Problem 1  Common-drain stage. The PMOS FET has
\[ K_\mu = 0.55 mA/V^2 \cdot (W_g / 1 \mu m), \]
\[ K_V = 0.69 mA/V \cdot (W_g / 1 \mu m) \]
\[ \Delta V = 0.625 V \]
and \( 1/\lambda = 10 \) Volts

The supplies are +/-3V. \(|V_{th}| = 0.25V\)

Choose the gate width and Rs so that the transistor carries 1 mA and has 0.5 V on the source electrode. The load resistance is 10 kOhm, Rg is 1 MOhm, Rgen is 100 kOhm.

Find the bias conditions, the small-signal gains \( V_{out}/V_{in}, V_{out}/V_{gen}, \) and \( V_{out}/V_{in} \), and find the input and output impedances.

Problem 2 The circuit above uses 2n3904 bjts. -- use datasheet values for beta and Re. For DC bias, \( V_{in}^+ \) and \( V_{in}^- \) are zero volts. \( V_{cc} = +7.5 \) V, \( V_{ee} = -7.5 \) V. The DC emitter currents are each 1 mA, and the DC collector voltages are 5 V.
\( R_{b1} = R_{b2} = 10 \) kOhm. RL1,2 are 10 kOhm. Find all resistor values. Find the bias conditions, the differential input impedance, the differential gain, and the common-mode rejection ratio.

Problem 3 The circuit now uses a constant current source to bias the differential amplifier. For Q1 and Q2 the DC collector voltages and DC collector currents remain the same as in problem 2. There is a 0.15 V IR drop across Ree3, while the DC current in Rb3a is 1/10th of the emitter current of Q3. Find all resistor values. Find the bias conditions, the differential and common-mode gains, and the common-mode rejection ratio. The diode has the same "on" voltage as the transistors.
Problem 4 The NMOSFETs have \( v_{th} = 0.2 \) Volt
\[ K_\mu = 10\text{mA/V}^2 \cdot (W_g / 1\mu\text{m}) \]
\[ K_v = 2.0\text{mA/V} \cdot (W_g / 1\mu\text{m}) \]
\[ \Delta V = 100\text{mV}, \ 1/\lambda = 5 \text{ Volts} \]
The supplies are + and - 1.0 Volts. Q3 and Q4 are to carry 0.2 mA drain current at \( V_{gs} = 0.3 \) V. Q1 and Q2 are to operate at \( V_{gs} = 0.3 \) V. The drain voltages are to be 0.5 Volts The load resistances (\( R_{L1}, R_{L2} \)) are 100 kOhm. Find all resistor values. Find the bias conditions, FET widths, the differential and common-mode gains, and the common-mode rejection ratio.

Problem #5. Nodal Analysis exercise. This is a "super-buffer". Ignore DC bias analysis. You don’t need it. The two transistors have transconductance \( gm1 \) and \( gm2 \) respectively. Their drain-source resistances \( R_{ds1} \) and \( R_{ds2} \) are both infinity.

a) Compute \( V_{out}/V_{in} \) by nodal analysis.

b) find numerical values of \( V_{out}/V_{in} \) given \( gm1 = 10 \text{ mS}, \ gm2 = 100 \text{ mS}, \ R1 = 10\text{kOhm}, \ R2 = 1\text{kOhms}. \)