

NAG Library Function Document

nag_sin_integral (s13adc)

1 Purpose

nag_sin_integral (s13adc) returns the value of the sine integral

$$\text{Si}(x) = \int_0^x \frac{\sin u}{u} du,$$

2 Specification

```
#include <nag.h>
#include <nags.h>
double nag_sin_integral (double x)
```

3 Description

nag_sin_integral (s13adc) calculates an approximate value for $\text{Si}(x)$.

For $|x| \leq 16.0$ it is based on the Chebyshev expansion

$$\text{Si}(x) = x \sum_{r=0}^l a_r T_r(t), \quad t = 2 \left(\frac{x}{16} \right)^2 - 1.$$

For $16 < |x| < x_{\text{hi}}$, where x_{hi} is an implementation-dependent number,

$$\text{Si}(x) = \text{sign}(x) \left\{ \frac{\pi}{2} - \frac{f(x) \cos x}{x} - \frac{g(x) \sin x}{x^2} \right\}$$

where $f(x) = \sum_{r=0} f_r T_r(t)$ and $g(x) = \sum_{r=0} g_r T_r(t)$, $t = 2 \left(\frac{16}{x} \right)^2 - 1$.

For $|x| \geq x_{\text{hi}}$, $\text{Si}(x) = \frac{1}{2}\pi \text{sign } x$ to within *machine precision*.

4 References

Abramowitz M and Stegun I A (1972) *Handbook of Mathematical Functions* (3rd Edition) Dover Publications

5 Arguments

1: **x** – double

Input

On entry: the argument x of the function.

6 Error Indicators and Warnings

None.

7 Accuracy

If δ and ϵ are the relative errors in the argument and result, respectively, then in principle

$$|\epsilon| \simeq \left| \frac{\delta \sin x}{\text{Si}(x)} \right|.$$

The equality may hold if δ is greater than the *machine precision* (δ due to data errors etc.) but if δ is simply due to round-off in the machine representation, then since the factor relating δ to ϵ is always less than one, the accuracy will be limited by *machine precision*.

8 Parallelism and Performance

Not applicable.

9 Further Comments

None.

10 Example

This example reads values of the argument x from a file, evaluates the function at each value of x and prints the results.

10.1 Program Text

```

/* nag_sin_integral (s13adc) Example Program.
 *
 * Copyright 2014 Numerical Algorithms Group.
 *
 * Mark 1, 1990.
 */

#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nags.h>

int main(void)
{
    Integer exit_status = 0;
    double x, y;

    /* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n]");
#else
    scanf("%*[\n]");
#endif
    printf("nag_sin_integral (s13adc) Example Program Results\n");
    printf("      x              y\n");
#ifdef _WIN32
    while (scanf_s("%lf", &x) != EOF)
#else
    while (scanf("%lf", &x) != EOF)
#endif
    {
        /* nag_sin_integral (s13adc).
         * Sine integral Si(x)
         */
        y = nag_sin_integral(x);
    }
}

```

```
    printf("%12.3e%12.3e\n", x, y);  
  }  
  
  return exit_status;  
}
```

10.2 Program Data

```
nag_sin_integral (s13adc) Example Program Data  
    0.0  
    0.2  
    0.4  
    0.6  
    0.8  
    1.0
```

10.3 Program Results

```
nag_sin_integral (s13adc) Example Program Results  
    x          y  
0.000e+00  0.000e+00  
2.000e-01  1.996e-01  
4.000e-01  3.965e-01  
6.000e-01  5.881e-01  
8.000e-01  7.721e-01  
1.000e+00  9.461e-01
```

