ELEN E3701 - Spring 2007
Solution to Midterm Exam -

Problem #1

a) $x_{FM}(t) = A\cos(2\pi F_o t + \beta \sin 2\pi W t$

b) $\Delta F = h A_m$ ← constant

c) $V_{out}(t) = k \Delta F \cos 2\pi W t$

d) If $\beta = 3.9$, $J_1(\beta) = J_{-1}(\beta) = 0$

There is only an unmodulated carrier which makes it through Filter #2 - So - Output $= 0$

(Unmodulated carrier $= k J_0(\beta) \cos 2\pi F_o t$)

e) $V_{out-AM}(t) = 0$, the capacitor "gets rid" of DC term

& $V_{out-PSB}(t) \Rightarrow k J_0(\beta)/2$ (DC)

We have

$k J_0(\beta) \cos 2\pi F_o t \cdot \cos 2\pi F_o t$

$\Rightarrow$ after LPF $\Rightarrow k J_0(\beta)/2$

Problem #2

$$s_{FM}(t) = A\cos\Big(\overbrace{2\pi F_0 t + 2\pi h\int_{-\infty}^{t} s(\tau)\,d\tau}^{\phi(t)}\Big)$$

$$= A\,\frac{e^{j\phi(t)} + e^{-j\phi(t)}}{2}$$

All of $e^{j\phi(t)}$ are positive freqs
All of $e^{-j\phi(t)}$ are negative freqs

$$\mathcal{H}\{\hat{s}_{FM}(t)\} = -j\,\mathrm{sgn}\,F\left\{\frac{Ae^{j\phi(t)} + e^{-j\phi(t)}}{2}\right\}$$

$$\Rightarrow A\left[\frac{e^{j(\phi(t)-\pi/2)} + e^{-j(\phi(t)-\pi/2)}}{2}\right]$$

$$\hat{s}_{FM}(t) \Rightarrow A\sin\phi(t)$$

$$\Rightarrow A\sin\left(2\pi F_0 t + 2\pi h\int_{-\infty}^{t} s(\tau)\,d\tau\right)$$

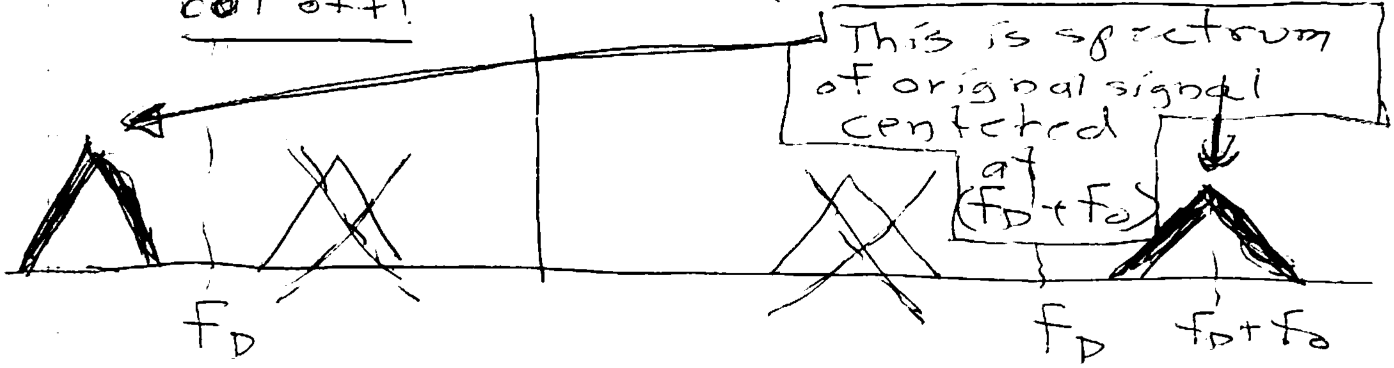
$$X_{USB-SSB}(t) = A\cos\phi(t)\cos 2\pi F_D t - A\sin\phi(t)\sin 2\pi F_D t$$

$$= A\cos\left(\phi(t) + 2\pi F_D t\right)$$

$$X_{USB-SSB}(t) = A\cos\left(2\pi(F_0 + F_D)t + 2\pi h\int_{-\infty}^{t} s(\tau)\,d\tau\right)$$

OR

For an SSB-Signal, the lower sideband of $s_{FM}(t)\cos 2\pi f_D t$ is <u>cut off!</u>



$$x_{USB-SSB}(t) = A\cos\left[2\pi(f_D+f_0)t + 2\pi\int_{-\infty}^{t} s(\tau)\,d\tau\right]$$

After cutting off the lower sideband (LSB), we have the spectrum shown above and described by signal above, $x_{USB-SSB}(t)$