
![Circuit Diagrams](Image)

**Problem 4.2:** For this problem, assume an amplifier with harmonic distortion terms up to 3rd order, and all higher order terms may be neglected: $v_{out} = \alpha_1 v_{in} + \alpha_2 v_{in}^2 + \alpha_3 v_{in}^3$. The gain of the amplifier is 10dB, and HD_3 is -40dB, measured at an input level of -15dBm in a 50Ω environment.

a) Estimate IM_3 of the amplifier at an input power level of -15dBm.

b) Assuming the input power was measured in a 50Ω environment; find the values of $\alpha_1$ and $\alpha_3$ for the amplifier.

c) Sketch a generic plot of the 3rd-order intercept point. Calculate the values of IIP3 and OIP3.
**Problem 4.3:** For this problem, assume an amplifier with harmonic distortion terms up to 3rd order, and all higher order terms may be neglected: \( v_{out} = \alpha_1 v_{in} + \alpha_2 v_{in}^2 + \alpha_3 v_{in}^3 \). The gain of the amplifier is 10dB, and HD2 is -20dB, measured at an input level of -20dBm in a 50\( \Omega \) environment.

a) Calculate the DC offset in Volts at the output due to the 2nd-order harmonic distortion in the amplifier at an input level of -20dBm.

b) What input level in dBm is required to reduce the DC offset at the output to 1mV.

**Problem 4.4:** You are given that an amplifier has a measured HD2, HD3, and HD4 of -30dB, -40dB, and -50dB, respectively. Assuming there are no other significant harmonics, calculate the THD in percent.

**Problem 4.5:** Use the circuit on the right for this problem. Consider only thermal noise in \( R_s \), drain thermal noise in the FET, and correlated gate noise in the FET. You may neglect body effect and channel length modulation. Include \( C_{GS} \), but ignore all other caps.

a) Find expressions for the input referred short-circuit noise voltage and open-circuit noise current of the amplifier (not including \( Y_S \)).

b) Find expressions for \( B_{S, opt} \) and \( G_{S, opt} \) \( (Y_S = G_{S, opt} + B_{S, opt}) \) that results in minimum noise factor. Your answer should be in terms of the intrinsic noise sources, and should be simplified. You may assume correlation coefficient \( c \) is imaginary and negative as we did in lecture.

c) Find an expression for the noise factor when \( Y_S = 1/50\Omega \). Your answer should be in terms of the intrinsic noise sources, and should be simplified.