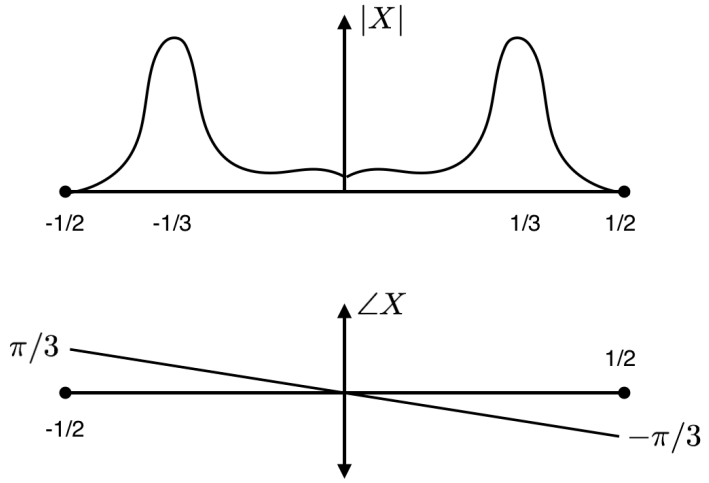
EE 102A - Final Exam

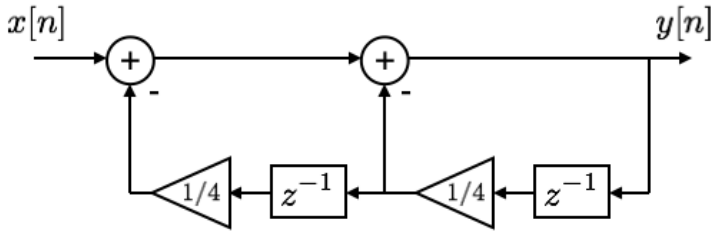
Notes, books, and electronics are not permitted on this exam.

Problem 1. *10 points - Predicting the Stock Market*
You're considering investing in a stock of company XYZ. You download a history of the stock price from the internet giving you the price of a stock at closing for the last 10,000 days (i.e. you get one price a day). So you have a vector $x \in \mathbb{R}^{10,000}$. The Discrete Fourier Transform of this data is shown below.



When should you purchase and sell the stock to maximize your profit. Justify your answer.

Problem 2. *12 points*
Consider the following discrete-time system.



Recall that a delay of one sample is represented by z^{-1}.
a) Is this system causal? Does it have memory? Is it linear?
b) Is this a Finite Impulse Response system or an Infinite Impulse Response system? (Justify your answer.)
c) Find the transfer function of this system.

Problem 3. *15 points*
A signal x with a bandwidth of 4 kHz is sampled with an A/D converter with a sampling rate of 10 kHz. You realize that this data exceeds the Nyquist sampling rate. You would like to alter the data in order to minimize the amount of memory required to store the signal. Explain how to do this. (If you require any filters, feel free to use an ideal filter. There is no need to specify the filter's implementation; just specify the filter's transfer function.)

Problem 4. *15 points*
Design an AM radio. Be sure to specify how a user would change the station. As much as possible,

specify the electrical components required to implement your AM radio. If you use an analog-to-digital converter, specify the sampling rate of that converter (and indicate why you chose that rate).

AM radio stations are separated by 10 kHz. The entire AM spectrum is from 530 kHz to 1700 kHz.

Formulas

$$\mathcal{FS}\{f\}[n] = F[n] = \frac{1}{T}\int_0^T f(x)\, e^{-i2\pi(nx)/T}\, dx$$
$$\mathcal{FS}^{-1}\{F\}(x) = f(x) = \sum_{n=-\infty}^{\infty} F[n]\, e^{i2\pi(nx)/T}$$

$$\mathcal{F}\{f\}(k) = F(k) = \int_{-\infty}^{\infty} f(x) \exp\left(-i\, 2\pi\, kx\right) dx$$
$$\mathcal{F}^{-1}\{F\}(x) = f(x) = \int_{-\infty}^{\infty} F(k) \exp\left(i\, 2\pi\, kx\right) dk$$

$$\mathcal{D}\{f\}(k) = F(k) = \sum_{n=-\infty}^{\infty} f[n] e^{-i2\pi\, nk}$$
$$\mathcal{D}^{-1}\{F\}[n] = f[n] = \int_0^1 F(k)\, e^{i2\pi nk}$$

$$\mathsf{DFT}\{f\}[k] = F[k] = \sum_{n=0}^{N-1} f[n] \exp\left(-i2\pi \frac{nk}{N}\right)$$
$$\mathsf{DFT}^{-1}\{F\}[n] = f[n] = \sum_{k=0}^{N-1} F[k] \exp\left(i2\pi \frac{nk}{N}\right)$$