

Lab 11

1. Write an m-file function that evaluates $\int_0^{2\pi} \sin^2(x) dx$ using the composite trapezoid rule, and composite Simpson’s rule, with four nodes per panel. Place the calls to Trapezoid, and Simpson inside a loop and repeat the calculations for $np = [2\ 4\ 8\ 16\ 32\ 64]$, where np is the number of panels. Record the number of function evaluations, n , for each method.

2. (a) Write a script file to integrate a function contained in an m-file using the Simpson rules. Use your numerical integration scheme to evaluate

$$I = \int_0^{\infty} \exp(-x)\sin(2x)dx .$$

Note that you cannot integrate to ∞ , but the integrand decays rapidly, so practically you may truncate the integral at some finite distance from the origin. Plot the integrand and choose the practical upper limit for numerical integration.

(b) Compute the integral for several values of n (the number of integration points), ranging for 1 – 10 using Simpson’s rule. Make a table comparing the values.

(c) Use MATLAB functions trapz or quad to integrate the function and compare with your answers.

3. F.M. White gives the following data for the velocity profile in a round pipe,

r / R	0.0	0.102	0.206	0.412	0.617	0.784	0.846	0.907	0.963
u / u_c	1.0	0.997	0.988	0.959	0.908	0.847	0.818	0.771	0.690

r is the radial position, $R = 12.35$ cm is the radius of the pipe, u is the velocity at the position r , and u_c is the velocity at the centerline $r = 0$. The average velocity in a round pipe is defined by

$$V = \frac{1}{\pi R^2} \int_0^R u 2\pi r dr \quad \text{or} \quad \frac{V}{u_c} = \int_0^1 2 \frac{V}{u_c} \eta d\eta$$

where $\eta = r/R$. What is the value of V for the given data if $u_c = 30.5$ m/s ? Do not forget to include the implied data point $u/u_c = 0$ at $r/R = 1$.