In the following problems, if reference to a semiconductor process is needed, assume processes with the following characteristics: CMOS Process -- $\mu_n C_{OX}=100 \mu\text{A}/\text{V}^2$, $\mu_p C_{OX}=\mu_n C_{OX}/3$, $V_{TNO}=0.5\text{V}$, $V_{TPO}=-0.5\text{V}$, $C_{OX}=2\text{fF}/\mu^2$, $\lambda_n=\lambda_p=0.01\text{V}^{-1}$, and $\gamma=0.4\text{V}^{-1/2}$. Bipolar Process -- $J_S=10^{-15} \text{A}/\mu^2$, $\beta=100$ and $V_{AF}=150\text{V}$.

Problem 1 Design an amplifier using the architecture shown below in the AMI 0.5u process for a dc gain of 35dB and a GB of 20MHz. How much power is required to obtain this performance? How to W/L and the power change if the GB must be increased to 40MHz? Assume $V_{DD}=2.5\text{V}$, $V_{SS}=-2.5\text{V}$ and $C_L=5\text{pF}$.

Problem 2 Identify one Current Mirror patent that has been issued in the past 2 years. Give the basic circuit structure in this current mirror patent and comment on what characteristics the inventors claim make it unique and useful.

Problem 3 A simple circuit is shown. Use this simple circuit as a quarter-circuit to build a differential input/differential output operational amplifier. Determine the dc gain and the GB of the op amp if the load capacitance on each output is 10pF.
Problem 4 (extra credit)  Repeat Problem 3 with the following circuit.

Problem 5  Determine the slew rate of the telescopic cascode amplifier shown below.
Problem 6   If the amplifier in Problem 5 is designed so that the excess bias of all transistors is 0.4V with $V_{DD}=2.5V$, and $V_{SS}=-2.5V$ and the power dissipation is 25uW,
   a) Determine the ac voltage gain
   b) Determine all of the natural design parameters for this amplifier
   c) Determine the GB if $C_L=2pF$
   d) Determine the SR if $C_L=2pF$

Problem 7   Consider an amplifier with two inputs $V_{IN1}$ and $V_{IN2}$.  If $V_{IN1}=.01\sin1000t$ and $V_{IN2}= -0.0101\sin1000t$, the output was $5\sin1000t$.  When the inputs were $V_{IN1}=0.01\sin1000t$ and $V_{IN2}= -.0102\sin1000t$ the output was $4\sin1000t$.
Determine
   a) The common-mode and difference-mode inputs for the first set of inputs
   b) Determine the common-mode gain, $A_C$, and the difference mode gain, $A_D$
   c) Determine the CMRR  ($CMRR=A_D/A_C$)

Problem 8   Determine the two-port equivalent for the following circuit.  Assume $Q_1$ and $M_1$ are operating in the forward active and saturation regions respectively.

Problem 9   3.3 and 3.5 of Martin and Johns
Problem 10  3.6 and 3.12 of Martin and Johns
Problem 11  4.10 and 4.12 of Martin and Johns
Problem 12  4.14 and 4.22 of Martin and Johns