# APMA 1930M: Homework Assignment # 5

Due: 11/20/14

## Problem 1 Book problems

1. pg. 148, #3.5

## Problem 2 Drag Model

Consider the equation

$$\ddot{x} + x = -\epsilon|\dot{x}|\dot{x}.$$

1. Use the method of multiple scales to to determine a first order uniform asymptotic expansion.
2. For $\epsilon = 1, .1, .01$, use Mathematica or some other software to plot numerical solutions along with the approximate solutions you obtained using the method of multiple scales. Be sure to plot the solutions for a long enough time to illustrate the multiple scales in the problem.

## Problem 3 van der Pol oscillator

Consider van der Pol's equation:

$$\ddot{x} + x = \epsilon\left(1 - x^2\right)\dot{x}.$$

1. Use the method of multiple scales to to determine a first order uniform asymptotic expansion.
2. For $\epsilon = 1, .1, .01$, use Mathematica or some other software to plot numerical solutions along with the approximate solutions you obtained using the method of multiple scales. Be sure to plot the solutions for a long enough time to illustrate the multiple scales in the problem.

## Problem 4 modified van der Pol oscillator

Consider the equation

$$\ddot{x} + x = \epsilon\left(1 - x^4\right)\dot{x}.$$

1. Use the method of multiple scales to to determine a first order uniform asymptotic expansion.
2. For $\epsilon = 1, .1, .01$, use Mathematica or some other software to plot numerical solutions along with the approximate solutions you obtained using the method of multiple scales. Be sure to plot the solutions for a long enough time to illustrate the multiple scales in the problem.

## Problem 5 van der Pol oscillator with cubic nonlinearity

Consider the equation

$$\ddot{x} + x = \epsilon \left(1 - x^2\right) \dot{x} - \epsilon x^3.$$

1. Use the method of multiple scales to to determine a first order uniform asymptotic expansion.

2. For $\epsilon = 1, .1, .01$, use Mathematica or some other software to plot numerical solutions along with the approximate solutions you obtained using the method of multiple scales. Be sure to plot the solutions for a long enough time to illustrate the multiple scales in the problem.