

Multiple Integration Program

User Manual

What's included in this Zip File:

- 1) MLTIINT.89p
- 2) MLTIINT_Manual.pdf

Features:

- 1) The program can integrate **single**, **double**, or even **triple** integrals!
- 2) Depending on the type of integration done, you can integrate in **rectangular**, **polar**, **cylindrical**, or even **spherical** coordinates!
- 3) Its menu operated, select options through drop-down boxes.
- 4) Only required input needed is the function your integrating and its upper and lower limits (with respect to particular variable(s))!

Sample Problems

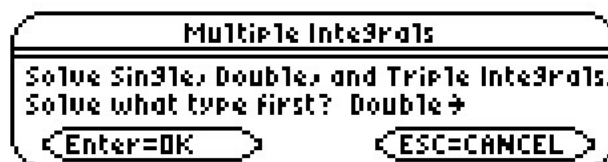
1)

Use a double integral to find the area of the region R enclosed between the parabola $y = \frac{1}{2}x^2$ and the line $y = 2x$.

The integration formula is $\int_0^4 \int_{x^2/2}^{2x} dy dx$ (Verify).

Let's take this step by step:

- a) Start the program and drop-down to Double and press Enter.



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USE ← AND → TO OPEN CHOICES

- b) At the next menu, the option highlighted is 'Polar'. Use the drop-down box and select Rect. Press Enter.

F1→ Tools	F2→ Algebra	F3→ Calc	F4→ Other	F5 Pr3md	F6→ Clean Up	
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Double Integrals	
Solve Double Integrals in Rect or Polar Coord. Which One? Rect. →	
←Enter=OK→	←ESC=CANCEL→

 $\text{math}\backslash\text{m1tiint}()$

 USE ← AND → TO OPEN CHOICES

- c) At the next menu, select the order of integration dydx and then press Enter.

F1→ Tools	F2→ Algebra	F3→ Calc	F4→ Other	F5 Pr3md	F6→ Clean Up	
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Double Integrals in Rect Coord.	
Please Define order of Integration Order? dydx →	
←Enter=OK→	←ESC=CANCEL→

 $\text{math}\backslash\text{m1tiint}()$

 USE ← AND → TO OPEN CHOICES

- d) You are prompted to put in $f(x,y)$. In this case, $f(x,y)$ is equal to 1. So type in 1 and then press Enter.

F1→ Tools	F2→ Algebra	F3→ Calc	F4→ Other	F5 Pr3md	F6→ Clean Up	
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$f(x,y)=$
1
Upper Limit on y
|

- e) You are then prompted to put in the upper limit of y.
Type 2x and then press Enter.

\int	\int	\int	\int	\int	\int	
1000	1000	1000	1000	1000	1000	

f(x,y)=
1
Upper Limit on y
2x
Lower Limit on y
|

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- f) You are then prompted to put in the lower limit of y.
Type (x^2)/2 and then press Enter.

\int	\int	\int	\int	\int	\int	
1000	1000	1000	1000	1000	1000	

1
Upper Limit on y
2x
Lower Limit on y
(x^2)/2
Upper Limit on x
|

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- g) You are then prompted to put in the upper limit of x.
Type 4 and then press Enter.

\int	\int	\int	\int	\int	\int	
1000	1000	1000	1000	1000	1000	

2x
Lower Limit on y
(x^2)/2
Upper Limit on x
4
Lower Limit on x

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- h) You are then prompted to put in the lower limit of x.
Type 0 and then press Enter. The answer is outputted.

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│F1=│ │F2=│ │F3=│ │F4=│ │F5=│ │F6=│ │F7=│
│1/4:│ │1/2:│ │1/3:│ │1/4:│ │1/5:│ │1/6:│ │1/7:│
└───┘ └───┘ └───┘ └───┘ └───┘ └───┘ └───┘
(x^2)/2
Upper Limit on x
4
Lower Limit on x
0
The Answer is
16/3
MAIN      RAD AUTO  FUNC  PAUSE

```

Let's verify the answer analytically.

$$\int_0^4 \int_{\frac{x^2}{2}}^{2x} dy dx = \int_0^4 [y]_{y=\frac{x^2}{2}}^{2x} dx = \int_0^4 \left(2x - \frac{1}{2}x^2 \right) dx = \left[x^2 - \frac{1}{6}x^3 \right]_0^4 = \frac{96-64}{6} = \frac{32}{6} = \frac{16}{3}.$$

This is the typical way you would solve a double integral. Now let's try a triple integral problem.

2)

Using spherical coordinates, find the volume of the solid that is bounded above by the sphere

$$\rho = 4 \text{ and the cone } \phi = \frac{\pi}{3}.$$

The integration formula is $\int_0^{2\pi} \int_0^{\frac{\pi}{3}} \int_0^4 \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta$ (Verify).

- a) Go back to the home screen by selecting Go Back from the dropdown menu. Select Triple and then press Enter.

```

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│F1=│ │F2=│ │F3=│ │F4=│ │F5=│ │F6=│ │F7=│
│1/4:│ │1/2:│ │1/3:│ │1/4:│ │1/5:│ │1/6:│ │1/7:│
└───┘ └───┘ └───┘ └───┘ └───┘ └───┘ └───┘

Multiple Integrals
Solve Single, Double, and Triple Integrals.
Solve what type first? TRIPLE →
<Enter=OK>      <ESC=CANCEL>

USE ← AND → TO OPEN CHOICES

```

- b) At the next menu, you are asked to select the coordinate system you want to integrate in. Select Spher. and then press Enter.

\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1
\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1

Triple Integrals

Solve Triple Integrals in diff coor systems.
In which Coor. System? Spher. \rightarrow

Enter=OK ESC=CANCEL

USE \leftarrow AND \rightarrow TO OPEN CHOICES

- c) At the next menu, you are asked what order of integration should be used. Select $dpd\phi d\theta$ and then press Enter.

\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1
\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1

Triple Integrals in Spherical Coor.

Again there are six orders of integration!
What's the Order? $dpd\phi d\theta \rightarrow$

Enter=OK ESC=CANCEL

USE \leftarrow AND \rightarrow TO OPEN CHOICES

- d) You are then asked to input $f(\rho, \phi, \theta)$. Type 1 and then press Enter.

\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1
\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1	\int_0^1

$f(\rho, \phi, \theta) =$
1
Upper Limit on ρ

- e) You are then asked for the upper limit of ρ . Type 4 and then press Enter.

ρ	ϕ	θ	ρ	ϕ	θ	
--------	--------	----------	--------	--------	----------	--

$f(\rho, \phi, \theta) =$
 1
 Upper Limit on ρ
 4
 Lower Limit on ρ
 |

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- f) You are then asked for the lower limit of ρ . Type 0 and then press Enter.

ρ	ϕ	θ	ρ	ϕ	θ	
--------	--------	----------	--------	--------	----------	--

1
 Upper Limit on ρ
 4
 Lower Limit on ρ
 0
 Upper Limit on ϕ

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- g) You are then asked for the upper limit of ϕ . Type $\pi/3$ and then press Enter.

ρ	ϕ	θ	ρ	ϕ	θ	
--------	--------	----------	--------	--------	----------	--

4
 Lower Limit on ρ
 0
 Upper Limit on ϕ
 $\pi/3$
 Lower Limit on ϕ
 |

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RAD AUTO
FUNC
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- h) You are then asked for the lower limit of ϕ . Type 0 and then press Enter.

ϕ	ϕ	θ	θ	π	π	
$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	

0

Upper Limit on ϕ
 $\pi/3$
 Lower Limit on ϕ
 0
 Upper Limit on θ

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- i) You are then asked for the upper limit of θ . Type 2π and then press Enter.

ϕ	ϕ	θ	θ	π	π	
$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	

$\pi/3$

Lower Limit on ϕ
 0
 Upper Limit on θ
 2π
 Lower Limit on θ

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- j) You are then asked for the lower limit of θ . Type 0 and then press Enter. The answer is outputted.

ϕ	ϕ	θ	θ	π	π	
$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	$\pi/3$	

Upper Limit on θ
 2π
 Lower Limit on θ
 0
 The Answer is
 $\frac{64 \cdot \pi}{3}$

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Let's verify this analytically as well.

$$\begin{aligned}\int_0^{2\pi} \int_0^{\frac{\pi}{3}} \int_0^4 \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta &= \int_0^{2\pi} \int_0^{\frac{\pi}{3}} \left[\frac{\rho^3}{3} \sin \phi \right]_{\rho=0}^4 d\phi \, d\theta = \frac{64}{3} \int_0^{2\pi} \int_0^{\frac{\pi}{3}} \sin \phi \, d\phi \, d\theta = \\ &= -\frac{64}{3} \int_0^{2\pi} [\cos \phi]_{\phi=0}^{\frac{\pi}{3}} d\theta = -\frac{64}{3} \int_0^{2\pi} \left(\frac{1}{2} - 1 \right) d\theta = \frac{32}{3} \int_0^{2\pi} d\theta = \frac{64}{3} \pi\end{aligned}$$

Questions? Comments? Suggestions?

Email me at:

Christ_L_T521@hotmail.com or
chritoni0988@stu.harpercollege.edu

Instant Message Me on AIM: Screen Name is [ThisIsChrisToni](#).

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