ECE3614: Intro to comm | HW3 | Christopher Mitchell

1) <u>Square law modulator</u>

message $= m(t)$
carrier $= c(t) = A_c \cos(2\pi f_c t)$

input $= m(t) + c(t)$

<u>nonlinear device</u>

input $\rightarrow \boxed{\text{device}} \rightarrow$ output $= T\{\text{input}\}$

$$\text{output} = T\{\text{input}\} = m(t) + c(t) + (m(t) + c(t))^2$$
$$= m(t) + c(t) + m(t)^2 + 2m(t)c(t) + c^2(t)$$
$$= m(t) + A_c\cos(2\pi f_c t) + m(t)^2 + 2m(t)A_c\cos(2\pi f_c t) + \frac{A_c^2}{2}(1 + \cos(4\pi f_c t))$$

<u>Band pass filter</u>

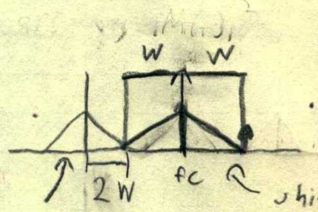
input $= m(t) + c(t) + m(t)^2 + 2c(t)m(t) + c(t)^2$

input $\rightarrow \boxed{\text{BPF}} \rightarrow$ output

$$\text{output} = T\{\text{input}\} = \cancel{m(t)}^{\,0} + c(t) + \cancel{m(t)^2}^{\,0} + 2m(t)c(t) + \cancel{\frac{A_c^2}{2}(1+\cos(4\pi f_c t))}^{\,0}$$
$$= \boxed{(1 + 2m(t))A_c\cos(2\pi f_c t) \;\therefore\; \text{DSB-PC} ✓}$$
$$\boxed{\text{As long as } f_c > 3 \text{ Bandwidth}}$$

Reasoning

Reason:

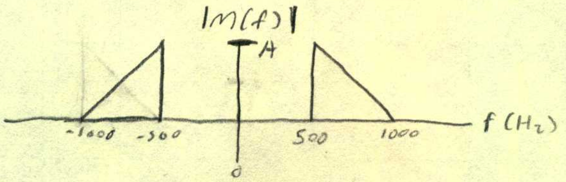


shifted $|m(f)|$

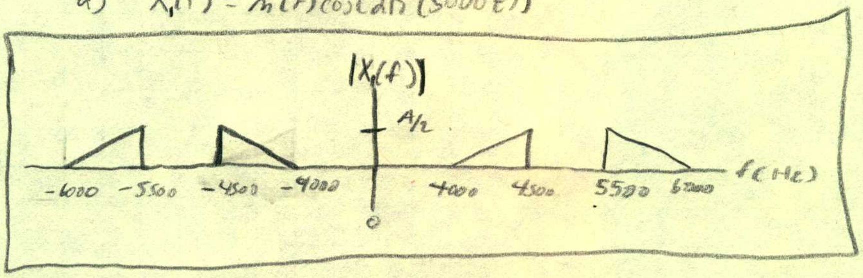
$|m(f) * m(f)| = F\{m(t)^2\}$

$\therefore$ for $m(t)^2$ to not be included, $f_c > 3W$ because when $m(t)$ is squared the bandwidth is doubled. A signal convolved with itself doubles the bandwidth. With this bandwidth requirement, the $c(t)^2$ term will create an impulse far outside the BPF at at least $6W$. The $m(t)$ term has half the bandwidth of $m(t)^2$ and will also be removed by the BPF, leaving only the DSB-PC terms.

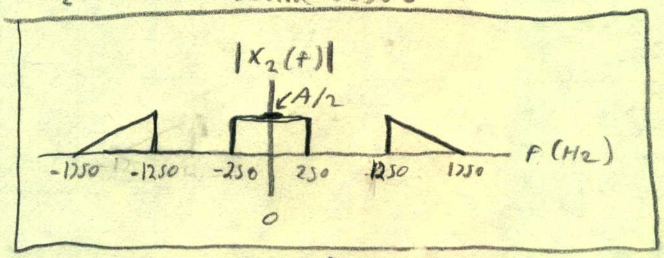
2)



a) $x_1(t) = m(t)\cos(2\pi(5000t))$



b) $x_2(t) = m(t)\cos(2\pi(750)t)$



$W < f_c < 2W$: there is overlap; creating the square wave