

MATH 609-602 Numerical Analysis
Program assignment #5
Numerical Integration and Richardson Extrapolation

Write a program for evaluation of the following integrals with an error of 0.00001 using composite trapezoidal rule and Richardson extrapolation technique by halving the integration interval. This is the Romberg algorithm from pp. 541-543 of Kincaid and Cheney's Numerical Analysis.

Specifications:

1. The program should be well commented and should use double precision.
2. For stopping criterion use $|R(i, i) - R(i - 1, i - 1)| \leq 0.000001|R(i - 1, i - 1)|$ where $R(i, j)$ are defined recursively using the error expansion of the trapezoidal rule (see p. 541- 544 of your textbook).
3. Write a short report in the usual format containing: (1) Table with all $R(i, i)$ for the integrals; (2) the requested plots.

Computational examples

(1) Evaluate the following integrals:

$$\int_0^2 x^2 e^x dx, \quad \int_0^3 e^{-x^2} dx, \quad 5(e^\pi - 2)^{-1} \int_0^{\pi/2} e^{2x} \cos x dx.$$

(2) Use the program to plot the Bessel function of order zero in the interval $(0, 4)$:

$$J_0(x) = \frac{1}{\pi} \int_0^\pi \cos(x \sin t) dt.$$

Remark: There will be penalties for delay - for each day 5 points (out of 100).