

Signals & Noise Homework W2

1. Use of F-T pairs: Derive and sketch the Fourier transform (FT) of the triangle function.

2. Prove in two lines one of the Wiener-Khintchine relations from the other. i.e. given the correlation in the time domain of a voltage $V(t)$:
 $K(s) = \langle V(t)V(t+s) \rangle$ operate on its FT $S(\omega)$ (the power spectrum) to get back $K(s)$. Hint: multiply both sides of $S = \int K \exp(-i\omega s) ds$ by the same function and integrate over s .

3. You have a box of wires, resistors, capacitors, and inductors. Sketch three simple electrical filter circuits you can build, showing 2-terminal voltage input and 2-terminal voltage output. One terminal on the input (“ground”) is connected directly to another terminal on the output. Sketch the absolute value of the filter response in the frequency domain. Or you could sketch the power spectral density (power per unit frequency) vs frequency. Write a simple relation for the characteristic frequency in terms of the component values.
 - A. “High pass” filter (passes signals mostly above some frequency).

 - B. A filter that mostly passes signals near one frequency (“band-pass”).

C. “Low pass” filter (passes signals mostly below some frequency).

D. Extra credit: Prove that circuit C is an integrator. i.e. its output voltage is the integral of the input voltage.