

**Olin College of Engineering**  
**ENGR2410 – Signals and Systems**

**Quiz 8**

**Instructions**

- A. Collaboration is not allowed on quizzes.
- B. Students may only use a page of notes and the tables from the website during the quizzes.
- C. Time is limited to one continuous hour.
- D. Quizzes are due at the beginning of lecture on Thursday.
- E. Late or missed quizzes will be given a score of zero. Any excuses must come directly from the Office of Student Life.
- F. The two lowest quiz scores will be eliminated to allow for unforeseeable circumstances.
- G. In case of doubt, students are expected to base their behavior on the values expressed in the Honor Code.

Name:

Start time:

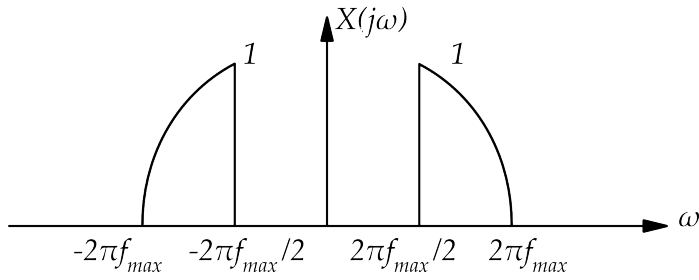
**Problem 1** (*5 points*) If the frequency content of a signal is concentrated in a narrow band, we can sample at much lower frequencies.

A. Sketch  $P(j\omega)$ , the transform of  $p(t)$ , where

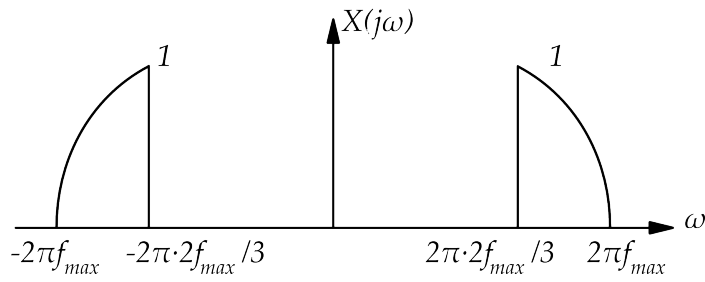
$$p(t) = \sum_n \delta(t - n/f_s)$$

B. If  $x_s(t) = x(t)p(t)$ , find an expression for  $X_s(j\omega)$  in terms of  $X(j\omega)$ .

- C. Assume that  $X(j\omega)$ , the frequency content of  $x(t)$ , is bounded between  $f_{max}$  and  $f_{max}/2$  as shown below. Show that you can avoid aliasing by sampling at  $f_{max}$ . Sketch clearly and carefully  $X_S(j\omega)$ , the frequency content of  $x_S(t)$ .



- D. Assume that  $X(j\omega)$ , the frequency content of  $x(t)$ , is bounded between  $f_{max}$  and  $2f_{max}/3$  as shown below. Show that you can avoid aliasing by sampling at  $2f_{max}/3$ . Sketch clearly and carefully  $X_S(j\omega)$ , the frequency content of  $x_S(t)$ .



**Problem 2** (5 points) The system

$$y[n] = \frac{1}{3}x[n-1] + \frac{1}{3}x[n] + \frac{1}{3}x[n+1]$$

is a moving average.

A. Find the transfer function  $H(\Omega) = Y(\Omega)/X(\Omega)$  for this system. *Hint: it can be simplified into two terms.*

B. Sketch the magnitude and phase of  $H(\Omega)$ .

C. Find the frequency  $\Omega_0$  where the magnitude of  $H(\Omega)$  goes to zero.

D. What is the output if the input is  $x[n] = \cos(\Omega_0 n)$ . Sketch this input. Does it make sense that the output is zero?

- E. Find an expression and sketch  $h[n]$ , the impulse response of the system. *Hint: You can find it relatively easily in either domain.*





## Course feedback

Feel free to send any additional feedback directly to us.

Name (optional):

- A. End time: How long did the quiz take you?
- B. Was the quiz a fair measure of your understanding?
- C. Was the assignment effective preparation for the quiz?
- D. Is the Monday session effective?
- E. Are the connections between lecture, assignment and quiz clear?
- F. Are the objectives of the course clear? Do you feel you are making progress towards those objectives?
- G. Anything else?



## Assignment grades

Date:

Assignment number:

Group member 1:

Grade:

Group member 2:

Grade:

Group member 3:

Grade: