Problem 1  
Passband Signaling
Let \( f_0, T_s \) be fixed.

(i) Show that a signal \( x \) is a Nyquist Pulse of parameter \( T_s \) if, and only if, the signal \( t \mapsto e^{i2\pi f_0 t} x(t) \)
\( \) is such a pulse.

(ii) Show that if \( x \) is a Nyquist Pulse of parameter \( T_s \), then so is \( t \mapsto \cos(2\pi f_0 t) x(t) \).

(iii) If \( t \mapsto \cos(2\pi f_0 t) x(t) \) is a Nyquist Pulse of parameter \( T_s \), must \( x \) also be one?

Problem 2  
The Self-Similarity Function of a Delayed Signal
Let \( u \) be an energy-limited signal, and let the signal \( v \) be given by \( v: t \mapsto u(t-t_0) \). Express the self-similarity function of \( v \) in terms of the self-similarity of \( u \) and \( t_0 \).

Problem 3  
The Self-Similarity Function of a Frequency Shifted Signal
Let \( u \) be an energy-limited complex signal, and let the signal \( v \) be given by \( v: t \mapsto u(t) e^{i2\pi f_0 t} \) for some \( f_0 \in \mathbb{R} \). Express the self-similarity function of \( v \) in terms of \( f_0 \) and the self-similarity function of \( u \).

Problem 4  
Relaxing the Orthonormality Condition
What is the minimal bandwidth of an energy-limited signal whose time shifts by even multiples of \( T_s \) are orthonormal? What is the minimal bandwidth of an energy-limited signal whose time shifts by odd multiples of \( T_s \) are orthonormal?

Problem 5  
A Specific Signal
Let \( p \) be the complex energy-limited bandlimited signal whose FT \( \hat{p} \) is given by
\[
\hat{p}(f) = T_s (1 - |T_s f - 1|) 1\{0 \leq f \leq \frac{2}{T_s}\}, \quad f \in \mathbb{R}.
\]
(i) Plot $\hat{p}(\cdot)$.

(ii) Is $p(\cdot)$ a Nyquist Pulse of parameter $T_s$?

(iii) Is the real part of $p(\cdot)$ a Nyquist Pulse of parameter $T_s$?

(iv) What about the imaginary part of $p(\cdot)$?

**Problem 6**  
*Mapping a Discrete-Time Stationary SP*

Let $(X_\nu)$ be a stationary discrete-time SP, and let $g: \mathbb{R} \to \mathbb{R}$ be some arbitrary (Borel measurable) function. For every $\nu \in \mathbb{Z}$, let $Y_\nu = g(X_\nu)$. Prove that the discrete-time SP $(Y_\nu)$ is stationary.

**Problem 7**  
*Mapping a Discrete-Time WSS SP*

Let $(X_\nu)$ be a WSS discrete-time SP, and let $g: \mathbb{R} \to \mathbb{R}$ be some arbitrary (Borel measurable) bounded function. For every $\nu \in \mathbb{Z}$, let $Y_\nu = g(X_\nu)$. Must the SP $(Y_\nu)$ be WSS?