**SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY**
**DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING**
**ACADEMIC YEAR 2019-2020 SEMESTER 1**
**DIGITAL SIGNAL PROCESSING**
**TUTORIAL 4**

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1. Determine the DTFT of the following sequences:
(a) two sided sequence $y[n] = \alpha^{|n|}, |\alpha| < 1$.
(b) causal sequence $x[n] = A\alpha^n \cos(\omega_0 n + \varphi)\mu[n]$, where $A, \alpha, \omega_0$, and $\varphi$ are real, and $|\alpha| < 1$.
(c) $x[n] = n\alpha^n \mu[n+2], |\alpha| < 1$

2. The values of the DTFT of the sequence $x[n] = a\delta[n] + b\delta[n-1] + c\delta[n-2]$ at the frequencies $\omega = \frac{3\pi}{2}, \omega = 3\pi$, and $\omega = 6\pi$ are given by $3 - j$, 0, and 2, respectively. Determine the values of the samples $a$, $b$, $c$.

3. Determine the inverse DTFT of the following DTFTs:
(a) $X(e^{j\omega}) = \sum_{k=-\infty}^{\infty} \delta(\omega + 2\pi k)$
(b) $X(e^{j\omega}) = \frac{e^{j\omega}(1-e^{j\omega N})}{1-e^{j\omega}}$
(c) $X(e^{j\omega}) = 1 + 2\sum_{l=0}^{N} \cos \omega l$
(d) $X(e^{j\omega}) = \frac{\alpha e^{-j\omega}}{(1-\alpha e^{-j\omega})^2}, |\alpha| < 1$

4. Evaluate the linear convolution of each following sequences with itself using the DTFT-based method.
(a) $x[n] = \{1, 2, 1\}, -1 \le n \le 1$,
(b) $x[n] = \{-2, 1, 0, -1, 2\}, 0 \le n \le 4$.

5. Let $X(e^{j\omega})$ denote the DTFT of a length-9 sequence $x[n]$ given by

$$x[n] = \{3, 1, -5, -11, 0, -5, 3, 3, 8\}, -5 \le n \le 3$$

Evaluate the following function of $X(e^{j\omega})$ without computing the transform itself:
(a) $X(e^{j0})$, (b) $X(e^{j\pi})$, (c) $\int_{-\pi}^{\pi} X(e^{j\omega})\, d\omega$, (d) $\int_{-\pi}^{\pi} |X(e^{j\omega})|^2\, d\omega$, (e) $\int_{-\pi}^{\pi} \left|\frac{dX(e^{j\omega})}{d\omega}\right|^2 d\omega$.

6. Let $G_1(e^{j\omega})$ denote the DTFT of the sequence $g_1[n] = \{1, 4, 2, 3\}, 0 \le n \le 3$. Express the DTFT of the following sequences in terms of $G_1(e^{j\omega})$. Do not evaluate $G_1(e^{j\omega})$.
(a) $g_2[n] = \{1, 4, 2, 3, 1, 4, 2, 3\}, 0 \le n \le 7$,
(b) $g_3[n] = \{1, 4, 2, 3, 3, 2, 4, 1\}, 0 \le n \le 7$,
(c) $g_4[n] = \{3, 2, 4, 1, 1, 4, 2, 3\}, 0 \le n \le 7$.