Low-power radio design for the IoT
Exercise 3 (18.03.2021)

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Problem 1 Nonlinearity and Time Variance

A list of input-output equations for several systems are given below. The instantaneous input is $x(t)$ and the instantaneous output is $y(t)$.

a) $2y(t) = 5x(t) + 7$

b) $2y(t) = 5x^2(t) + x(t)$

c) $2t\,y(t) = 5x(t) + 7$

d) $\frac{dy(t)}{dt} + 2y(t) = 3x(t)$

e) $\frac{d^2y(t)}{dt^2} + 3y(t)\frac{dy(t)}{dt} = 5x(t)$

- Classify each system as time invariant or time variant, linear or nonlinear and with memory or memoryless.

Problem 2 Third-Order Input Intercept Point

Consider the scenario shown in Fig. 1, where $\omega_3 - \omega_2 = \omega_2 - \omega_1$ and the band-pass filter (BPF) provides an attenuation of 17 dB at ω_2 and 37 dB at ω_3.

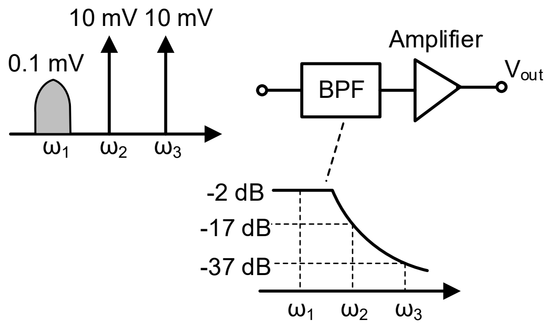

Figure 1: Cascade of BPF and amplifier.

- Compute the A_{IIP3} of the amplifier such that the intermodulation product falling at ω_1 is 20 dB below the desired signal.
- Suppose an amplifier with a voltage gain of 10 dB and $A_{IIP3} = 3.979$ dBm precedes the band-pass filter. Calculate the A_{IIP3} of the overall chain (neglect the second order nonlinearities and the nonlinearity of the BPF).

Problem 3 Cascade of Nonlinear Stages

The circuit in Fig. 2 is a cascade of two identical common-source stages loaded by a resistor, R_D.

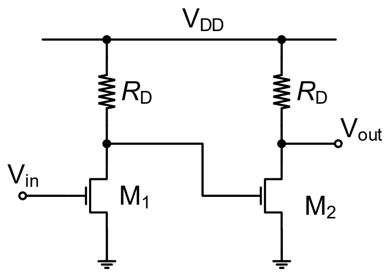

Figure 2: Cascade of common source stages.

- Assume that each transistor operates in saturation and SI and determine the A_{IIP3} of the cascade.