MATH 3341 — Spring 2020

Lab 11: MATLAB Integration Routines & Gauss Quadrature

Download `Math.3341.Lab.11.zip`, unzip it by following the Windows Instructions on WyoCourses. Change the current working directory of MATLAB to the unzipped folder, and type `edit lab_11_script` in the Command Window.

1 Built-in Integration Functions

(a) Use both `polyint` and `integral` to evaluate $\int_{-1}^{3} (x^2 - 2x + 1)\,dx$.

(1) Define the lower bound `a` and upper bound `b`.

(2) Define the polynomial `P` as $p(x) = x^2 - 2x + 1$.

(3) Integrate $p(x) = x^2 - 2x + 1$ using `polyint` and store the result to `pI`.

(4) By fundamental theorem of calculus, evaluate the integral `pI` on $[a, b]$ using `polyval` and store the result to `pI_value`.

(5) Define the anonymous function `f` by $f(x) = x^2 - 2x + 1$, and then use `integral` to evaluate $\int_{-1}^{3} (x^2 - 2x + 1)\,dx$ and store it to `I`.

(b) Evaluate the previous integral again, now using `trapz` and `cumtrapz`.

(c) Use `integral2` to evaluate $\int_{-\pi}^{-3\pi/2} \int_{0}^{2\pi} (y \sin x + x \cos y)\,dy\,dx$.

(d) Use `integral3` to evaluate $\int_{0}^{1} \int_{x^2}^{x} \int_{x-y}^{x+y} y\,dz\,dy\,dx$.

2 Gauss Quadrature

(a) Implement Gauss quadrature using n Gauss nodes, which is given by Equation (2.1), in the function file `gauss_quad.m`.

$$\int_{-1}^{1} f(x)\,dx \approx \sum_{i=1}^{n} w_i f(x_i). \tag{2.1}$$

(b) Use `gauss_quad` to evaluate the integral

$$\int_{1}^{1.6} \frac{2x}{x^2 - 4}\,dx,$$

with $n = 1, 2, \ldots, 15$ Gauss nodes.

Note: `legendre_pair.m` is provided to calculate x_i and w_i. Use `help legendre_pair` to check the usage.

At last, call `diary('lab_11_output.txt')`, run the scripts `lab_11_script.m`, then call `diary off`. You will upload the script files `lab_11_script.m`, `lab_11_output.txt`, and `gauss_quad.m` to Overleaf. Then recompile, and submit the generated .pdf file on WyoCourses.