Chapter 13 / **Example 13**

Definite integrals with technology

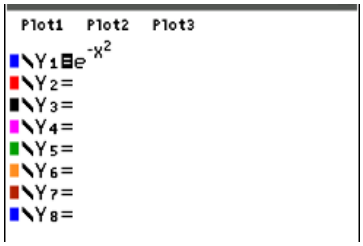
There are techniques of integration beyond the scope of this course, however, use technology to find the values of definite integrals of these functions.

a Find the area of the region bounded by the curve $f(x) = e^{-x^2}$, the lines $x = -1$ and $x = 1$, and the x-axis.

b Find the area of the region bounded by the curves $f(x) = \sin x$ and $g(x) = 0.5x$.

Press [f1] [y=] to display the equation entry screen.

Type e^{-x^2} and press [enter] to enter the equation as Y_1.

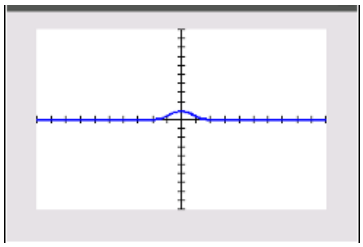


Press [f5] [graph] to display the graph screen

The GDC now displays the function:

$Y_1 = e^{-x^2}$

The default axes are $-10 \le x \le 10$ and $-10 \le y \le 10$.

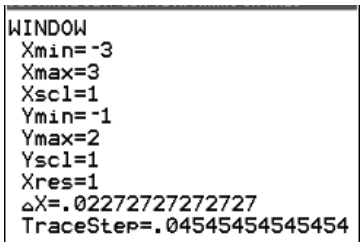


Press [f2] [window]

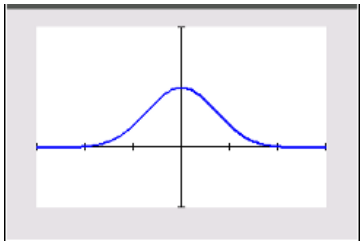
Set the axes to show $-3 \le x \le 3$ and $-1 \le y \le 2$

You can leave the last three items as they are.

Press [f5] [graph] when you have finished.



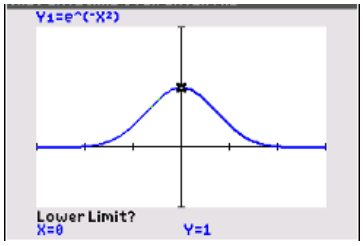
The GDC displays the function $Y_1 = e^{-x^2}$ in a suitable window.



To find the integral press [2nd] [f4] [calc] 7:∫f(x)dx

To find the area you need to give the lower and upper limits of the region that includes the intersection.

The GDC asks you to set the lower limit.



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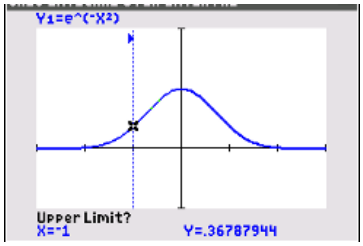
Type -1 and press enter.

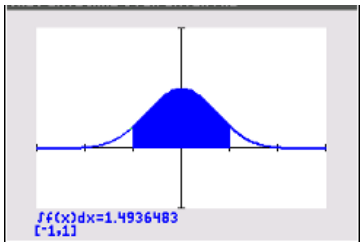
The GDC asks you to set the upper limit.



Type 1, the upper limit, and press enter.

The GDC shows the area defined by the integral and its value.

$\int_{-2}^{2} e^{-x^2}\,\mathrm{d}x = 1.49$

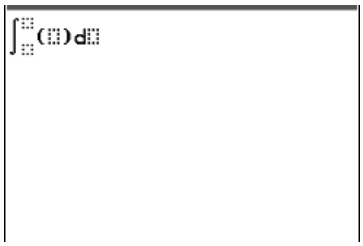


The integral can also be calculated without the need for a graph.

Press 2nd [quit].

To enter the integral template press MATH [f2] 4:fnInt(.

The template shows places for the limits, the function and the variable that you are integrating with respect to.



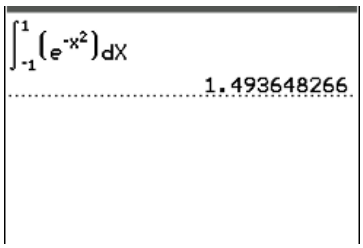
Enter the lower limit -1 and using the upper limit 1.

Enter the function e^{-x^2}

Use ◄ ► ▲ ▼ to navigate around the template.

Type X.

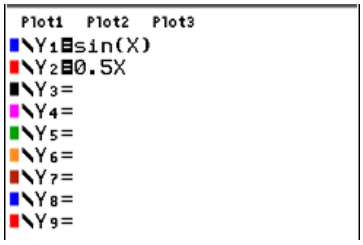
Press enter.



Press [f1] y= to display the equation entry screen.

Type $\sin x$ and press enter to enter the equation as Y_1.

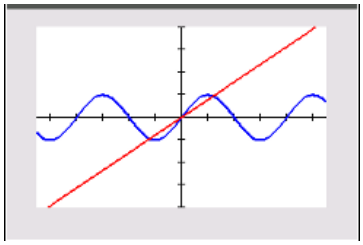
Type $0.5x$ and press enter to enter the equation as Y_2.



Press [f3] zoom 7:ZTrig to display the graph screen

The GDC now displays the functions:

$Y_1 = \sin x$ and $Y_2 = 0.5x$ with the default trigonometric axes.



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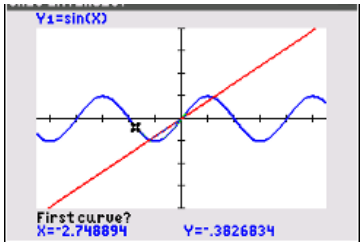
Find the intersection points and then the areas under each of the curves between these limits. To find the area bounded by the two curves you will need to subtract the areas.

Press [2nd] [f4] [calc] 5:intersect

To find the intersection you need to choose the two lines that intersect.

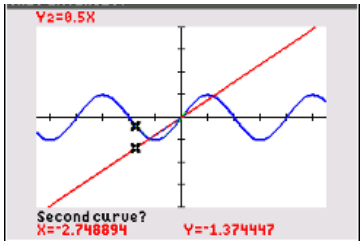
The GDC shows a cross on one of the lines and 'First curve?'.

Press [enter].



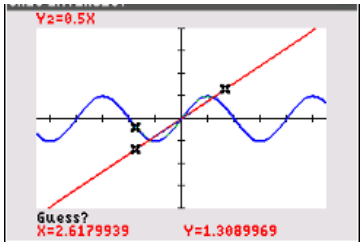
The GDC shows a cross on the other line and 'Second curve?'.

Press [enter].



The GDC requires an initial guess for the position of the intersection. Choose a point near the right-hand intersection by pressing [◀] [▶].

Press [enter].

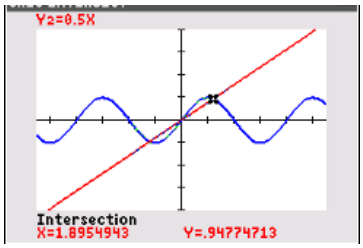


The GDC displays the intersection of the two straight lines at the point $(1.90, 0.948)$.

To store an accurate value of the area press [2nd] [quit] to enter the home screen.

Press [sto→] [X,T,θ,n] A and press [enter].

Using the symmetry of the curve the intersections are at $x = -1.90$, $x = 0$ and $x = 1.90$ The area between the curve and the line will be twice the area from 0 to 1.90.

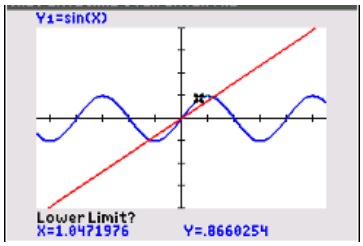


Press [2nd] [calc] 7:∫f(x)dx

Make sure that Y_1 is selected.

To find the area you need to give the lower and upper limits of the region that includes the intersection.

The GDC asks you to set the lower limit.



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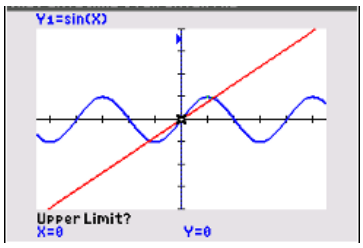
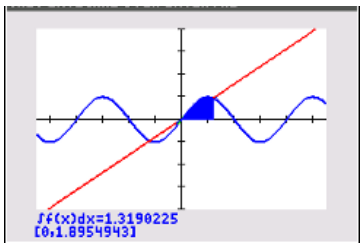
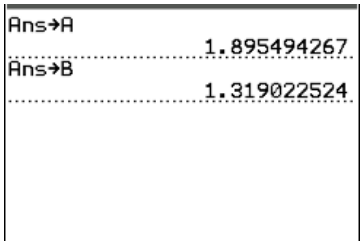
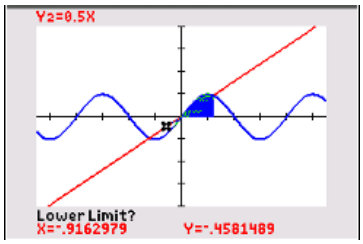
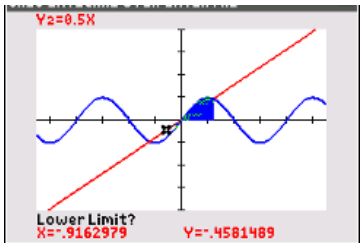
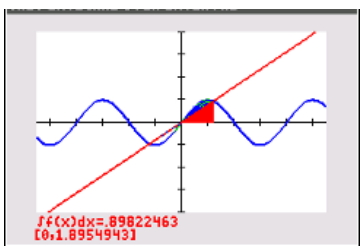
Type 0 and press [enter]. The GDC asks you to set the upper limit.	
Type [ALPHA] A and press [enter]. (The value of the x-coordinate is stored in the GDC as X) The area under the line Y_1 is 1.32	
To store an accurate value of the area press [2nd] [quit] to enter the home screen. Press [sto→] [ALPHA] B and press [enter].	
Press [2nd] [calc] 7: ∫f(x)dx Make sure that Y_2 is selected. To find the area you need to give the lower and upper limits of the region that includes the intersection. The GDC asks you to set the lower limit.	
Type 0 and press [enter]. The GDC asks you to set the upper limit.	
Type [ALPHA] A and press [enter]. The area under the line Y_2 is 0.898.	

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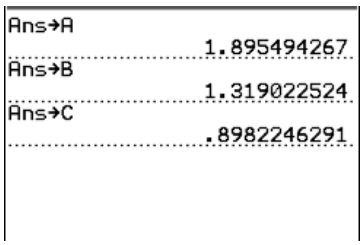
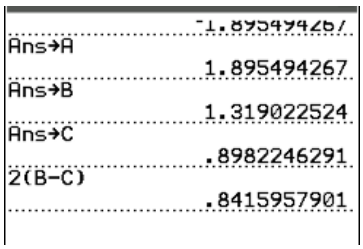
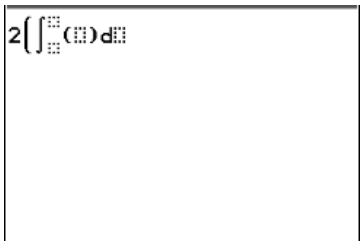
Definite integrals with technology

To store an accurate value of the area press [2nd] [quit] to enter the home screen. Press [sto→] [X,T,θ,n] C and press [enter].	
Type 2 ([X,T,θ,n] B [−] [X,T,θ,n] C) The GDC has calculated the difference between the two areas which is the area between the curve and the line. The area of the region is 0.842.	
To calculate $2\left(\int_0^A (Y_1 - Y_2)\right) dx$ Type 2 (and enter the integral template by pressing [X,T,θ,n] [f2] 4:fnInt(. The template shows places for the limits, the function and the variable that you are integrating with respect to.	
Enter the lower limit 0 and [ALPHA] A for the upper limit Type [ALPHA] [f4] 1:Y_1 − [ALPHA] [f4] 2:Y_2 Use [◄] [►] [▲] [▼] to navigate around the template. Type X and close the parentheses. Press [enter].