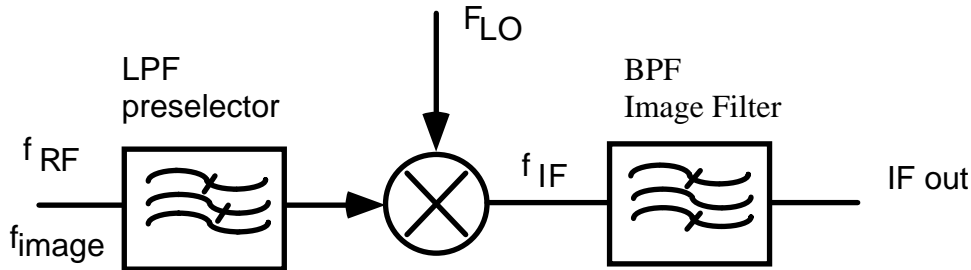
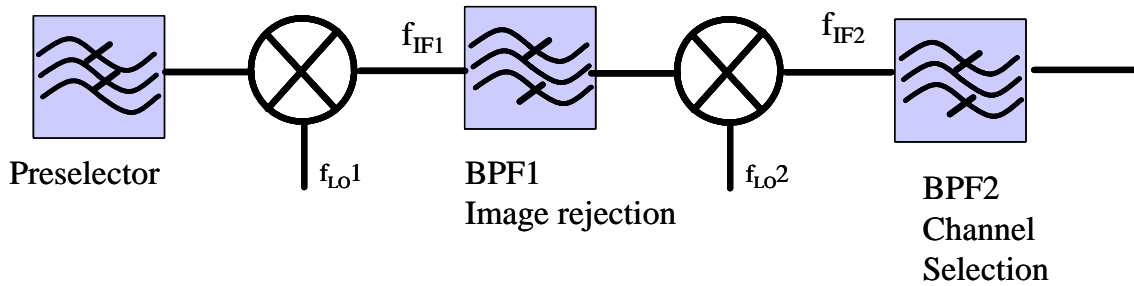


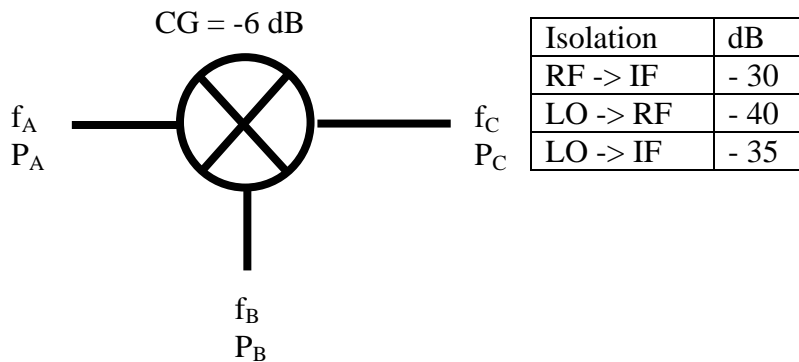
1. Consider the receiver front end below. You are to determine  $f_{IF}$  and  $f_{LO}$  such that the image rejection for the FM broadcast band will be at least 30 dB. The minimum RF frequency is 88 MHz and maximum is 108 MHz. The preselector low pass filter has a cutoff frequency of 108 MHz and has a 40 dB/decade slope after cutoff.



b. Now add a second mixer with a 10.7 MHz channel selection IF filter at the output. Specify the Image Filter (BPF1) bandwidth needed to suppress the image at the output of mixer 1 by 30 dB. Assume BPF1 has a 3 to 60 dB bandwidth ratio of 5. Also specify  $f_{LO2}$ .



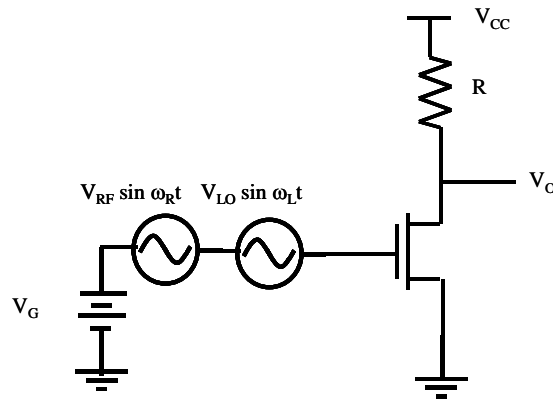
2.



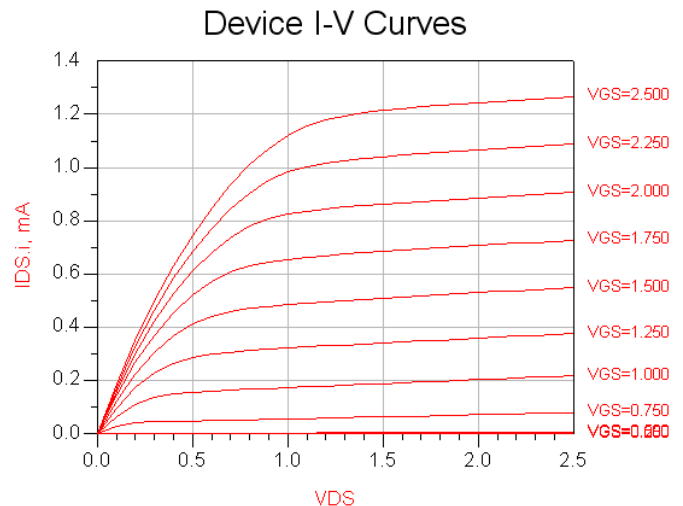
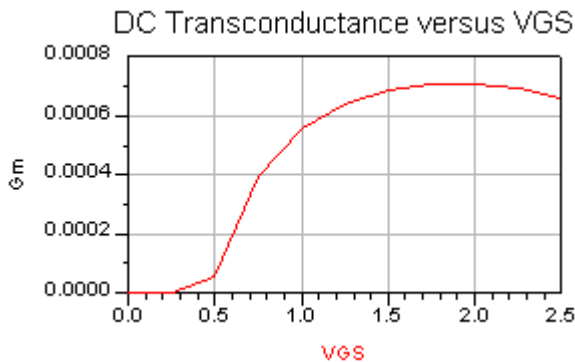
a. Let  $f_A = 90$  MHz and  $f_B = 200$  MHz. What frequencies will be found at  $f_C$  (up to fourth order)? Assume the mixer operates as an ideal LO switch.

- b. If  $P_A = -20$  dBm and  $P_B = 0$  dBm, calculate the power that would be observed at port C for each of the first and second order frequencies.
- c. Suppose  $f_C = 400$  MHz for the above mixer with  $f_A = 100$  MHz and  $f_B = 300$  MHz. Determine the image frequency at port A.
- d. The mixer  $IIP3 = 0$  dBm. Determine the input power (port A) required to produce a 3<sup>rd</sup> order carrier-to-IMD ratio of 60 dBc at port C.

3. A MOSFET whose I-V characteristic is shown below is used as a mixer. Assume that  $V_{LO}$  is NOT large enough to cause the FET to behave as a switch. Thus, this is an old-fashioned nonlinear mixer.



- a. The  $g_m$  vs.  $V_{GS}$  characteristic was measured at  $V_{DS} = 1.25$  V. In this type of mixer, the LO and RF signal must be multiplied through a nonlinearity. Thus, choose  $V_{GS}$  so the  $g_m$  is signal dependent. Determine required values for  $V_G$  and  $R$  to bias the transistor properly.  $V_{CC} = 3.3$  V.



- b. Fit an equation to the  $g_m$  region you have selected, then use that to predict the conversion gain of the mixer. Also identify any additional DC, first and second order mixing products.