EE6320 RF Integrated Circuits Homework 1

1. Fig. 1 below shows the low-frequency model of a *bipolar* transistor. The base resistance and its associated noise are represented by r_b and $v^2_{n,b}$ respectively. The base-emitter and base-collector junctions have "*shot noise*" associated with them. {Note: the power spectral density of shot noise in a *p-n* junction is *white* in nature, and is proportional to the DC current through the junction.} The base and collector mean-square noise currents are given by

$$i^2_{n,b} = 2qI_B\Delta f \quad \text{and}$$

$$i^2_{n,c} = 2qI_C\Delta f$$

respectively, where q is the electronic charge. Assume that all noise sources are uncorrelated, and that the source resistance is R_s. Ignore all flicker noise sources. Derive an expression for the (low-frequency) noise figure. {Hint: in this case, it may be easier to use the fundamental definition of noise figure instead of working with a two-port model; also recall that $\beta = g_m r_\pi$}

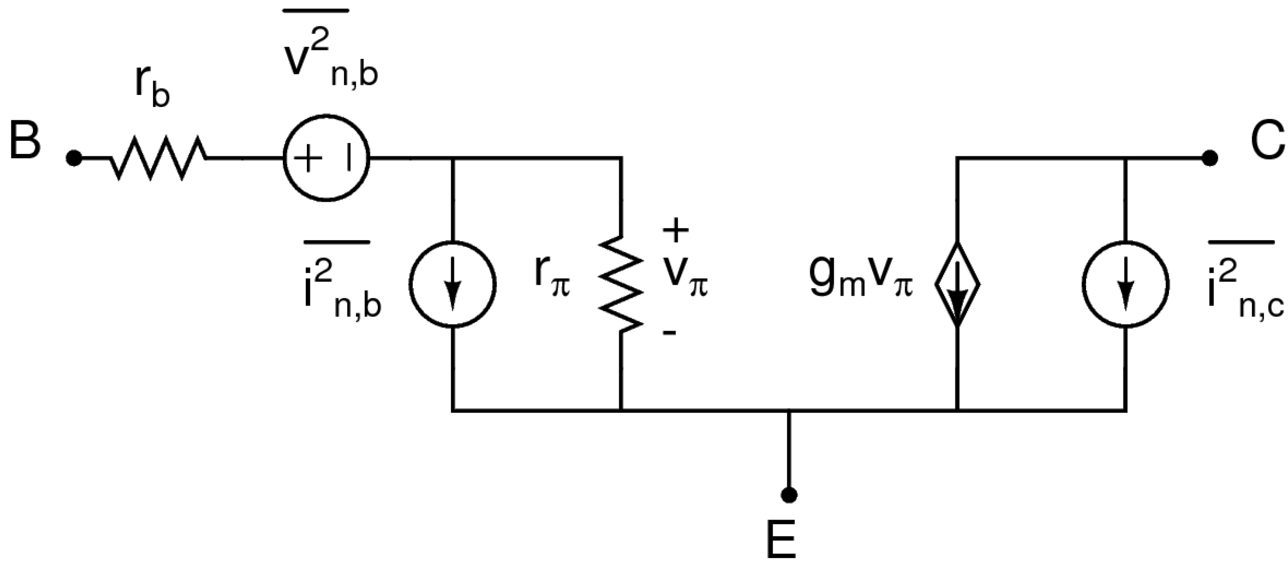

Figure 1

For the following problems, neglect device parasitics and consider only drain thermal noise. Some bias details are not shown.

2. Calculate the noise figure of the circuit shown in fig. 2 with respect to the source resistance R_S. Assume R_F is very large.

3. Calculate the noise figure of the circuit of fig. 3 with respect to the source resistance R_S.

4. Calculate the noise figure of the circuit of fig. 4 with respect to the source resistance R_S.

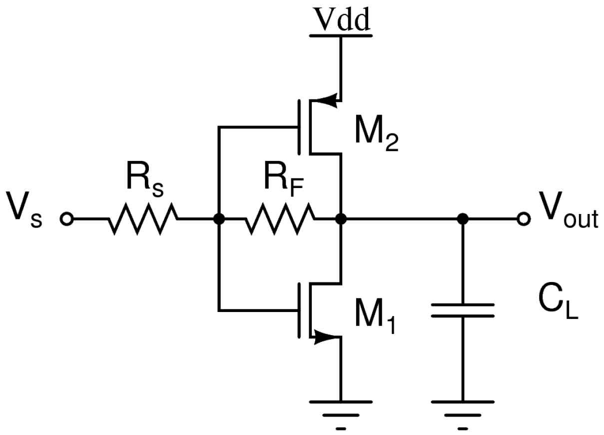

Figure 2

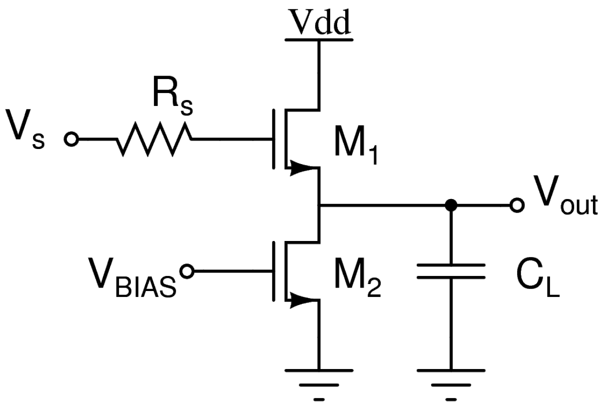

Figure 3

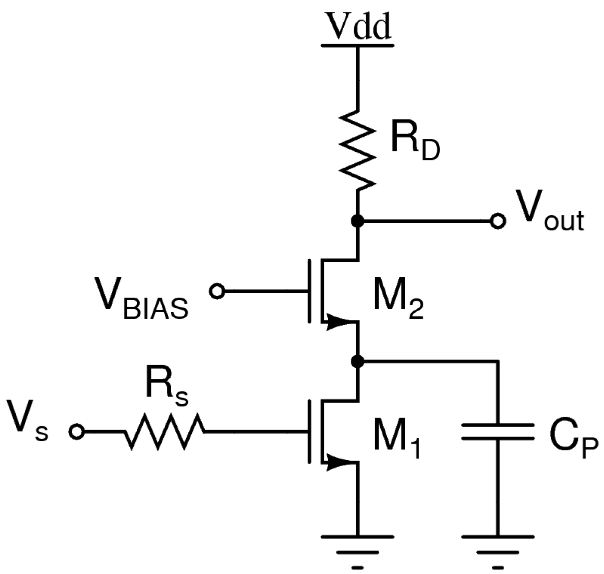

Figure 4