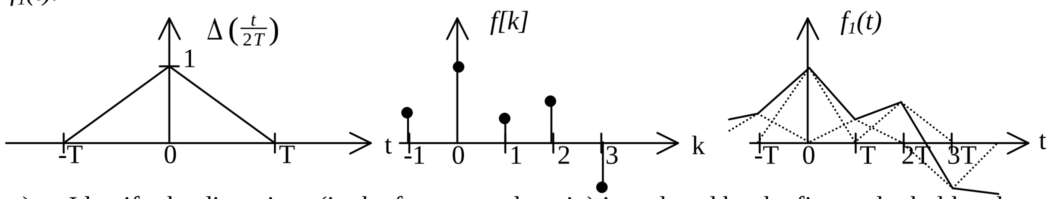
1. The zero-order hold produces a stairstep approximation to the sampled signal *f(t)* from samples *f[k]*. A device termed a first-order hold linearly interpolates between the samples *f[k]* and thus produces a smoother approximation to *f(t)*. The output of the first-order hold may be described as

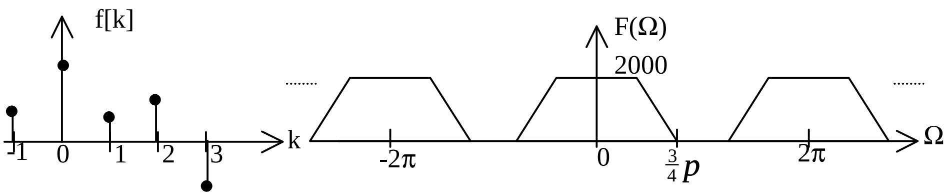
$$f_1(t) = \sum_{k=-\infty}^{\infty} f[k]\Delta\left(\tfrac{t-kT}{2T}\right)$$

where $\Delta\left(\tfrac{t}{2T}\right)$ is the triangle function shown below. Also shown is the relationship between *f[k]* and $f_1(t)$.



a) Identify the distortions (in the frequency domain) introduced by the first-order hold and compare them to those introduced by the zero-order hold.
b) Design an anti-imaging filter to follow the first-order hold process such that *f(t)* can be reconstructed from $f_1(t)$. Sketch the filter's magnitude response precisely labeling all important features.

2. Consider the discrete-time signal f[k] and its corresponding DTFT F(Ω) shown where *f[k]* was found by sampling the continous-time signal *f(t)* at $F_s = 1000$Hz.



a) Sketch the zero-order hold approximation of *f(t)* from *f[k]*.
b) Assuming no aliasing occurred during sampling, sketch the Fourier Transform (frequency content) *F(w)* of *f(t)*.

3. Given the discrete-time signal *f[k] = 1, 1, -1, -1* for *k = 0, 1, 2, 3*, respectively, with *f[k] = 0* for *k < 0* and *k ³ 4* , perform the following:
a) determine the DTFT in closed-form,
b) compute the 4-point DFT in rectangular and polar form by hand,
c) use your matlab dft() function to verify your result in part (b) and plot resulting DFT magnitude and phase spectra for *r = 0, …, 3*,
d) compute the 8-point DFT in rectangular and polar form by hand noting we've padded signal with four zeros here,
e) use your matlab dft() function to verify your result in part (d) and plot resulting DFT magnitude and phase spectra for *r = 0, …, 7*,
f) plot the DTFT found in part (a) and 4-point DFT (versus rW_o) found in part (c) on the same graph for $0 \le \Omega < 2\pi$ and discuss what you see,
g) plot the DTFT found in part (a) and 8-point DFT (versus rW_o) found in part (e) on the same graph for $0 \le \Omega < 2\pi$ and discuss what you see.