1. For the circuit shown below, find:

   A. [13 points] its small signal transfer function \( H(j\omega) = \frac{v_{out}}{v_{in}} \),

   B. [12 points] and plot \(|H(j\omega)|\) as a function of frequencies. Sketch just a rough shape of the curve, and clearly mark the value of \(|H(j\omega)|\) when \( \omega = \frac{1}{\sqrt{LC}} \). For \(|H(j\omega)|\), use [V/V] as its unit, not dB.

   For both parts A and B, assume the OP-Amp is ideal.
2. [25 points] For the circuit shown below, find its low-frequency small-signal output voltage \( V_{out} \) as a function of input current \( i_{in} \). [Note: The input is a small-signal current, not voltage.]

Assume:
- All transistors are biased in saturation.
- No parasitic capacitance exists.
- All bias current and voltage sources are ideal.
- \( r_{o1} = r_{o2} = r_{o3} = r_{o4} = r_{o5} = \infty \)
- \( g_{m1} = g_{m2} = g_{m3} = g_{m4} = g_{m5} = g_m \)
- \( R_1 = R_2 = R_4 = \frac{1}{g_m} \)

(M1, M2, M3, M4 and M5 are n-channel MOSFETs.)
3. For the circuit shown below, assume:
   - All transistors are biased in saturation.
   - No parasitic capacitance exists.
   - \( r_{o1} = r_{o2} = \infty \)
   - \( r_{g} \neq \infty \)
   - \( g_{m1} = g_{m2} = g_m \)
   - \( I_{bias} \) is ideal.

(M1 and M2 are n-channel MOSFETs.)

[13 points] Find the small-signal voltage \( v_{p1} \) when a common mode small signal \( v_c \) is applied.
[12 points] Now a differential small-signal input $v_{in}$ is applied to the same circuit. Find $v_{p2}$.
4. [25 points] For the circuit shown below, find $H(j\omega) = \frac{V_{\text{out}}}{V_{\text{in}}}$.

**Use one pole per one node approach.**
**Don’t find zero(s).**

Assume:
- All transistors are biased in saturation.
- All bias current and voltage sources are ideal.
- $r_{o1} = r_{o2} = \infty$
- $g_{m1} = g_{m2} = g_{m}$
- $R_1 = R_2 = R$
- $C_1 = C_2 = C_L$

For M1 and M2, use the small signal model shown below ($C_{g1} = C_{g2} = C_{g}$):

![Circuit Diagram](Image URI)