AV314 - Questions - Random Processes and Noise. (from UM textbook)

1) Let $(X(t), t \in (-\infty, \infty))$ be a random process. Let the autocorrelation function of the random process be $R_X(\tau) = e^{-a|\tau|}$, for $a > 0$. Here τ is the autocorrelation time lag variable.

a) Find out the output power when X is passed through an ideal LPF of two sided bandwidth W.

b) Find the 99% power containment bandwidth of X. How does it scale with the parameter a?

2) A zero mean random process X has a power spectral density $S_{xx}(f)$ as shown.
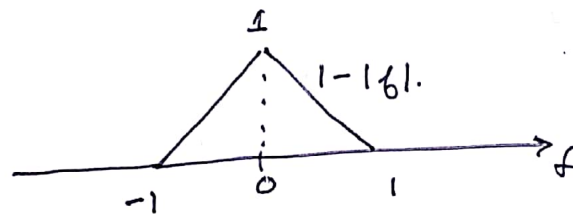
a) Find out $\mathbb{E}[X(100) \cdot X(100.5)]$.

b) Find out the output power when X is passed through a filter with impulse response $h(t) = \text{sinc}(t)$.

3) A signal $s(t)$ in a communication system is modelled as a zero mean random signal with PSD $S_s(f) = (1 - |f|)$ for $f \in [-1, 1]$. The receiver of the system receives the above signal $s(t)$ and additive noise, i-e, the received signal $y(t) = s(t) + n(t)$, where $n(t)$ has a PSD $= 0.001$ for all f. The received signal is passed through a ideal LPF with transfer function $H(f) = 1$ for $f \in [-B, B]$ and 0 o/w.

a) Find SNR of filter input

b) Find SNR at filter output. Is the SNR better for $B = 1$ or $B = \frac{1}{2}$?