

# Integration Methods: by Substitution and by Parts

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## Overview

The objective of this lab is to use Maple to help you practice your integration skills, such as integration by substitution and integration by parts. Several interactive tools are introduced as follows:

## Maple Essentials

- The *Integration Methods* tutor is started from the Maple 9.5 user interface under the Tools menu:

Tools → Tutors → Calculus - Single Variable → Integration Methods...

This tutor will, in individual steps, check your inputs, give hints, or show answers for a user-specified indefinite or definite integral. It is a great tool to use when you need a quick hint for a difficult problem or want to check your work and answer to a homework problem. It is like to have a personal tutor available 24-7. However, there are a few things that you should know:

1. There are many different ways to calculate an integral and maple's way may be different from yours. If you use maple to check your work, be aware that maple may insist on his way even if yours is correct or better. On the other hand, if you use the tutor to get a hint for a homework problem, it in general will do a good job.
  2. Because of the constant  $c$  in integral formulas, your final answer to an indefinite integral may look very different from the one given by Maple but both could be correct. The best way to be sure in such cases is to take the derivative of the difference to see if it equals to zero.
  3. The maple is very capable in finding integrals and the tutor may show some methods that we have not learned yet.
  4. Since you do need to know how to calculate integrals by hand, don't depends on Maple too much. Don't just let the tutor do problems for you. Instead, it should be used as a tool to help you understand what taught in your class.
- The *Integration by Substitution* maplet is available from the course website:  
<http://www.math.sc.edu/calclab/142L-S06/labs> → Integration by Substitution

This maplet is designed to help you to understand integration by the method of substitutions following individual steps. When click on **Indefinite Integral** or on **Definite Integral**, the maplet will generate a problem for you to practise. Make sure that you type in your answers with correct syntax. For a definite integral, you will be asked to calculate the associated indefinite integral first. You can then select either to change integral limits from the original variable to the new variable or to substitute the original variable back. Click on **Hint** or **Show** if you need help.

- The *Integration by Parts* maplet is available from the course website:

<http://www.math.sc.edu/calclab/142L-S06/labs> → Integration by Parts

This maplet is designed to help you to understand the method of integration by parts following individual steps and its interface is very similar to the last maplet. Again, make sure that you type in your answers with correct syntax.

### *Related course material*

§6.3 and §8.2 of the textbook.

### *Activities*

1. Use the *Integration Methods* tutor to help you to evaluate  $\int x^3 e^{x^2} dx$  (Exercise 17 on page 520):
  - (a) Start a Maple session and launch the *Integration Methods* tutor.
  - (b) Enter the function  $x^3 \cdot \exp(x^2)$  in the **Function** box and proceed. (If it were a definite integral, you need to input integral limits in **From** and **To** boxes).
  - (c) If you are not sure what to do, click on **Hint** and you will see the following the **Messages** window: `[parts, x^2, 1/2*exp(x^2)], [change, u = x^2, u]` could be applied. It suggests to use parts first with  $u = x^2$  and  $v = e^{x^2}/2$  and then a  $u$ -substitution with  $u = x^2$ . Notice that  $u = x^3$  won't work since  $v = \int e^{x^2} dx$  cannot be evaluated. You may apply hints step by step (click on **Apply Hints repeatedly** or see all steps at once (click on **All Steps**)).
  - (d) Your TA will give you more problems to work on and you may want to use the tutor to help you with some of your homework problems. Make sure to change the variable name in the **Variable** box to the one used in the **Function** box.
2. Launch *Integration by Substitution* maplet from the course web and do a few practice problems.
3. Launch *Integration by Parts* maplet from the course web and do a few practice problems.

### *Assignment*

Complete lab activities and use maple's *Integration Methods* tutor to do exercises 20, 24, and 40 on page 520.