Suppose a discrete-time filter has group delay $\tau(\omega)$. Does $\tau(\omega) > 0$ for all $\omega \in (-\pi, \pi)$ imply that the filter is necessarily causal? Clearly explain your reasoning.

In the system below, $w[n]$ is a real, zero-mean, white, wide-sense stationary random sequence with variance $\sigma_w^2$.

\[
\begin{array}{c}
\text{w[n]} \rightarrow \uparrow 2 \rightarrow x[n] \rightarrow h[n] \rightarrow \downarrow 2 \rightarrow y[n] \rightarrow \uparrow 2 \rightarrow d[n]
\end{array}
\]

(a) Determine the autocorrelation of $x[n]$, i.e., $R_{xx}[n,m] = \mathcal{E}(x[n]x[n+m])$, and state whether or not $x[n]$ is wide-sense stationary.

(b) Find an expression for the autocorrelation of $y[n]$ i.e., $R_{yy}[n,m] = \mathcal{E}(y[n]y[n+m])$, in terms of $\sigma_w^2$ and $h[n]$ for even values of $n$. (For full credit, your expression should be in the simplest possible form.)

(c) Are there conditions on $h[n]$ which would ensure that $d[n]$ is wide-sense stationary? If yes, give the least restrictive such conditions.

OSB Problem 4.47
Problem 3.4
  OSB Problem 4.57 a-c

Problem 3.5 (Optional)
  OSB Problem 4.61