SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
ACADEMIC YEAR 2019-2020 SEMESTER 1
DIGITAL SIGNAL PROCESSING
TUTORIAL 5

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1. Compute the DTFT of the following sequences with ω_0 real, and discuss the convergence of the DTFT of the sequences for $-\infty < n < \infty$.
(a) $x[n] = e^{j\omega_0 n}$, (b) $x[n] = \cos(\omega_0 n + \varphi)$

2. The Nyquist frequency of a continuous-time signal $x_c(t)$ is ω_c. Determine the Nyquist frequency of each of the following continuous signals:

(a) $y_1(t) = x_c(t)x_c(t)$, (b) $y_2(t) = \int_{-\infty}^{\infty} x_c(t-\tau)\, x_c(t)d\tau$, (c) $y_3(t) = x_c(t/3)$,

(d) $y_4(t) = x_c(3t)$, (e) $y_5(t) = \frac{dx_c(t)}{dt}$

(3) A 4.0 s long segment of a continuous-time signal is uniformly sampled without aliasing and generating a finite-length sequence containing 8500 samples. What is the highest frequency component that could be present in the continuous-time signal?

(4) A continuous-time signal $x_c(t)$ is composed of a linear combination of complex sinusoidal signals of frequencies 300Hz, 500Hz, 1.2kHz, 2.15kHz, and 3.5kHz. The signal $x_c(t)$ is sampled at a 3.0kHz rate, and the sampled sequence is passed through an ideal lowpass filter with a cutoff frequency of 900Hz, generating a continuous-time signal $y_c(t)$. What are the frequency components present in the reconstructed signal $y_c(t)$?

(5) A continuous-time signal $x_c(t)$ is composed of a linear combination of complex sinusoidal signals of frequencies F_1 Hz, F_2 Hz, F_3 Hz, and F_4 Hz. The signal $x_c(t)$ is sampled at an 8kHz rate, and the sampled sequence is passed through an ideal lowpass filter with a cutoff frequency of 3.5kHz, generating a continuous-time signal $y_c(t)$ composed of three sinusoidal signals of frequencies 150Hz, 400Hz, and 925Hz, respectively. What are the possible values of F_1, F_2, F_3, and F_4? Is your answer unique? If not, indicate another set of possible values of these frequencies.

(6) Consider the system in the Figure 6.1, where the signal $x_a(t)$ has a band-limited spectrum $X_a(j\Omega)$, as sketched in Figure 6.2, and is being sampled at the Nyquist rate. The block of "Discrete time system" has an ideal lowpass filter with a frequency response $H(e^{j\omega})$, as shown in Figure 6.3, and has a cutoff frequency $\omega_c = \Omega_m T/2$, where T is the sampling period. Sketch as accurately as possible the spectrum $Y_a(j\omega)$ of the output continuous-time signal $y_a(t)$.

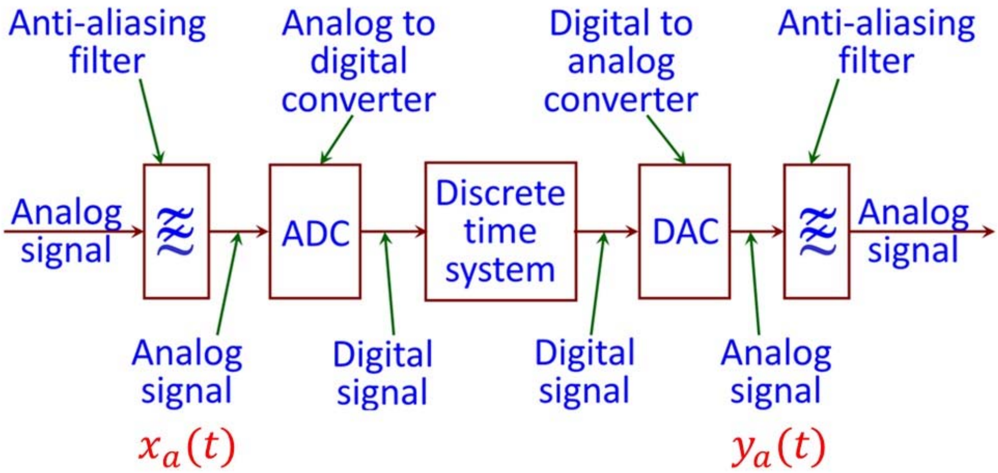

Figure 6.1

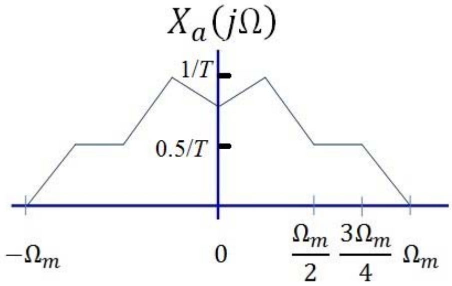

Figure 6.2

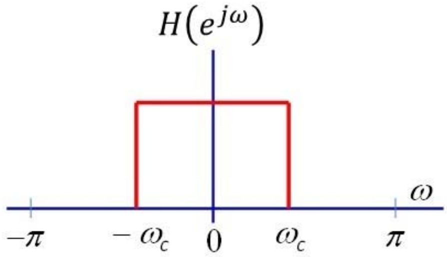

Figure 6.3