Ex 01

Chapter 1. Introduction to Signals and Systems

Date (yy/mm/dd): 2021 / 12 / 28

Student ID: 5129 0174 Name: Ryoma Ohtuda Score: _____ /100

Math Problem: (20 = 5 × 4 points/each)

- Let $x(t)$ be the complex exponential signal $x(t) = e^{j\omega_0 t}$ with radian frequency ω_0 and fundamental period $T_0 = 2\pi/\omega_0$.
- Consider the discrete-time signal $x[n]$ obtained by uniform sampling of $x(t)$ with sampling interval T_s. That is, $x[n] = x(nT_s) = e^{j\omega_0 nT_s}$
- Find the condition on the value of T_s so that $x[n]$ is periodic.

Answer:

If $x[n]$ is periodic with fundamental period N_0, then

$$e^{j\omega_0(n+N_0)T_s} = e^{j\omega_0 nT_s} \cdot e^{j\omega_0 N_0 T_s} = e^{j\omega_0 nT_s},$$

Thus, we must have

$$e^{j\omega_0 N_0 T_s} = 1$$

Therefore, $\omega_0 N_0 T_s = \frac{2\pi}{T_0} N_0 T_s = 2\pi m$, m = positive integer

Or, $\frac{T_s}{T_0} = \frac{m}{N_0}$ = rational number

Thus $x[n]$ is periodic if the ratio T_{0m} of the sampling interval and the fundamental period of $x(t)$ is a rational number.

$$\hookrightarrow T_s = \frac{T_{0m}}{N_0}$$

MATLAB Problem: (80 = 8 × 10 points/each plot)

- Setup MATLAB environment and practice some useful commands such as figure, plot, subplot, xlabel, ylabel, set, grid, axis, title, suptitle, strcat, num2str, rand, length, real, imag.
- Develop a MATLAB program to plot 8 subplots in a figure as showed in the next page. $x[n] = e^{(\sigma+j\omega_0)T_s n}$, ($n$=-100:1:100; T_0=0.5; T_s=0.01; $\sigma = \pm 1$)