ECE 351 DSP: Practice Problems 2

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1) Consider an LTI system with $h[n] = \cos(\frac{\pi}{2}n)u[n]$ being fed an input $x[n] = n(\frac{1}{2})^n u[n]$. Compute its output.

2) Consider a recursive LTI system characterised by the difference equation $y[n] = \frac{5}{6}y[n-1] - \frac{1}{6}y[n-2] + \frac{1}{4}x[n] + \frac{1}{2}x[n-1]$. Find its unit sample response $h[n]$.

3) Consider an input $x[n] = \sum_{k=-\infty}^{\infty} \delta[n-2k]$ to an LTI system with impulse response $h[n] = [1, -1, 2, -1, 1]$. The output $y[n]$ is then time truncated to 4 samples at $n = 0, 1, 2, 3$, and a 4-point DFT is taken. Find $Y(0)$.

4) Consider the matrices $A = \begin{pmatrix} 1 & 1 & 1 \\ 1 & -\frac{1}{2} - \frac{\sqrt{3}}{2}j & -\frac{1}{2} + \frac{\sqrt{3}}{2}j \\ 1 & -\frac{1}{2} + \frac{\sqrt{3}}{2}j & -\frac{1}{2} - \frac{\sqrt{3}}{2}j \end{pmatrix}$, $B = \begin{pmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ -1 & 1 & 0 \end{pmatrix}$, and $C = [1\ 0\ 2]^T$. Calculate ABC.
[**Hint**: This is not a linear algebra course, so the point is not to test your matrix multiplication skills. Instead, try to write down circular convolution as a linear transform.]

I. Answers

1) $\frac{(5n+8)}{25}(\frac{1}{2})^n u[n] - 2\cos(\frac{n\pi}{2} + \tan^{-1}\frac{3}{4})u[n]$.

2) $\frac{15}{4}(\frac{1}{2})^n u[n] - \frac{7}{2}(\frac{1}{3})^n u[n]$.

3) 4.

4) $[0 \quad 3 \quad 1+3\sqrt{3}j]^T$.