ECE 301-003, Homework #10 (CRN: 11474)
Due date: Wed 4/17/2024

https://engineering.purdue.edu/~chihw/24ECE301S/24ECE301S.html

Question 92: [Basic] Textbook p. 631, Problem 8.22.

8.22. In Figure P8.22(a), a system is shown with input signal $x(t)$ and output signal $y(t)$. The input signal has the Fourier transform $X(j\omega)$ shown in Figure P8.22(b). Determine and sketch $Y(j\omega)$, the spectrum of $y(t)$.
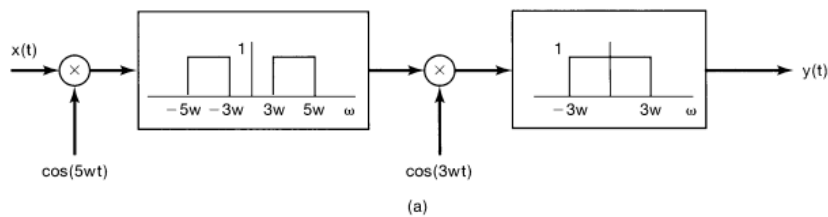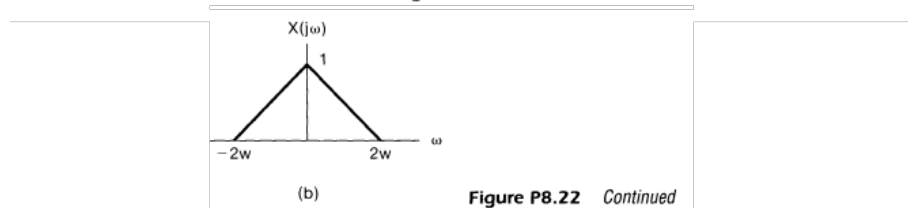

Figure P8.22

Figure P8.22   *Continued*

Question 93: Perform the following MATLAB tasks/projects:

Task 1: https://engineering.purdue.edu/~chihw/24ECE301S/com/Instruction.html

Hint: Sometimes your pdf reader may not support directly clicking a hyperlink. If so, please manually enter the above address into your browser. Sometimes copy-&-paste won't work either because the character "~" in pdf is different than the one in the browser address bar. Please simply type down the link address if you experience any technical problem, which should resolve most of these problems.

Question 94: Perform the following MATLAB tasks/projects:

Task 2: https://engineering.purdue.edu/~chihw/24ECE301S/com/FDMA.html

Hint: Sometimes your pdf reader may not support directly clicking a hyperlink. If so, please manually enter the above address into your browser. Sometimes copy-&-paste won't work either because the character "~" in pdf is different than the one in the browser address bar. Please simply type down the link address if you experience any technical problem, which should resolve most of these problems.

Question 95: [Advanced] Textbook p. 633, Problem 8.25.

[Optional] Implement your system in MATLAB in a similar way as that of the projects.

8.25. A commonly used system to maintain privacy in voice communication is a *speech scrambler.* As illustrated in Figure P8.25(a), the input to the system is a normal speech signal $x(t)$ and the output is the scrambled version $y(t)$. The signal $y(t)$ is transmitted and then unscrambled at the receiver.

We assume that all inputs to the scrambler are real and band limited to the frequency ω_M; that is, $X(j\omega) = 0$ for $|\omega| > \omega_M$. Given any such input, our proposed scrambler permutes different bands of the spectrum of the input signal. In addition, the output signal is real and band limited to the same frequency band; that is, $Y(j\omega) = 0$ for $|\omega| > \omega_M$. The specific algorithm for the scrambler is

$$Y(j\omega) = X(j(\omega - \omega_M)), \quad \omega > 0,$$
$$Y(j\omega) = X(j(\omega + \omega_M)), \quad \omega < 0.$$

(a) If $X(j\omega)$ is given by the spectrum shown in Figure P8.25(b), sketch the spectrum of the scrambled signal $y(t)$.

(b) Using amplifiers, multipliers, adders, oscillators, and whatever ideal filters you find necessary, draw the block diagram for such an ideal scrambler.

(c) Again using amplifiers, multipliers, adders, oscillators, and ideal filters, draw a block diagram for the associated unscrambler.
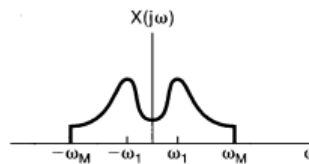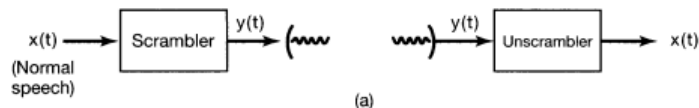

(a)

(b)

Figure P8.25

Question 96: [Advanced] Textbook p. 635, Problem 8.28(a,b).

8.28. In Section 8.4 we discussed the implementation of single-sideband modulation using $90°$ phase-shift networks, and in Figures 8.21 and 8.22 we specifically illustrated the system and associated spectra required to retain the lower sidebands.

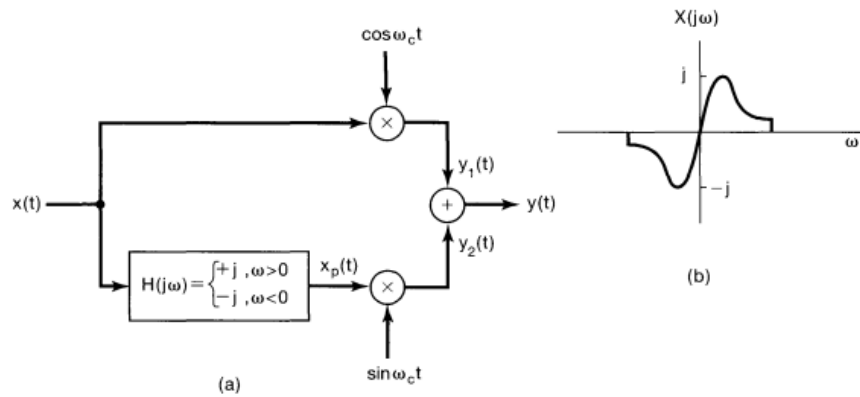Figure P8.28(a) shows the corresponding system required to retain the upper sidebands.

Figure P8.28

(a) With the same $X(j\omega)$ illustrated in Figure 8.22, sketch $Y_1(j\omega)$, $Y_2(j\omega)$, and $Y(j\omega)$ for the system in Figure P8.28(a), and demonstrate that only the upper sidebands are retained.

(b) For $X(j\omega)$ imaginary, as illustrated in Figure P8.28(b), sketch $Y_1(j\omega)$, $Y_2(j\omega)$, and $Y(j\omega)$ for the system in Figure P8.28(a), and demonstrate that, for this case also, only the upper sidebands are retained.