and V-				
ΔV in just V+				
ΔV in just V-				