EE 703: Digital Message Transmission

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1. Suppose we define the complex envelope of a passband signal $s_p(t)$ centered at $\pm f_c$ as

$$S(f) = 2S_p(f - f_c)u(-f + f_c)$$

where $S_p(f)$ is the Fourier transform of $s_p(t)$. Derive the following with explanations for each step.

   (a) $s_p(t)$ in terms of $s(t)$
   (b) $s_p(t)$ in terms of $s_c(t)$ and $s_s(t)$ (the in-phase and quadrature components of $s(t)$)
   (c) $s(t)$ in terms of $s_p(t)$
   (d) $S_p(f)$ in terms of $S(f)$
   (e) The relationship between $\|s\|^2$ and $\|s_p\|^2$.

2. For a real baseband signal $s(t)$, the corresponding single side band (SSB) modulated signal is given by

$$s_{ssb}(t) = s(t) \cdot \cos(2\pi f_c t) - \hat{s}(t) \cdot \sin(2\pi f_c t)$$

where $\hat{s}(t)$ is the Hilbert transform of $s(t)$. We saw in class that the frequency spectrum of $s_{ssb}(t)$ only has the upper sideband of $s(t)$. Suppose we want a SSB signal which has only the lower sideband of $s(t)$. What is the time domain representation of such a signal in terms of $s(t)$ and $\hat{s}(t)$?