

# Computing for Mathematics: Handout 3

This handout contains a summary of the topics covered and an activity to carry out prior or during your lab session.

At the end of the handout is a specific coursework like exercise.

For further practice you can do the exercises available at the calculus chapter of Python for Mathematics.

## 1 Summary

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The purpose of this handout is to cover Calculus which corresponds to the Calculus chapter of Python for Mathematics.

The topics covered are:

- Getting the derivative of a symbolic expression.
- Getting the indefinite integral of a symbolic expression.
- Getting the definite integral of a symbolic expression.
- Getting the limit of a symbolic expression.

## 2 Activity

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We will be tackling the problem from the tutorial of the Calculus chapter of Python for Mathematics.

Consider the function  $f(x) = \frac{24x(a-4x)+2(a-8x)(b-4x)}{(b-4x)^4}$

1. Given that  $\frac{df}{dx}|_{x=0} = 0$ ,  $\frac{d^2f}{dx^2}|_{x=0} = -1$  and that  $b > 0$  find the values of  $a$  and  $b$ .
2. For the specific values of  $a$  and  $b$  find:
  - (a)  $\lim_{x \rightarrow 0} f(x)$ ;
  - (b)  $\lim_{x \rightarrow \infty} f(x)$ ;
  - (c)  $\int f(x)dx$ ;
  - (d)  $\int_5^{20} f(x)dx$ .

There are instructions for how to do all of this is in the Calculus chapter of Python for Mathematics.

1. Create the variable `expression` which has value  $f(x) = \frac{24x(a-4x)+2(a-8x)(b-4x)}{(b-4x)^4}$ .
2. Use the `sympy.diff` command to obtain the derivative.
3. Create the variable `first_equation` which has value the equation that comes from the first condition of the question:  $\frac{df}{dx}|_{x=0} = 0$ .
4. Create the variable `second_equation` which has value the equation that comes from the second condition of the question:  $\frac{d^2f}{dx^2}|_{x=0} = -1$ .
5. Solve both equations (use substitution if you helpful) and recalling that  $b > 0$  substitute the correct values of  $a$  and  $b$  in to `expression`.
6. Obtain the required limits.

### 3 Coursework like exercise

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Consider the second derivative  $f''(x) = 4x + \cos(x)$ .

1. Create a variable `derivative` which has value  $f'(x)$  (use the variables `x` and `c1` if necessary):
2. Create a variable `equation` that has value the equation  $f'(0) = 0$ .
3. Using the solution to that equation, output the value of  $\int_0^{5\pi} f(x)dx$ .

### 4 Summary examples

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Calculate the second derivative of  $\cos(x^2)$ :

```
import sympy as sym
x = sym.Symbol("x")
expression = sym.cos(x ** 2)
sym.diff(expression, x, 2)
```

Calculate the indefinite integral of  $e^x$

```
import sympy as sym
x = sym.Symbol("x")
expression = sym.exp(x)
sym.integrate(expression, x)
```

Calculate the definite integral  $\int_0^5 1/x$

```
import sympy as sym
x = sym.Symbol("x")
expression = 1 / x
sym.integrate(expression, (x, 0, 5))
```

Obtain the limit  $\lim_{h \rightarrow \infty} \frac{1}{\cos^2(x)}$

```
import sympy
x = sympy.Symbol("x")
expression = 1 / (sym.cos(x) ** 2)
sym.limit(expression, x, sym.oo)
```