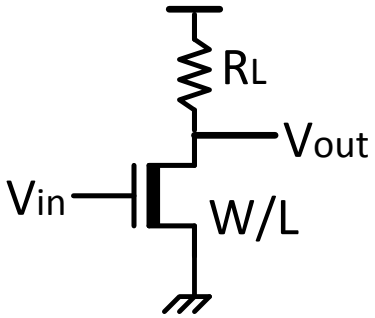
VirginiaTech
Invent the Future

ECE 5220 RFIC HW -3

(Due: 03/19/2012, Hand in by the end of class time, 10:45AM)

Homework will not be acceptable after the class.

Problem-1: Single-ended amplifier



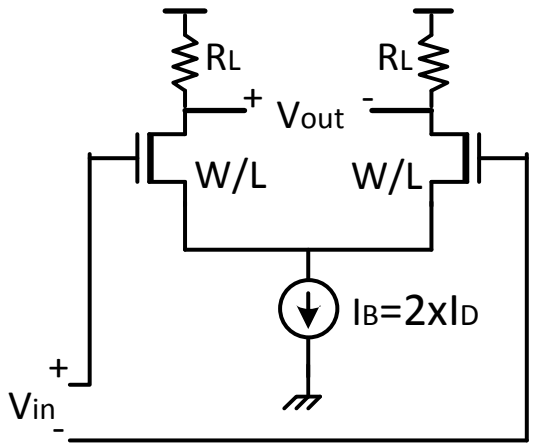
Assume that DC bias current is determined by square-law characteristic, i.e.,

$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{th})^2$.

1) Calculate THD when $V_{in} = cos\omega t$.
2) Calculate output SNR (assumption: the only noise source in drain thermal current noise).
3) If we increase W/L twice while maintaining same bias current I_D, how much increase (or decrease) in THD, noise power and SNR?
4) If we increase overdriving voltage (V_{GS}-V_{th}) twice while maintaining same bias current I_D, how much increase (or decrease) in THD, noise power and SNR?
5) If we maintain W/L same and increase I_D twice, how much increase (or decrease) in THD, noise power and SNR?
6) Express maximum V_{in} (in terms of the overdriving voltage) which allows less than 1% of THD.

* From this question, you can think about sizing of a transistor and trade-offs between linearity, noise figure and power consumption.

Problem-2: Differential amplifier



* Think about which topology between single-ended and differential is better for each of noise and linearity perspective.

Assume that DC bias current for each transistor is determined by square-law characteristic, i.e.,

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{th})^2,$$
$$V_{in} \ll V_{GS} - V_{th}$$

1) Calculate THD when $V_{in} = cos\omega t$ (use approximation of $\sqrt{1-x} \approx 1 - \frac{x}{2}\ if\ x \ll 1$)
2) Calculate output SNR (assumption: the only noise source in drain thermal current noise).
3) If we increase W/L twice while maintaining same bias current I_B, how much increase (or decrease) in THD, noise power and SNR?
4) If we increase overdriving voltage (V_{GS}-V_{th}) twice while maintaining same bias current I_B, how much increase (or decrease) in THD, noise power and SNR?
5) If we maintain W/L same and increase I_B twice, how much increase (or decrease) in THD, noise power and SNR?
6) Express maximum V_{in} (in terms of the overdriving voltage) which allows less than 1% of THD.