Prob.	Score
1	/18
2	/8
3	/10
4	/16
5	/18
Total	/70

EECS140
Spring 2015
Midterm 1

Name______________________________

SID_______________________________

1) Fill in the following table where each row is a different single-pole amplifier

G_m [S]	**R_o [Ω]**	**C_L [F]**	**Av**	**ω_p [rad/s]**	**ω_u [rad/s]**
10m			10		100G
1u	1M	10f			
		1p	100	10M	

2) You have a single-pole amplifier with a gain of 100 at 100MHz, and a low frequency gain of 500. What is the unity gain frequency? What is the pole frequency? What is the gain at 100Hz, and 1GHz?

Frequency	Gain
ω_u	
ω_p	
100Hz	
1GHz	

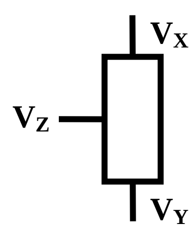
3a) You apply a 1V sine wave at 1M rad/s to a capacitor, and measure 1μA of current.
What is the capacitance?
What current will flow if you raise the frequency to 1Grad/s?

C	
I	

3b) You invent a new transistor, and find that the output current is given by

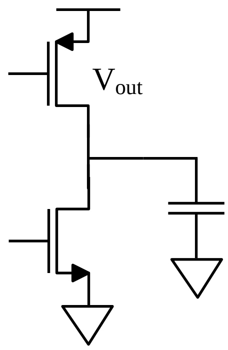
$$\mathbf{I_{xy} = K\, V_{zy}^{3}\, V_{xy}^{1/2} \quad ; \quad I_z = 0}$$

What are the formulas for the transconductance and the output resistance?
What is the intrinsic gain when the device is biased at $V_{zy}=V_{xy}=1V$? (give a numerical answer)



g_m	
r_o	
Av	

4) You have biased the amplifier below with a particular input overdrive voltage V_{ov}. Both devices are in saturation, and the quadratic model is appropriate. The low frequency gain is -1000. C_{gs1}=1pF, C_{gd1}=0.1pF.



What is the input capacitance? (give an exact numerical answer)

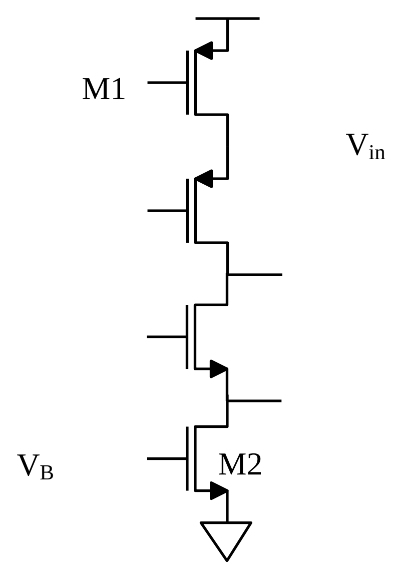
C_{in}	

You adjust the bias voltages so that **V_{ov} increases by a factor of two**. What happens to the current, small signal parameters, low frequency gain, output pole frequency, output unity gain frequency, and input capacitance? Answers should be of the form "increase 5x" "decrease 10x" "stay the same", etc.

I_D	
g_m	
r_o	
A_{v0}	
ω_p	
ω_u	
C_{in}	

Find the total low frequency impedance seen "looking up" and "looking down" at each output node indicated in each circuit. Write your answer in terms of g_m , $g_{m,}$ r_o, and r_o. Assume that all devices have transconductance g_m and output resistance r_o. Write the full expression for up and down, and then the simplified total impedance assuming that g_m*r_o >> 1.

	Full expression	Simplified expression for Ro, assuming gm ro >>1
$R_{out, up}$		R_{out}
$R_{out, dn}$		
$R_{D1,up}$		R_{D1}
$R_{D1,dn}$		



Given the bias voltages above, what are the bias voltages at the sources of the cascode transistors, and what is the output swing? Assume that **$|V_{tp}|=V_{tn}=0.5V$**, and that M1 and M1C have the same W/L, and that M2 and M2C have the same W/L.

V_{S1C}	
V_{S2C}	
swing	