Due in the "EE 105 box" near 125 Cory Hall by 5pm on Friday 11/9/2012.

Read Sections 11.3–6 in B. Razavi: Fundamentals of Microelectronics

Use the following parameters in all problems, unless otherwise specified (problems from B. Razavi: Fundamentals of Microelectronics use the parameters specified in B. Razavi: Fundamentals of Microelectronics):

Device	Parameter values
BJT	$I_s = 1\,\text{fA}$, $\beta = 100$, and $V_A = 100\,\text{V}$
N/PMOS	$\lvert V_{TH}\rvert = 400\,\text{mV}$, $C_{ox} = 10\,\text{fF}/\mu\text{m}^2$, $C_{ol} = 0.2\,\text{fF}/\mu\text{m}$, $\lambda = 0.02\,\text{V}^{-1}$, $\gamma = 0\,\text{V}$, $L_{\text{min}} = 180\,\text{nm}$
NMOS	$\mu_n = 300\,\text{cm}^2/\text{Vs}$
PMOS	$\mu_p = 150\,\text{cm}^2/\text{Vs}$

Unless otherwise specified, assume room temperature and $V_t = 25\,\text{mV}$.

1. Do the Exercise after Example 11.15 in B. Razavi: Fundamentals of Microelectronics.

2. Answer the Exercise after Example 11.16 in B. Razavi: Fundamentals of Microelectronics.

3. Do the Exercise after Example 11.18 in B. Razavi: Fundamentals of Microelectronics. Use a plotting program (e.g. Excel, Matlab, ...) for the plot.

4. Do the Exercise after Example 11.19 in B. Razavi: Fundamentals of Microelectronics.

5. Do the Exercise after Example 11.20 in B. Razavi: Fundamentals of Microelectronics.

6. Do the Exercise after Example 11.21 in B. Razavi: Fundamentals of Microelectronics.

7. Do the Exercise after Example 11.22 in B. Razavi: Fundamentals of Microelectronics.

8. Do the Exercise after Example 11.24 in B. Razavi: Fundamentals of Microelectronics.

9. Do Problem 11.29 in B. Razavi: Fundamentals of Microelectronics.

10. Do Problem 11.14 in B. Razavi: Fundamentals of Microelectronics.

11. Do Problem 11.17 in B. Razavi: Fundamentals of Microelectronics.

12. Do Problem 11.20 in B. Razavi: Fundamentals of Microelectronics.

13. Design a PMOS common source amplifier with the following specifications:

- Small-signal DC gain $a_{vo} = -5$
- Load resistance $R_L = 5\,\mathrm{k\Omega}$
- Source resistance $R_s = 5\,\mathrm{M\Omega}$ (output resistance of the small signal source driving the CS amplifier)
- 3-dB bandwidth $BW = 2\,\mathrm{MHz}$
- Minimum power dissipation (minimum I_D)
- $V_{dd} = 5\,\mathrm{V}$

Proceed as follows:

a) Draw large and small-signal models of the amplifier.
b) Determine the minimum transconductance g_m required.
c) In the first pass, assume $C_{ol} = 0$. Determine the maximum value of C_{GS} that still meets the specification.
d) Determine the channel length L that meets the specification (this is easy).
e) Determine the minimum value of $V_{GS} - V_{TH}$ that meets the specification.
f) Determine the minimum drain current I_D that meets the specification.
g) Determine the the value of W.
h) Verify your design with SPICE. Turn in a printout of the schematic (or netlist) and a bode-plot. Mark the points values where you read off a_{vo} and BW. Explain discrepancies between specifications and simulation results.
i) Redo steps (c) to (h) for $C_{ol} \neq 0$. Suggestion: use the Miller approximation.
j) By what percentage did you have to increase I_D due to finite C_{ol}?

Look at the notes for lecture L17 on the course web for an example. An ac-analysis example has been added to the LTSpice notes.

Note: Finding a good sequence of steps that minimizes iteration is one of the challenges of design. In this problem you are given a lot of help, increasingly you will have to find an appropriate approach yourself. Unlike most design problems, this one does not require iteration—provided you use the right approach.