Introduction to Communication Systems
Columbia University
ELEN E3701
Spring Semester- 2008

Problem Set # 5

Problems Due: 4 March 2008

Problem #1
Problem- 2.44, Haykin's Book

Problem #2
The following FM signal is transmitted.

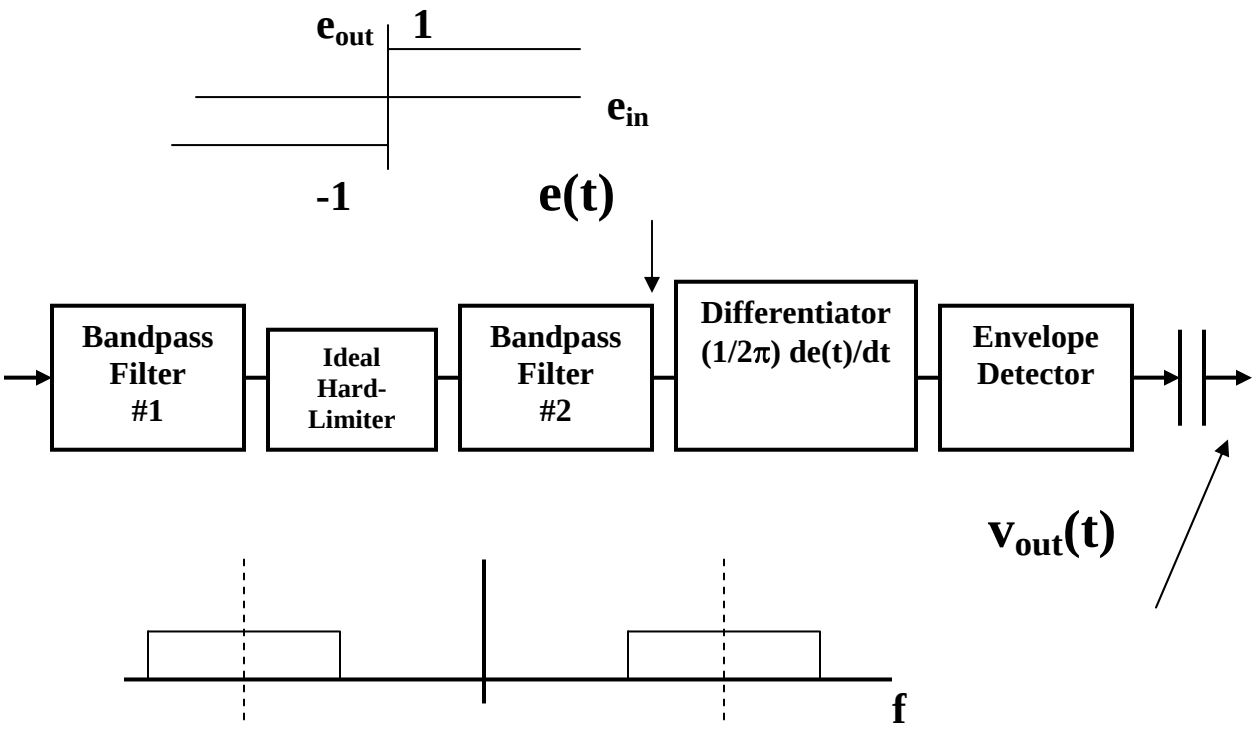
$$x_{FM}(t)= A \cos \{2\pi f_0 t+2\pi h \int_{-\infty}^{t} s(\tau)\, d\tau\}$$

with s(t) equal to $A_m \cos 2\pi Wt$.

a. **Write down the equation for the $x_{FM}(t)$ after integrating s(t).**
b. **What is the maximum frequency deviation, Δf, in terms of h and A_m?**
c. **We now use an FM detector, as described in class, and shown on the next page.**

What is the output signal, $v_{out}(t)$ of the FM detector?

FM Detector



Carson Bandwidth = 2 Δf + 2W

The filter bandwidths of both Filters 1 and 2 are equal to the Carson bandwidth of the FM signal.

d. Suppose that we are still using the same FM detector shown above, but the input signal is now an AM signal, $x_{AM}(t)$ given by the equation below

$$x_{AM}(t)= A[1+ms(t)] \cos 2\pi f_0 t$$

$$\text{with } 0 < m < 1$$

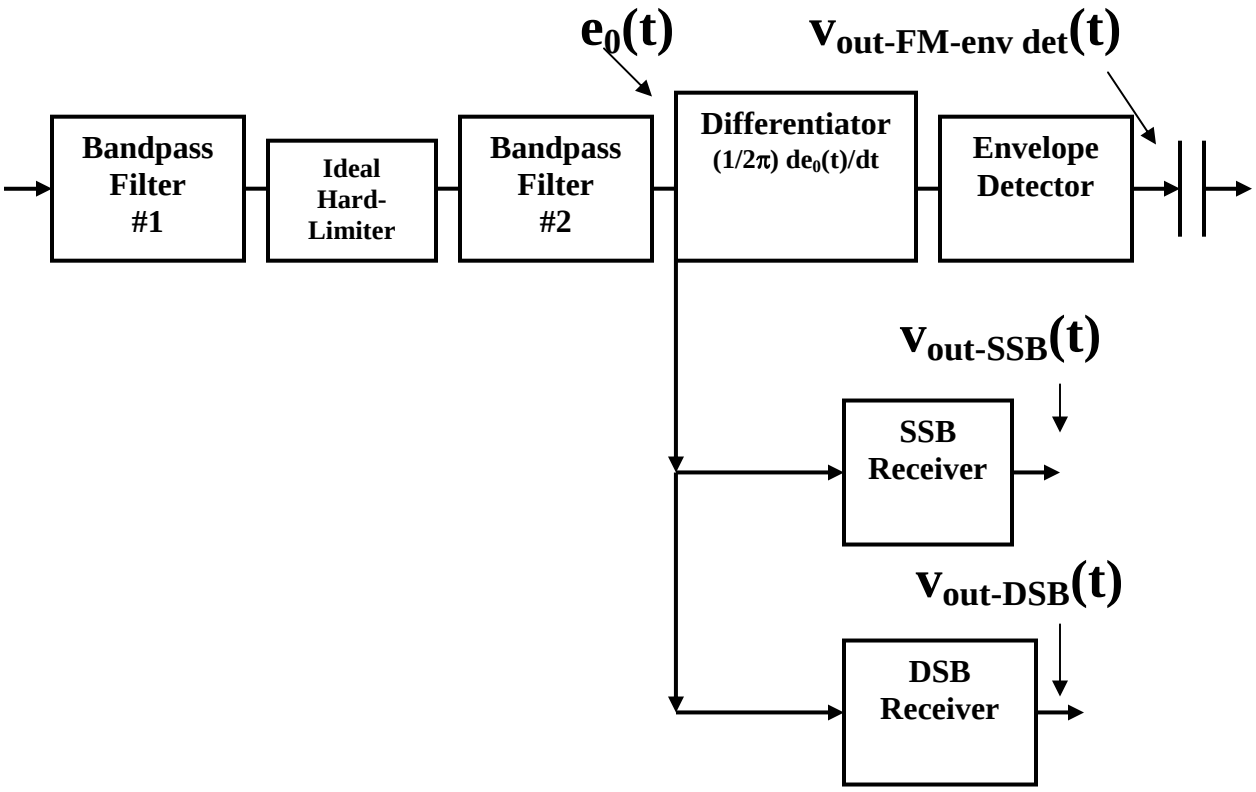
$$\text{and}$$

$$s(t)= B \cos 2\pi W t.$$

Find the output signal of the FM receiver if $x_{AM}(t)$ is the input signal.

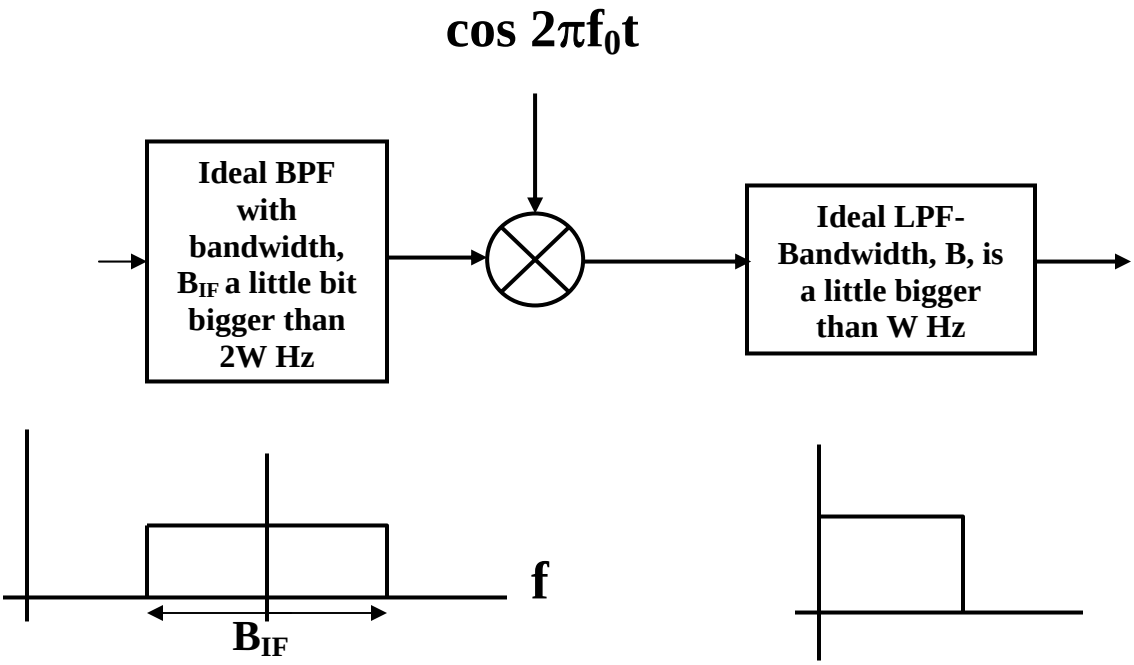
Assume that $f_0 >>>> W$.

e. Suppose we now add on the following two branches, shown below, to our FM receiver.



What will be the outputs $v_{out\text{-}SSB}(t)$ and $v_{out\text{-}DSB}(t)$, if the input signals are the FM (with β=2.2) signal and AM signal of the previous parts?

DSB Receiver



SSB Receiver