# Numerical Analysis. Exercise 08

## Task 1. Numerical Differentiation

For function **f(x) = sin(x)** calculate the derivative at points 0, 0.1PI, 0.2PI, 0.3PI, 0.4PI, 0.5PI
**a)** using forward difference formula with h = 0.025PI;
**b)** using central difference formula with h = 0.025PI.

Create computer code, which performs computations a-b. The output of your code should contain the following for two methods:

*Method*
*x, Derivative value, Error*

Here *Derivative value* is the value obtained by numerical differentiation, *Error* is the difference between your numerical value and the exact value.

## Task 2. Numerical Integration

Calculate the following integral using different methods:

$$I = \int_0^1 \frac{dx}{x^2+1} = \arctan(1) = \frac{\pi}{4}$$

**a)** Use trapezoidal rule with $n = 24$ ($n$ is the number of subintervals for integration).

**b)** Use Simpson's 1/3 rule with $n = 24$.

Create computer code, which performs computations. The output of your code should contain the following for all methods:

*Method*
*Integral value, Error, Relative error (%)*

Here *Integral value* is the value obtained by numerical integration, *Error* is the difference between your numerical value and the exact value.

---

The results may be as follows:

```
Numerical differentiation
```

```
Forward difference
x = 0.0 PI  Deriv =   0.998972   Error =  -0.001028
x = 0.1 PI  Deriv =   0.937950   Error =  -0.013106
x = 0.2 PI  Deriv =   0.785115   Error =  -0.023902
x = 0.3 PI  Deriv =   0.555427   Error =  -0.032358
x = 0.4 PI  Deriv =   0.271371   Error =  -0.037646
x = 0.5 PI  Deriv =  -0.039250   Error =  -0.039250

Central difference
x = 0.0 PI  Deriv =   0.998972   Error =  -0.001028
x = 0.1 PI  Deriv =   0.950079   Error =  -0.000977
x = 0.2 PI  Deriv =   0.808186   Error =  -0.000831
x = 0.3 PI  Deriv =   0.587181   Error =  -0.000604
x = 0.4 PI  Deriv =   0.308699   Error =  -0.000318
x = 0.5 PI  Deriv =   0.000000   Error =  -0.000000

Numerical integration
I = Integral(1/(x^2+1)), limits: [0,1]

Trapezoidal rule, nsub = 24
I =   0.785325825437   Error =  -7.2338e-05   R =  -9.21e-03 %

Simpson 1/3 rule, nsub = 24
I =   0.785398163346   Error =  -5.1911e-11   R =  -6.61e-09 %
```

Show source code and demonstrate results to your teaching assistant.