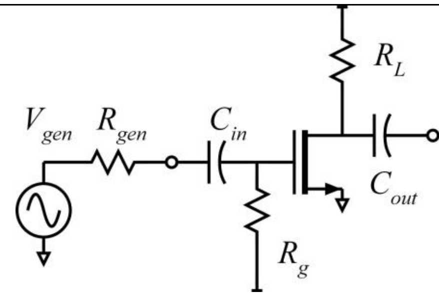
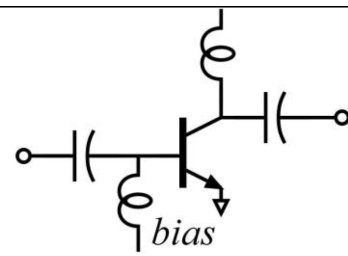
ECE 145b problem set (noise)

Problem 1: Microphone preamplifier. The microphone generates 1 mV, RMS, from a voice signal which is uniformly distributed in frequency over 400 Hz-4 kHz. Rgen=600 Ohms, Rg=100 MOhm (treat as infinite), RL=10 kOhm. The FET has zero parasitic capacitances, infinite Rds, and zero parasitic resistances Rg, Rs, Rd, and Ri. The blocking capacitors are infinite. The FET channel noise parameter is Gamma=1.0, and gm=5 mS. (a) Find the total input referred noise voltage and (b) find the system signal/noise ratio over the 400 Hz-4 kHz bandwidth.

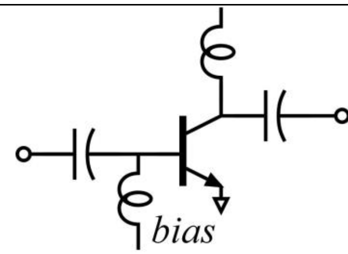


Problem 2: The bipolar Transistor has beta=200 and Rbb=50 Ohms. All other parasitic elements are zero. It is biased at 1mA collector current. The L's and C's shown here are bias T elements, and are infinite. Find (a) the spectral densities of the input referred noise voltage and current generators En and In, and their cross spectral density, (b) The total amplifier input noise voltage given a 500 Ohm generator (c) the noise figure given a 500 Ohm generator and (d) the minimum noise figure and optimum generator impedance.

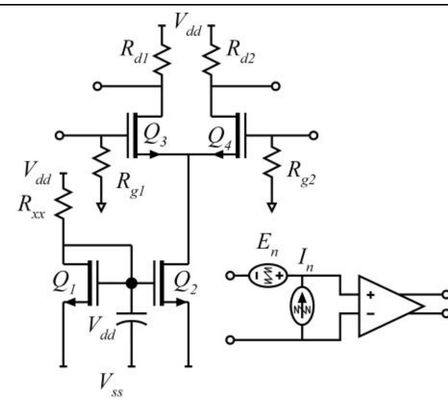


ECE 218B problem set (noise)

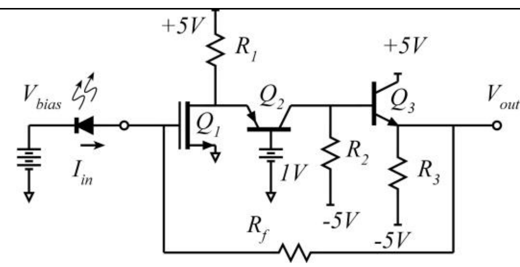
Problem 1: The bipolar Transistor has beta=200 and Rbb=50 Ohms. All other parasitic elements are zero. It is biased at 1mA collector current. The L's and C's shown here are bias T elements, and are infinite. find (a) the spectral densities of the input referred noise voltage and current generators En and In, and their cross spectral density, (b) The total amplifier input noise voltage given a 500 Ohm generator (c) the noise figure given a 500 Ohm generator and (d) the minimum noise figure and optimum generator impedance.



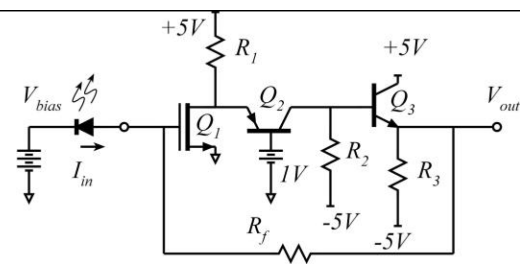
Problem 2: Differential amplifier. The FETs have zero parasitic capacitances, infinite Rds, and zero parasitic resistances Rg, Rs, Rd, and Ri. Assume square-law models for the FETs with $I_d = K_1 \cdot (V_{gs} - V_{th})$, with $K_1 = (1\text{mA/V}^2)$, with a 0.3 V threshold. Assume power supplies of +/- 2 Volts, and Rg1=Rg2=1 MegOhm. Q3 and Q4 are to be biased with 200 microamps drain current, and the DC voltage drops across Rd1 and Rd2 are each 0.5 Volts. The current mirror bypass capacitor is infinite. (a) Find all component values and DC bias voltages and currents. (b) find the small signal differential voltage gain. (c) Assuming a FET channel noise parameter $\Gamma = 0.75$, find the spectral densities of E_n and I_N . (d) If the generator impedances for V+ and V-, the two input signal generators, are each 10 kOhm, find the total input-referred noise voltage spectral density, and the RMS noise voltage in a DC-1MHz bandwidth. (e) Find the noise spectral density of the drain current of Q2



Problem 4: This is a transimpedance optical preamp. Vout is at zero volts. Q2 and Q3 have infinite beta. Q1-3 have zero parasitic resistances and capacitances. Q3 is biased at 10 mA, Q2 at 5 mA, Q1 at 5 mA; this will allow you to find the resistor values. Q1 has 20 mS transconductance and Gamma=1. Rf is 10kOhm. Find the input-referred noise current.



Problem 5: With the same parameters as problem 4, now *ignore the noise sources of R1, R2, R3, Q2, and Q3, so that you are only considering the noise of Q1 and Rf.* The FET has infinite Rds, and zero parasitic resistances Rg, Rs, Rd, and Ri. The FET has Cgd=Cds= 0fF, however Cgs is nonzero and is determined from $f_\tau = g_m/2\pi C_{gs}$=100 GHz. Find the input-referred noise current spectral density



as a function of frequency. This is a classic optical receiver sensitivity calculation.