# Practice Midterm Exam

**Concepts to Practice:**
- How to write, draw, and perform basic operations on signals
- How to compute the DTFT of a signal
- How to use the table of transform pairs and DTFT properties

## Question 1: Basic operations on DT signals

You're given a DT signal $x(n) = \delta(n-1) + 2\delta(n-2) + 3\delta(n-3)$. Sketch $x(n)$ and the following versions of $x(n)$.

**(a)** $x(n-2)$

**(b)** $x(n+2)$

**(c)** $3x(-n)$

**(d)** $-x(-n+1)$

**(e)** $x^2(n)u(n)$

**(f)** $2x(n) + \cos(\pi n)\big(u(n) - u(n-3)\big)$

**(g)** $x(n) * \delta(n-3)$

**(h)** $x(n) * \mathrm{rect}_3(n)$

## Question 2: Practice computing the DTFT

You're given a signal $x(n) = 2\delta(n+2) + \delta(n) + 2\delta(n-2)$. Compute the DTFT of each of the following modified versions of $x(n)$. **You must simplify your answers as much as possible to receive full credit**.

**(i)** $2x(n)$

**(j)** $x(n-2)$

**(k)** $3x(-n)$

**(l)** $-x(-n+1)$

**(m)** $x^2(n)u(n)$

**(n)** $x(n+1)u(n-1)$

**(o)** $2x(n)\cos(\pi n)$

**(p)** $x(2n)$

## Question 3: Many ways of computing the DTFT

You're given a signal $x(n) = \cos\left(\frac{\pi}{2}n\right)\mathrm{rect}_5(n+2)$.

**(a)** Sketch $x(n)$ and compute its length and energy.

**(b)** Compute $X\left(e^{j\omega}\right)$ (i.e., compute the DTFT of $x(n)$) by directly using the DTFT formula.

**(c)** Sketch $X\left(e^{j\omega}\right)$ over the range $[-2\pi, 2\pi]$.

**(d)** Compute the magnitude and phase of $X\left(e^{j\omega}\right)$. Sketch these magnitude and phase spectra over the range $[-2\pi, 2\pi]$.

**(e)** Repeat (b), except this time use the table of transform pairs and the frequency-shift property.

**(f)** Repeat (b), except this time use the table of transform pairs and the multiplication-in-time property.

**(g)** Verify your answer to (d) by using the `freqz()` function in Matlab. Provide your script and clearly labeled Matlab plots of $\left|X\left(e^{j\omega}\right)\right|$ and $\measuredangle X\left(e^{j\omega}\right)$ over the range $[-2\pi, 2\pi]$.