THE UNIVERSITY OF TEXAS AT AUSTIN
Dept. of Electrical and Computer Engineering

EE313 Linear Systems and Signals
Problem Set #6: Difference Equations and Discrete-Time Stability

Prof. Brian L. Evans

Date assigned:	October 9, 2010
Date due:	October 14, 2010

Homework is due at 11:00 am sharp in class. Late homework will not be accepted.

Reading: *Signals and Systems*, ch. 3

You may use any computer program to help you solve these problems, check answers, etc.

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be absolutely sure to submit your own independent homework solution."

The office hours in ENS 433B for Prof. Evans follow:

- Tuesdays 12:15pm–1:00pm (right after lecture)
- Wednesdays 12:30pm–2:00pm
- Thursdays 12:15pm–1:00pm (right after lecture)
- Fridays 9:30am–11:00am

Prof. Evans will not be available for his coffee hour on Friday afternoon, October 15th. Prof. Evans can be reached at `bevans@ece.utexas.edu`.

The teaching assistant is Mr. Jackson Massey. His office hours will be on Wednesdays 4:00pm–7:00pm in ENS 138. Mr. Massey can be reached at `jackson.massey@gmail.com`.

The ECE Department is offering tutoring sessions for all basic sequence ECE courses, including EE 313, on Sundays through Thursdays, 7:00–10:00 pm, in ENS 314. Mr. Massey will be a tutor during the Monday and Wednesday evening sessions.

Problem 6.1 Difference Equations and Stability

A discrete-time linear time-invariant (LTI) system is described by the following causal difference equation:

$$y[n] = (2\cos\Omega_0)y[n-1] - y[n-2] + (\sin\Omega_0)x[n-1]$$

(a) Find the impulse response of the system.

Hint: The impulse response is zero for $n < 0$.

(b) Is this system bounded-input bounded-output (BIBO) stable?

(c) Describe two applications of this system.

Note: The form of the above difference equation is very common in digital signal processing applications.

Problem 6.2 Discrete-Time Frequency Response
Roberts, Chapter 3, Problem 42.
Here are the specific subparts of the problem to solve:

(a) Find the impulse response $h[n]$. The impulse response is causal, i.e. $h[n] = 0$ for $n < 0$.

(b) Compute the output $y[n] = h[n] * x[n]$ where $x[n] = e^{-j\Omega n}$. The output will be of the following form, as per lecture slide 7-6: $y[n] = H_{\text{freq}}(\Omega)\, e^{-j\Omega n}$.

(c) Plot the magnitude and phase of the system frequency response, $H_{\text{freq}}(\Omega)$, using MATLAB.

(d) What is the frequency selectivity? Lowpass, highpass, bandpass or bandstop?

Problem 6.3 Difference Equation
Roberts, Chapter 3, Problem 60.
In addition, plot the population of Freedonia on January 1st for all years between 2000 and 2050, inclusive, in Matlab using the stem command.