# VC-3

# August 2015 QE



1. [25 points] In the circuit below, find the transfer function $H(s) = v_{out}/v_{in}$, and plot $|H(s)|$ vs. $\omega$. In the plot, mark the value of $|H(s)|$ when $\omega = 1/(RC)$.
   Assume:
   - The op-amp is ideal.
   - R1 = R2 = R
   - C1 = C2 = C

2. [25 points] In the circuit below, find the small signal output voltage $v_{out}$.

   Assume:
   - The op-amp is ideal.
   - The DC current source $I_{Bias}$ is ideal.
   - The DC voltage sources $V_{Bias1}$ and $V_{Bias2}$ are ideal.
   - M1 is biased in saturation region.
   - The output resistance of M1, $r_o = 100k\Omega$
   - The transconductance of M1, $g_m$ = 20 mA/V.
   - M1 has no parasitic capacitance (Cgs = Cgd = Csb = Cdb = 0).

3. [25 points] In the circuit below, find the input impedance $Z_{in}$ seen by the voltage signal source $v_{in}$.

   Assume:
   - The current source $I_{Bias}$ is ideal.
   - M1 is biased in saturation region.
   - M1 has no parasitic capacitance (Cgs = Cgd = Csb = Cdb = 0).
   - The output resistance of M1, $r_0 = \infty$.

4. [25 points] In the circuit below, find the small signal output voltage $v_{out+}$.
   Assume:
   - The circuit is fully symmetric
   - M1 and M2 are biased in saturation region.
   - The current source is ideal.
   - M1 and M2 have no parasitic capacitance (Cgs = Cgd = Csb = Cdb = 0).
   - For both M1 and M2, $r_0 = \infty$.
   - For both M1 and M2, the transconductance gm = 30mA/V.
   - R1 = 1 kΩ
   - R2 = 2 kΩ
   - C1 = 10 pF