

MATH 3340 - Scientific Computing Homework 7

Libao Jin

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The deadline will be strictly enforced. If you do not submit in time there will be a 20% penalty for each day you're late. If you do not submit in time there will be a 20% penalty upfront plus another 20% for each day you're late. Remember that you are allowed to work in teams of two on this assignment. You are encouraged to prepare your work in \LaTeX ; a template will be provided to help you put it all together. If you choose to submit a hard copy, you may submit only one copy for a team, indicating the names of both contributors. Online submission is encouraged, however, in that case both members of a team should submit the PDF file containing their work and showing both their names.

All plots generated in this homework should have a title, legend, and labeled x and y -axes.

Instruction

1. Go to <https://www.overleaf.com> and sign in (required).
2. Open [template](#), click *Menu* (up left corner), then *Copy Project*.
3. Go to `LaTeX/meta.tex` (the file `meta.tex` under the folder `LaTeX`) to change the section and your name, e.g.,
 - change title to `\title{MATH 3340-01 Scientific Computing Homework 7}`
 - change author to `\author{Albert Einstein \& Carl F. Gauss}`
4. For Problem 1 and 2, you are encouraged to type solutions in \LaTeX . But if you want to write it on the printout, make sure your scanned work is *clear* enough, and compile all solutions *in order*, i.e., 1, 2, 3, in a single PDF (failure to do so will lead to points deduction).
5. For Problem 3, you need to write function/script files, store results to output files, and save graphs to figure files. Here are suggested names for function files, script files, output files, and figure files:

Problem	Function File	Script File	Output File	Figure File
3	<code>gauss_quad.m</code>	<code>hw7_p3.m</code>	<code>hw7_p3.txt</code>	

Once finished, you need to upload these files to the folder `src` on Overleaf. If you have different filenames, please update the filenames in `\lstinputlisting{./src/your_script_name.m}` accordingly. You can code in the provided files in [hw7.zip](#), and use the MATLAB script `save_results.m` to generate the output files and store the graphs to `.pdf` files automatically (the script filenames should be exactly same as listed above).

6. Recompile, download and upload the generated PDF to WyoCourses.
7. You may find [\$\text{\LaTeX}\$.Mathematical.Symbols.pdf](#) and the second part of [Lab 01 Slides](#) and [Lab 02 Slides](#) helpful.

1 Problem 1

Calculate, by hand, the value of

$$\int_0^{2\pi} x^2 \sin^2 x \, dx$$

using both the composite trapezoidal rule and the composite Simpson's rule. For a fair comparison, keep the same number of function evaluations at five equally spaced points: $\{x_0, x_1, x_2, x_3, x_4\}$. Keep a minimum of four decimal places in all your calculations.

Solution.

- Composite Trapezoidal Rule:

- Composite Simpson's Rule:

□

2 Problem 2

This computation should again be done by hand. Use Gauss quadrature with $N = 2$, $N = 3$ and $N = 4$ to compute the approximate value for

$$I = \int_1^3 (x^3 - 1)e^{-x^2} dx.$$

Perform all calculations by rounding off to four decimal places.

Solution.

- Gauss quadrature with $N = 2$:

- Gauss quadrature with $N = 3$:

- Gauss quadrature with $N = 4$:

□

3 Problem 3

Write a MATLAB code that implements the Gauss quadrature calculation in the problem above, but allows for a wider range of values of N , from $N = 1$ through $N = 5$.

Solution.

- Output file hw7_p3.txt:

```

1 Summary for f(x) = x^2 + cos(x): (REPLACE THIS FILE WITH YOUR OWN)
2   N   I_gauss
3   1   4.000000
4   2   6.950103
5   3   7.159114
6   4   7.151795
7   5   7.151930

```

- Function file richardson.m:

```

1 function [I] = gauss_quad(f, a, b, N)
2 %gauss_quad: Gauss Quadrature on a general interval [a, b]
3 % Syntax: [I] = gauss_quad(f, a, b, N)
4 % Inputs:
5 %   f = the integrand (function handle)
6 %   a = lower limit of the integral (scalar)
7 %   b = upper limit of the integral (scalar)
8 %   N = the number of Gauss nodes (scalar)
9 % Outputs:
10 %   I = the values of the integration (scalar)
11 %
12 % Author: first_name last_name
13 % Date: mm/dd/yyyy
14
15 % PUT YOUR CODE HERE
16
17 end

```

- Script file hw7_p3.m:

```

1 % MATH 3340, Semester
2 % Homework 7, Problem 3
3 % Author: first_name last_name
4 % Date: mm/dd/yyyy
5
6 clear; close all; clc;
7
8 % PUT YOUR CODE HERE

```

□