5. Consider the following functions
(a) 
\[ q_1(\tau) = \begin{cases} 
\frac{\sin \tau}{\tau}, & |\tau| < \pi \\
0, & \text{otherwise.}
\end{cases} \]
(b) 
\[ q_2(\tau) = \begin{cases} 
1 - |\tau|, & |\tau| < 1 \\
0, & \text{otherwise.}
\end{cases} \]
(c) \(q_3(\tau)\) is a periodic waveform as shown below:

\[ \begin{array}{ccccccccc}
\cdots & \multicolumn{1}{c}{\text{\textbullet}} & \multicolumn{1}{c}{\text{\textbullet}} & \multicolumn{1}{c}{\text{\textbullet}} & \multicolumn{1}{c}{\text{\textbullet}} & \multicolumn{1}{c}{\text{\textbullet}} & \multicolumn{1}{c}{\text{\textbullet}} & \cdots \\
\tau & -1 & 1 & \cdots
\end{array} \]

Which among the above waveforms represent autocorrelation functions?

6. \(X(t)\) is a wide sense stationary (W.S.S) zero mean stochastic process with autocorrelation function \(R_{xx}(\tau)\) and power spectrum \(S_{xx}(\omega)\). Consider the process
\[ Z(t) = X(t) \cos(\omega_0 t + \theta) + Y(t) \sin(\omega_0 t + \theta) \]
with
\[ Y(t) = X(t) \ast h(t), \]
where \(h(t)\) is the impulse response of a linear time-invariant system, and \(\theta\) is a uniformly distributed random variable that is independent of \(X(t)\).
Find the power spectrum of \(Z(t)\) and express it in terms of \(S_{xx}(\omega)\), \(H(\omega)\) and \(\omega_0\).
7. A W.S.S zero mean Gaussian stochastic process $X(t)$ is passed through a linear time-invariant system with impulse response $h(t)$. The output $Y(t)$ is then applied to a nonlinear system to generate $Z(t)$ as shown below.

![Diagram with boxes for $X(t)$, $h(t)$, $Y(t)$, and $Z(t)$]

(a) Is $Z(t)$ a Gaussian process? Is $Z(t)$ stationary in any sense?

(b) Is $Z(t)$ and $Y(t)$ jointly stationary in any sense? If so determine $R_{ZY}(t_1, t_2)$ in terms of the autocorrelation function of $X(t)$ and $h(t)$.

(c) Can you express $R_{ZX}(t_1, t_2)$ in terms of the autocorrelation of $X(t)$ and $h(t)$?