CS 3500 AA – Numerical Methods I
Fall 2015
Homework Problem Set #9
Due: 11/12/2015

Be sure to do all your work on separate paper, and include all steps where appropriate. All homework must follow the formatting rules posted on Blackboard. For the optional MATLAB exercises, print the output from the command window and attach to the rest of your solutions.

1. Consider the integral $I = \int_1^2 \ln(x+1)\,dx$.
   (a) Determine the exact value of I using integration by parts.
   (b) Approximate I using the composite trapezoidal method with $n = 6$ subintervals. What is the absolute error of the approximation?
   (c) Approximate I using the composite Simpson's 1/3 method with $n = 6$ subintervals. What is the absolute error of the approximation?
   (d) Approximate I using the composite Simpson's 3/8 method with $n = 6$ subintervals. What is the absolute error of the approximation?

2. The integral $I = \int_0^1 e^{-x^2}\,dx$ cannot be expressed in terms of elementary functions, however, integrals such as this play a very important role in fields such as probability and statistics. Approximate I using the composite Simpson's 1/3 method with $n = 8$ subintervals.

3. The following table gives the velocity v of an object t minutes after motion began. Use Simpson's 1/3 method to approximate the total distance traveled during the interval $0 \le t \le 10$.

t (minutes)	0	1	2	3	4	5	6	7	8	9	10
v (centimeters per minute)	0	2.3	5.6	2.4	6.5	3.5	4.0	8.0	6.1	2.3	1.9

4. For each of the following, use the information given in the table to determine the minimum number of subintervals needed to approximate $\int_0^5 f(x)\,dx$ to within 10^{-6}.

$$\max_{0\le x\le 5}\left|f'(x)\right| = 4, \quad \max_{0\le x\le 5}\left|f''(x)\right| = 8, \quad \max_{0\le x\le 5}\left|f'''(x)\right| = 12, \quad \max_{0\le x\le 5}\left|f^{(4)}(x)\right| = 18$$

   (a) Using the composite trapezoidal method.
   (b) Using the composite Simpson's 1/3 method.

5. To approximate $\int_0^2 \sqrt[3]{x+1}\,dx$ to within 10^{-6} of the exact value using the composite trapezoidal rule, what is the minimum number of subintervals needed?

6. **[Bonus]** In each of the following you may need to do a little research to determine the appropriate formula needed to solve each problem. Also, you must use the MATLAB functions in the text (pages 418 & 420) to compute the stated approximation.
   (a) Use the composite trapezoidal method with $n = 24$ subintervals to approximate the volume of the solid formed when the region bounded by $f(x) = \sin\left(\pi x^2\right)e^{-x}$ over the interval $0 \le x \le 1$ is revolved about the x-axis.
   (b) Use the composite Simpson's 1/3 method with $n = 24$ subintervals to approximate the surface area of the solid formed when the region bounded by $y = e^x$ over $0 \le x \le 1$ is revolved about the x-axis.
   (c) Use the composite Simpson's 1/3 method with $n = 24$ to approximate the arc length of the curve defined parametrically by:

$$x = 2\cos(t), \quad y = \sin(t), \quad 0 \le t \le 2\pi$$