EBU4375: SIGNALS AND SYSTEMS

TOPIC 4- TUTORIAL

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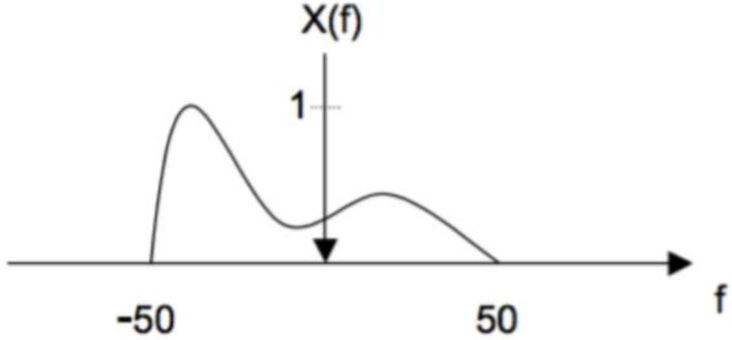
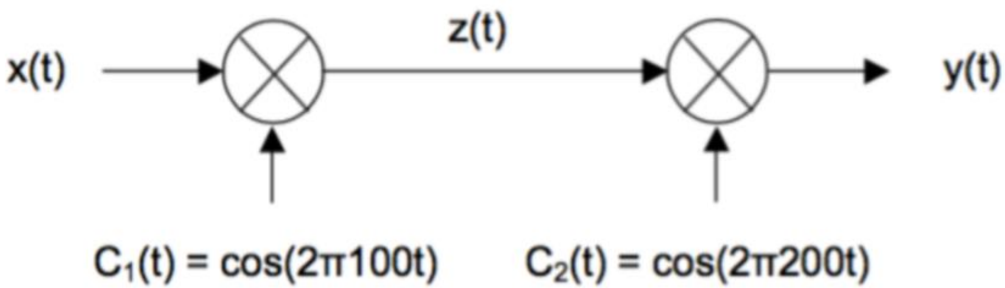
Problem 1



a) Consider the system shown in Figure 1, which consists of two sinusoidal waves of unit amplitude and frequencies 100 Hz and 200 Hz. The spectrum of the input signal $x(t)$ is $X(f)$.



i) Find the expression for the Fourier transform of the intermediate signal z(t).
ii) Plot the Fourier transform of the intermediate signal z(t).
iii) Find the expression for the Fourier transform of the output signal y(t).
iv) Plot the Fourier transform of the output signal y(t).

Problem 2

- Determine the Nyquist rate in Hz of:

$$x_1(t) = 17 + 4\cos(2\pi t + \tfrac{7\pi}{8}) + 8\cos(\pi t + \tfrac{5\pi}{8}) + 2\cos(6\pi t + \tfrac{\pi}{8}).$$

Problem 3

1- Assume that the signal $\mathrm{x}(\mathrm{t}) = \frac{\sin(4\pi t)}{\pi t}$ is sampled at the Nyquist rate, resulting in signal $x_p(\mathrm{t})$. Obtain the Fourier Transform $X_p(\omega)$ of $x_p(\mathrm{t})$.

Problem 3

2- Design a system to recover $x(\mathrm{t})$ from $x_p(\mathrm{t})$.

Problem 4

3- Assume you sample the signal $\mathrm{z(t)} = x(2t)$ at the same rate as $x(t)$ and recover $\mathrm{z(t)}$ from the samples version $z_p(\mathrm{t})$ using the system designed in (Problem 3). Would you recover $\mathrm{z(t)}$? Why?

Problem 5

- Let x(t) be a signal with Nyquist rate ω_0 . Determine the Nyquist rate for each of the following signals:

a) $x(t) + x(t - 1)$

b) $x^2(t)$

c) $x(t) \cos \omega_0 t$

Problem 6

- Let x(t) be a real-valued signal for which $X(\omega) = 0$ when $|\omega| > 2{,}000\pi$. Amplitude modulation is performed to produce the signal
$$g(t) = x(t)\sin(2{,}000\pi t).$$
- A proposed demodulation technique is illustrated below where g(t) is the input, y(t) is the output, and the ideal lowpass filter has cutoff frequency 2,000 π and passband gain of 2. Determine y(t).