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

EE313 Linear Systems and Signals
Problem Set #4: Differential Equations and Stability

Prof. Brian L. Evans

Date assigned:	September 17, 2010
Date due:	September 23, 2010

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

Reading: *Signals and Systems*, Section 3.7

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

In addition, Prof. Evans holds a coffee hour on Fridays 1:30pm–2:30pm at a nearby café. 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 will begin offering tutoring sessions for all basic sequence ECE courses, including EE 313, on Sundays through Thursdays, 7:00–10:00 pm, in ENS 318, on Sept. 20th. Mr. Massey will be a tutor during the Monday and Wednesday evening sessions.

You might find Matlab's `roots` command useful for this homework set. For the polynomial $s^2 + 3s + 2$, the roots can be computed in Matlab as

```
>> roots( [1 3 2] )

ans =
     -2
     -1
```

Problem 4.1 Differential Equation

Roberts, Chapter 3, Problem 58.

Problem 4.2 Stability in a Feedback Control System

The following continuous-time linear time-invariant (LTI) system has input $x(t)$ and output $y(t)$:

$$y''(t) + 2y'(t) + Ky(t) = x(t)$$

Here, K represents a real-valued gain that is under either user or computer control to tune a system while it is operating.

(a) Determine the range of K for which the LTI system is stable. So, we would only allow those values of K that yield system stability to be used in an implementation.

(b) Turn in the root locus plot for the above system. Plot the root locus using values of K that show regions of instability and stability.

Please see the homework hints for more information.

Problem 4.3 Acoustic Reverberation

Roberts, Chapter 3, Problem 64

Problem 4.4 Block Diagrams

Roberts, Chapter 3, Problem 68.