AUSTRALIAN NATIONAL UNIVERSITY
Department of Engineering

ENGN6612/4612 Digital Signal Processing and Control
Problem Set #6 Discrete Fourier Transform (DFT)

Q1

The periodic function $x[n]$ is defined as:

(a)

$$x[n] = \begin{cases} 1 & \text{for } n = 4l+2 \\ 0 & \text{elsewhere} \end{cases}$$

(b)

$$x[n] = \begin{cases} 1 & \text{for } n = 4l \text{ and } n = 4l+3 \\ 2 & \text{for } n = 4l+1 \text{ and } n = 4l+2 \end{cases}$$

(c)`(challenge problem)`

$$x[n] = \begin{cases} 0 & \text{for } n = 4l \\ 1 & \text{for } n = 4l+1 \text{ and } n = 4l+3 \\ 2 & \text{for } n = 4l+2 \end{cases}$$

with $l = 0, \pm 1, \pm 2, \cdots$.

For each $x[n]$:

- Plot the fundamental interval for $x[n]$.
- Calculate the N-point DFT of $x[n]$.
- Calculate and plot the magnitude and phase of DFT.
- Calculate and plot the real and imaginary parts of DFT..

Q2

The N-point DFT $X[k]$ is defined as:

(a) $N = 4$

$$X[k] = \begin{cases} 1 & \text{for } k = 4l \text{ and } k = 4l+1 \text{ and } k = 4l+2 \text{ and } k = 4l+3 \\ 0 & \text{elsewhere} \end{cases}$$

(b) $N = 4$

$$X[k] = \begin{cases} 2 & \text{for } k = 4l+1 \\ 2 & \text{for } k = 4l+3 \\ 0 & \text{elsewhere} \end{cases}$$

(c) $N = 16$ `(challenge problem)`

$$X[k] = \begin{cases} 2 & \text{for } k = 16l+1 \text{ and } k = 16l+15 \\ 1 & \text{for } k = 16l+3 \text{ and } k = 16l+13 \\ 0 & \text{elsewhere} \end{cases}$$

with $l = 0, \pm 1, \pm 2, \cdots$.

For each $X[k]$:

- Plot the fundamental interval for $X[k]$.
- Calculate the N-point IDFT of $X[k]$.
- Plot the fundamental interval for $x[n]$.