AV312 - Lecture 3

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Figures from “Communication Systems” by Simon Haykin

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Announcements

- Class test for 10 mins on Friday 5th
- 5 MCQs + a problem for 10 marks (no negative marking)
- Tested on portions covered till and including today's

Review

- Modulation and demodulation process
- Amplitude modulation and demodulation
  - Remember the first example? $(s(t) = A_c m(t) cos(2\pi f_c t))$
  - Remember AM? $(s(t) = A_c(1 + k_a m(t)) cos(2\pi f_c t))$

Today's plan

- Amplitude modulation and demodulation
  - DSBSC
  - SSB
  - VSB
- Scribes are Al Saj and Pavan Kumar Reddy

Double sideband suppressed carrier (DSBSC)

- $s(t) = A_c m(t) cos(2\pi f_c t)$ vs $s(t) = A_c(1 + k_a m(t)) cos(2\pi f_c t)$
- What are the similarities?
- What are the differences?

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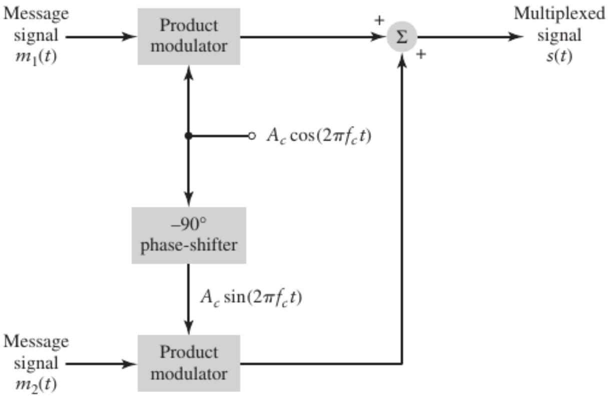
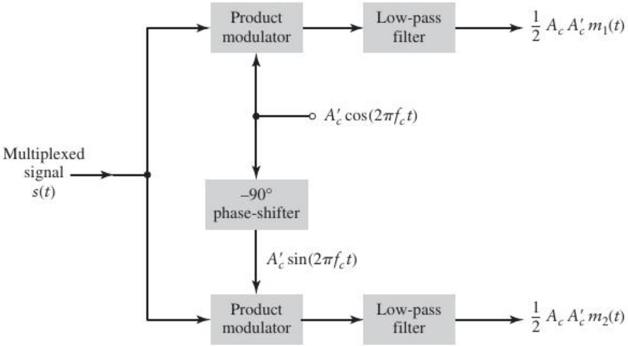
- What are the similarities?
- What are the differences?
  - Carrier - needs carrier recovery
  - Complexity is higher!
- Carrier/phase recovery
  - Pilot tone (separate band)
  - Phase locked loop (PLL)
  - Costas receiver for DSBSC

Quadrature carrier multiplexing



- Bandwidth conservation using two DSBSC signals for $m_1(t)$ and $m_2(t)$

Quadrature carrier multiplexing (Receiver)



Single sideband modulation

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- What is the relationship between $M(f)$ and $M(-f)$?

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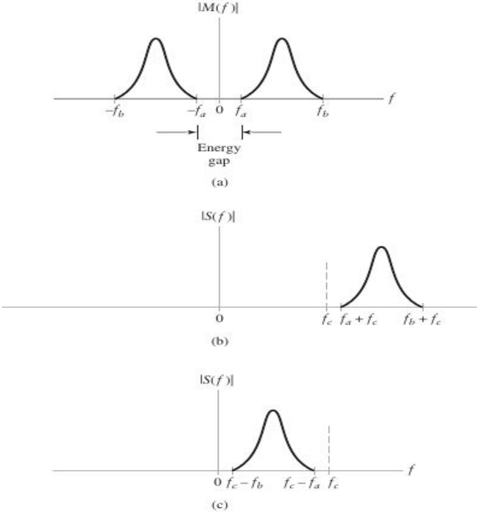
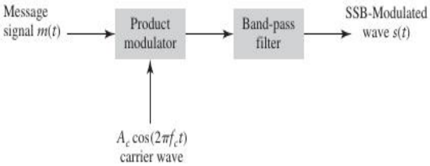
$$
\begin{aligned}
M(f) &= \int_{-\infty}^{\infty} m(t) e^{-j2\pi ft} dt \\
M^*(f) &= \int_{-\infty}^{\infty} m^*(t) e^{j2\pi ft} dt \\
&= \int_{-\infty}^{\infty} m(t) e^{j2\pi ft} dt \\
&= M(-f)
\end{aligned}
$$

Single sideband modulation



- An intuitive approach - frequency discrimination
- Applicable to speech signals, $f_a \approx 100Hz$



Hilbert transform

- See the Appendix of your textbook
- CT signal $g(t)$ with FT $G(f)$
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- The inverse HT is

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- Interpret HT as a LTI system
- Verify that FT of $\frac{1}{\pi t}$ is $-j \times \text{sgn}(f)$

Properties of Hilbert transform

- Show that $|G(f)| = |\hat{G}(f)|$
- Show that HT(HT($g(t)$)) = -$g(t)$
- Show that $\int_{-\infty}^{\infty} g(t)\hat{g}(t) = 0$
- Why is HT useful in the context of SSB ?