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

EECS140

Spring 2016

Midterm 1

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SID\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gm [S]** | **Ro []** | **CL [F]** | **Av** | **p [rad/s]** | **u [rad/s]** |
| 10m |  |  | 10 |  | 100G |
| 1u | 1M | 10f |  |  |  |
|  |  | 1p | 100 | 10M |  |

Diodes parallel/series; diodes/BJT 60mV/decade problem

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 |
| u |  |
| p |  |
| 100Hz |  |
| 1GHz |  |

3a) You apply a 1V sine wave at 1M rad/s to a capacitor, and measure 1A of current.

What is the capacitance?

What current will flow if you raise the frequency to 1Grad/s?

|  |  |
| --- | --- |
| C |  |
| I |  |

3b) You are testing a transistor and measure the drain current at 10uA when the input and the output are both biased at 1V. You find that to get 11uA of current to flow, you need to either increase the input voltage by 10mV, or the output voltage by 10V.

Estimate the transconductance, output resistance, and intrinsic gain of the transistor (give numerical answers). What is the gain if the transistor is used with a resistive load of 1M?

|  |  |
| --- | --- |
| transconductance |  |
| output resistance |  |
| Av, intrinsic |  |
| Av, resistive load |  |

4) You have biased the amplifier below with a particular input overdrive voltage Vov. Both devices are in saturation, and the quadratic model is appropriate. The low frequency gain is -1000. Cgs1=1pF, Cgd1=0.1pF.

Vin

VB

Vout

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

|  |  |
| --- | --- |
| Cin |  |

You adjust the bias voltages so that **Vov 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.

|  |  |
| --- | --- |
| ID |  |
| gm |  |
| ro |  |
| Av0 |  |
| p |  |
| u |  |
| Cin |  |

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 gm , gm, ro, and ro. Assume that all devices have transconductance gm and output resistance ro. Write the full expression for up and down, and then the simplified total impedance assuming that gm\*ro >> 1.

|  |  |  |
| --- | --- | --- |
|  | Full expression | Simplified expressionfor Ro, assuming gm ro >>1 |
| Rout, up |  | Rout |
| Rout, dn |  |
| RD1,up |  | RD1 |
| RD1,dn |  |

VIN=0.8V

7.2V

M1

M2

M1C

M2C

3V

5V

8V

Vout

VD1

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 **|Vtp|=Vtn=0.5V**, and that M1 and M1C have the same W/L, and that M2 and M2C have the same W/L.

|  |  |
| --- | --- |
| VS1C |  |
| VS2C |  |
| swing |  |