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EE334 Homework PS9

Problems from Supplement (Beige Book):

- 4.1, 4.3 (assume LO tuned to **"higher"** not "lower" frequency as stated in problem), 4.5

Additional Problems (Instructor Option):

- Any as assigned by instructor

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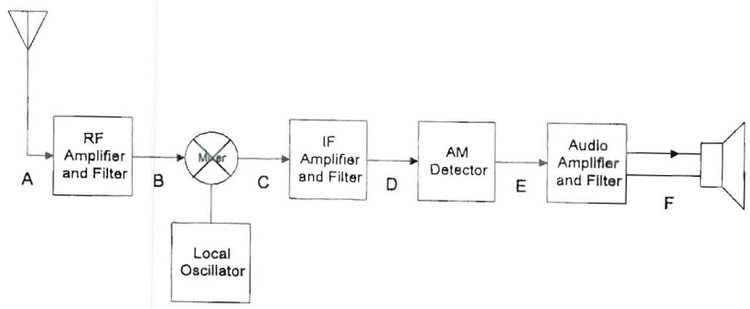
Problem 4.1

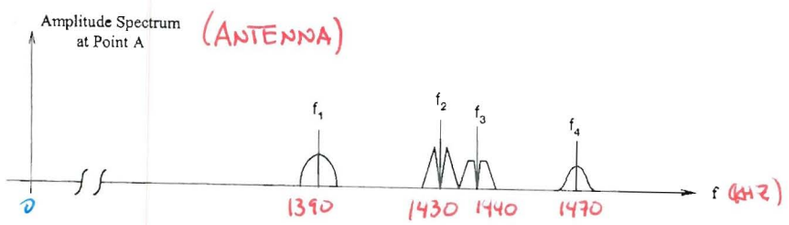
A commercial AM tuner which is tuned to one of the stations shown in the amplitude spectrum below has the following characteristics:

Current Frequency of Local Oscillator, f_{LO}	1885 KHz
RF Amplifier Bandwidth	500 KHz
Intermediate Frequency, f_{IF}	455 KHz
Bandwidth of IF Amplifier, BW_{IF}	10 KHz

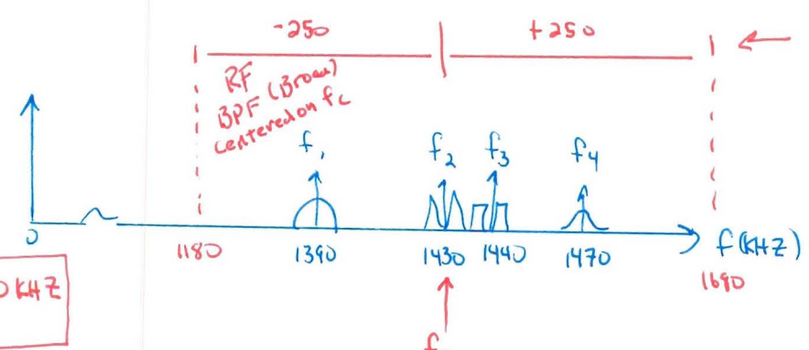
A spectrum analyzer is to be connected at several test points of a superheterodyne radio receiver, the block diagram of which is shown below. Key characteristics of the receiver settings are listed in the table above. The carrier frequencies in the amplitude spectrum are: $f_1 = 1390$ kHz, $f_2 = 1430$ kHz, $f_3 = 1440$ KHz and $f_4 = 1470$ KHz. Determine and plot the expected spectrum display at points B, C, D, and E, given the spectrum as shown at point A. Include both sum and difference generated spectra at point C.



A:



B:

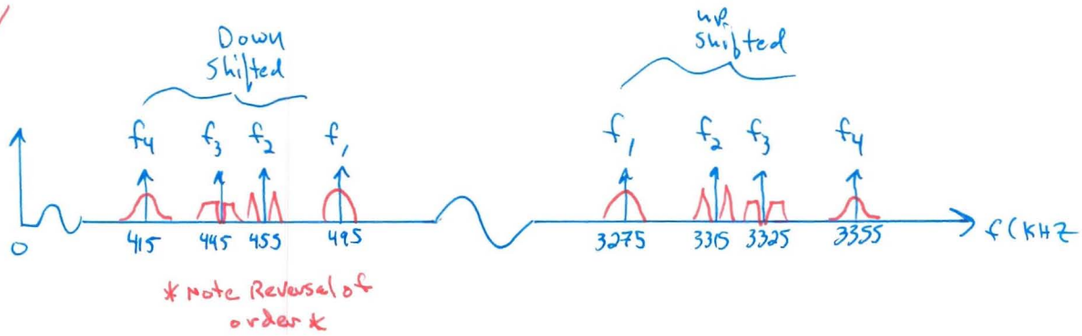


• (4.1) $f_C = f_{LO} - f_{IF} = 1430$ KHz

Next

4.1 Cont.

C:



* Note Reversal of order k

Down Shifted

$f_{LO} - f_1 = 495$ KHz

$f_{LO} - f_2 = 455$ KHz ← f_{IF}

$f_{LO} - f_3 = 445$ KHz

$f_{LO} - f_4 = 415$ KHz

Up Shifted

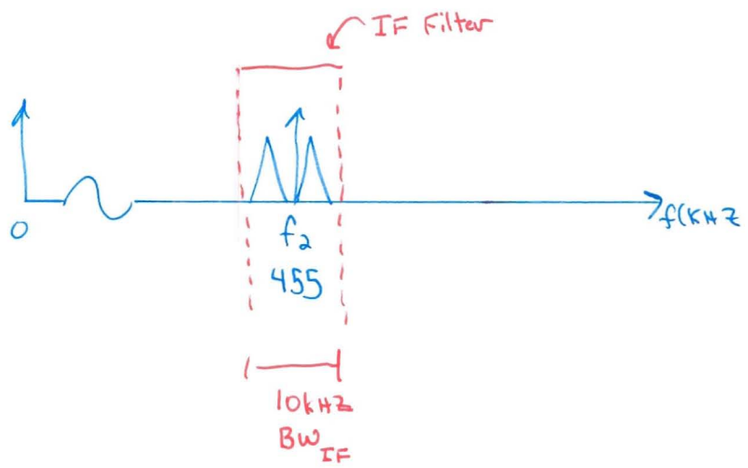
$f_{LO} + f_1 = 3275$ KHz

$f_{LO} + f_2 = 3315$ KHz

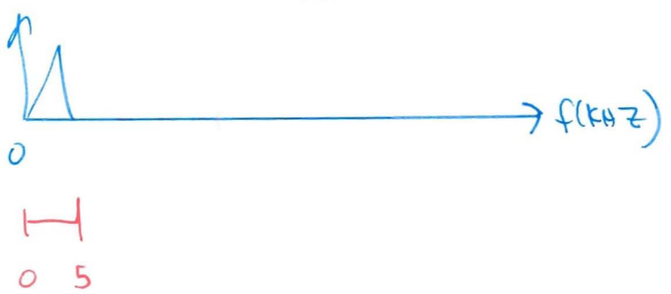
$f_{LO} + f_3 = 3325$ KHz

$f_{LO} + f_4 = 3355$ KHz

D:



E:



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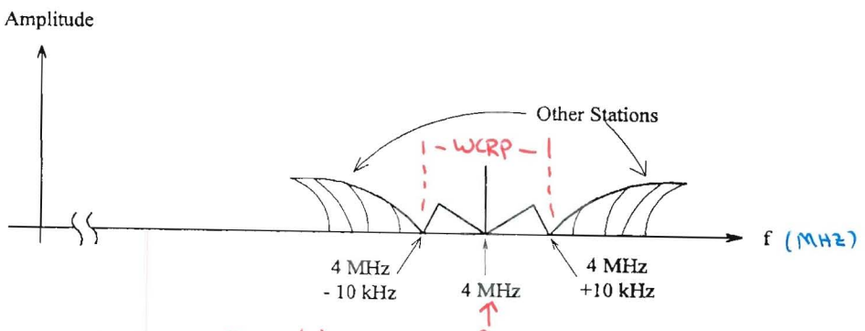
Problem 4.3

The spectrum of WCRP is shown below. We wish to receive and demodulate this station with a superheterodyne receiver. The IF filter is centered at 700 KHz and the LO is tuned to a ~~lower~~ Higher frequency than the RF carrier (Note, this is not the typical commercial AM system). (up-conversion)

(a) To what frequency must the LO be tuned to receive WCRP?

(b) What is the value of the upper corner frequency of the IF filter such that the band width is just enough to include the full RF bandwidth of WCRP but no more?

(c) What is the value of the image frequency and how can this potential interference be rejected?

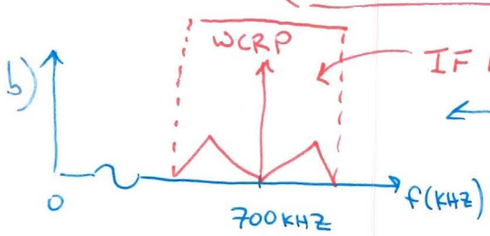


* Note- use up conversion for problem *

a) (4.1) $f_{LO} - f_c = f_{IF}$

$f_{LO} = 700\,kHz + 4\,MHz = 4.7\,MHz$

b)



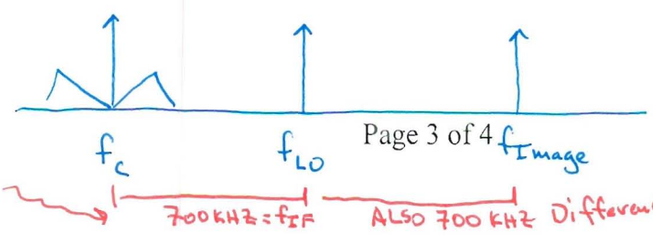
"WCRP was shifted" or "Heterodyned" from 4MHz Down to 700KHz so that it fit in the IF Filter

10KHz 10KHz

$f_{corner} = 710\,kHz$ (upper)

c) $f_{Image} = f_{LO} + f_{IF} = 4.7MHz + 700\,kHz = 5.4\,MHz$

(Pg.32) Bottom



Down Shift f_c into TR window $\rightarrow f_{LO} - f_c$

700KHz = fIF

ALSO 700 KHz Difference

Eliminated upfront w/ RF BPF (Broad)

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Problem 4.5
Calculate the image frequency when a commercial DSB-LC AM receiver is tuned to a 540 KHz carrier. Is this image in the AM band?

(4.1) • $f_{LO} = f_{IF} + f_c$

$= 455\text{KHz} + 540\text{KHz}$

$f_{LO} = 995\text{ KHz}$

$f_{Image} = \underset{(f_{LO})}{995\text{KHz}} + \underset{(f_{IF})}{455\text{KHz}} = 1450\text{KHz}$

* Note - Not f_{IF} *

• Yes, Image is in AM Band
But it is Eliminated by the
Broad BPF in RF Section

Notes

$\cos A \cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$

Difference = 455 KHz ← gets through IF Filter Centered at 455 KHz

So, Both 540 KHz & 1450 KHz give a Difference of 455 KHz

RF BPF up front Eliminates