

NAME:
EE301 Signals and Systems
Exam 3

NAME
In-Class Exam
Thursday, Apr. 19, 2018

Cover Sheet

Test Duration: 75 minutes.

Coverage: Chaps. 5,7

Open Book but Closed Notes.

One 8.5 in. x 11 in. crib sheet

Calculators NOT allowed.

All work should be done on the sheets provided.

You must show all work for each problem to receive full credit.

For Problem 4, plot your answers on the graphs provided.

VIP Note Regarding DTFT Plots: *The abscissa in each plot is the frequency axis. For each plot, the abscissa goes from -2π to 2π with tic marks every $\pi/8$. There is a dashed vertical line at $\omega = -\pi$ and another dashed vertical line at $\omega = +\pi$. You only have to plot any DTFT over $-\pi < \omega < \pi$.*

Problem 1. Short answer questions.

- (a) Briefly write and explain **ONE** of the main advantages of digital over analog, in terms of storage, transmission, and/or processing, in a coherent sentence.

- (b) If one samples a real-valued signal at a rate ω_s in radians/sec, what analog frequency is the frequency $\frac{\omega_s}{2} + \Delta\omega$ aliased to? Assume $0 < \Delta\omega < \frac{\omega_s}{2}$.

Problem 2. Consider the input signal $x_0(t)$ below.

$$x_0(t) = e^{-j32t} + e^{-j28t} + e^{-j24t} + e^{-j16t} + e^{-j12t} + e^{-j8t} + e^{-j4t} + 1 + e^{j4t} + e^{j8t} + e^{j12t} + e^{j16t} + e^{j24t} + e^{j28t} + e^{j32t}$$

This signal is first input to an analog filter with impulse response

$$h_{LP}(t) = \left\{ \frac{\sin(15t)}{\pi t} + \frac{\sin(5t)}{\pi t} \right\} 2j \sin(15t)$$

to form $x(t) = x_0(t) * h_{LP}(t)$, and then $x(t)$ is sampled at a rate of $\omega_s = 64$ to form $x[n]$, so that the time between samples is $T_s = \frac{2\pi}{64}$. The DT signal $x[n]$ thus obtained is then input to a DT LTI system with impulse response

$$h[n] = 16 \left\{ \frac{\sin\left(\frac{\pi}{2}n\right)}{\pi n} \right\}^2 \quad (1)$$

Show all work. Write your expression for the output $y[n] = x[n] * h[n]$ in the space below. Plot both the Fourier Transform of $h_{LP}(t)$ and the DTFT of $h[n]$ to help solve the problem, but since the input is a sum of sinewaves, it is not necessary to plot the Fourier Transform of $x_0(t)$ or the DTFT of the sampled signal $x[n]$.

Problem 2. You can continue your work for 2 here.

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Workout Problem 3 (a). Consider the continuous-time signal $x_a(t)$ below. A discrete-time signal is created by sampling $x_a(t)$ according to $x[n] = x_a(nT_s)$ for $T_s = \frac{2\pi}{60}$. Plot the DTFT of $x[n]$, $X(\omega)$, over $-\pi < \omega < \pi$.

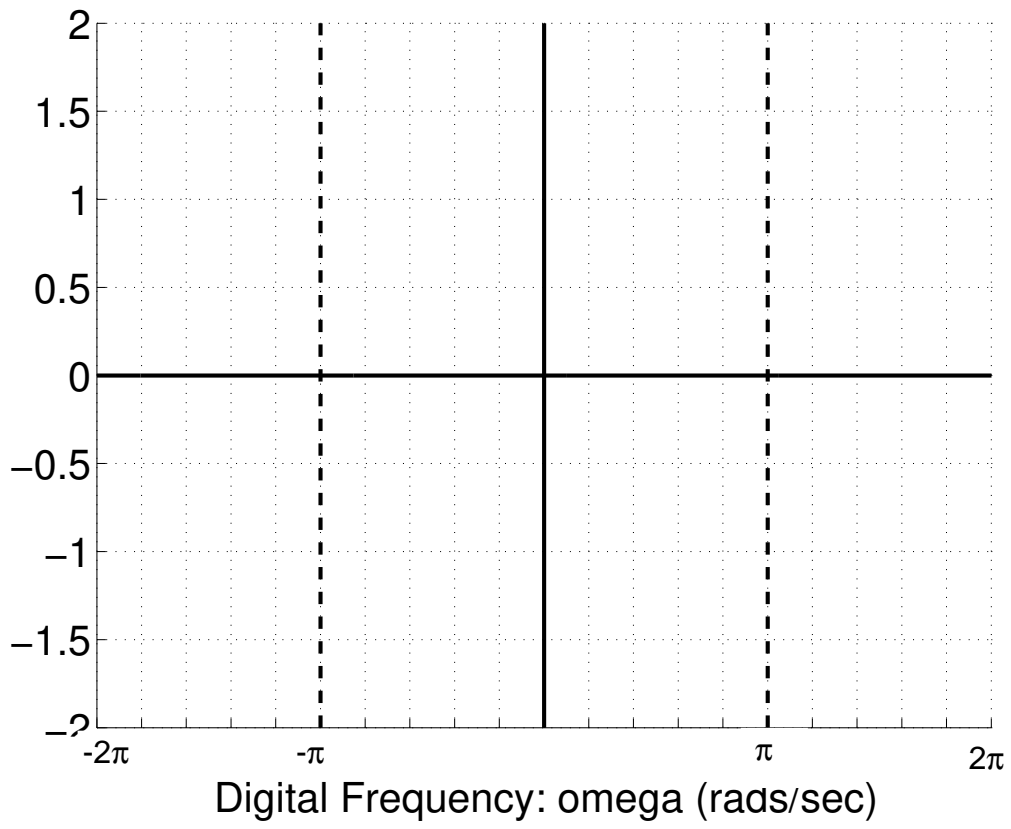
$$x_a(t) = T_s \frac{\pi}{2} \left\{ \frac{\sin(2t)}{\pi t} \frac{\sin(8t)}{\pi t} \right\}$$

(b) Repeat part (a) for $T_s = \frac{2\pi}{18}$

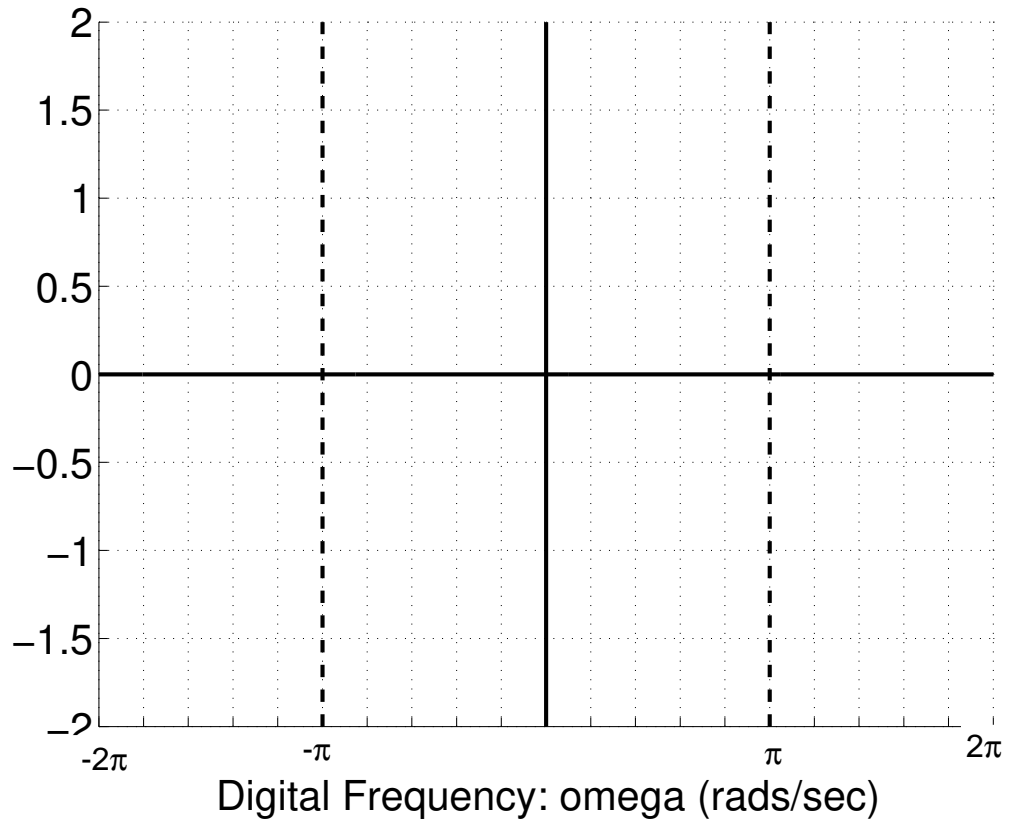
(c) Repeat part (a) for $T_s = \frac{2\pi}{16}$ and also determine a closed-form expression for the reconstructed signal formed as

$$x_r(t) = \sum_{n=-\infty}^{\infty} x[n]h(t - nT_s) \quad \text{where: } T_s = \frac{2\pi}{16} \quad \text{and} \quad h(t) = \frac{\sin(8t)}{\pi t}$$

Plot your answer to Problem 3 (a) here. Show work .



Plot your answer to Problem 3 (b) here. Show work .



Plot your answer to Problem 3 (c) here. Show work .

