Practice Test 1 (FALL 2018)
Closed Book, No Electronic Devices, 100 Minutes

Problem 1 [40 Points]

(a) (10 points): Sketch $y[n] = u[n] * \delta[n+3]$, where $*$ denotes convolution, $u[n]$ is the unit step, and $\delta[n]$ is the unit impulse. *Justify your answer*.

(b) (10 points): What is the fundamental period of the discrete-time signal $x[n] = \cos(2.5\pi n + 0.125\pi)$? *Justify your answer*.

(c) (10 Points): Sketch a signal $y[n]$ given that $y[n] = x[3n]$ and $x[n] = u[n] - u[n-7]$. *Justify your answer*.

(d) (10 Points): If $x(t)$ is a real-valued signal whose Fourier transform $X(j\omega)$ has the property that $X(j\omega) = 0$ for $\omega \geq 1000\pi$, what is the lowest sampling rate that could be used on $x(t)$ to ensure that no aliasing takes place? *Justify your answer*.

Problem 2 [30 points]

(a) (10 points): Sketch the signal $x_a[n]$ that has an analog envelope given as $x_a(t) = \dfrac{\sin(\pi(t-2)}{\pi(t-2)}$. *Justify your answer*.

(b) (10 points): Sketch and label the inverse of the Discrete-Time Fourier transform (DTFT) given as $X_b(e^{j\omega}) = e^{-j\frac{5\omega}{2}} \dfrac{\sin(3\omega)}{\sin(0.5\omega)}$. *Justify your answer*.

(c) (10 points): Suppose an LTI system has impulse response $h[n] = u[n] - u[n-8]$. Sketch the output signal of this LTI system when the input signal is $x[n] = \cos(0.25\pi n + 0.125\pi)$. *Justify your answer*.

Problem 3 (10 points)

(a) (10 Points) Let $x_a[n] = (-1)^n \dfrac{\sin(0.5\pi n)}{\pi n}$. Does the real-valued discrete-time signal $x_a[n]$ have a real-valued analog envelope? *Justify your answer*.

(b) (10 points) Sketch the *phase of the DTFT* of

$$x_b[n] = \sum_{k=-\infty}^{\infty} \left(\frac{\sin(0.25\pi k)}{\pi k} \times \frac{\sin(0.25\pi(n-k))}{\pi(n-k)}\right)$$

Justify your answer.

(c) (10 points): Sketch the 10-point DFT of the signal given as

$$x_c[n] = \begin{cases} \cos(0.6\pi n) & \text{for } 0 \le n \le 9 \\ 0 & \text{otherwise.} \end{cases}$$

Justify your answer.