

# Double Integrals over Non-Rectangular Regions

Ref. Textbook: *Calculus* (10<sup>th</sup> ed.) by Anton, Bivens and Davis

## Iterated Integrals with Nonconstant Limits of Integration

Double integrals over nonrectangular regions can be evaluated as iterated integrals of the following types:

Type I	Type II
$\iint_R f(x, y) dA = \int_a^b \int_{g_1(x)}^{g_2(x)} f(x, y) dy dx$	$\iint_R f(x, y) dA = \int_c^d \int_{h_1(y)}^{h_2(y)} f(x, y) dx dy$
<p>A type I region</p>	<p>A type II region</p>

10-Mar-24

Lesson 09: Double Integrals over Non-Rectangular Regions

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# Double Integrals over Non-Rectangular Regions

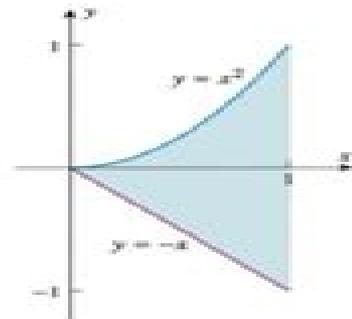
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**Example.** Evaluate the following integrals:

(a)  $\int_0^1 \int_{-x}^{x^2} y^2 x dy dx$       (b)  $\int_0^{\pi/3} \int_0^{\cos y} x \sin y dx dy$

**Solution (a).**

$$\begin{aligned} \int_0^1 \int_{-x}^{x^2} y^2 x dy dx &= \int_0^1 \left[ \int_{-x}^{x^2} y^2 x dy \right] dx = \int_0^1 \left. \frac{y^3 x}{3} \right|_{y=-x}^{x^2} dx \\ &= \int_0^1 \left[ \frac{x^7}{3} + \frac{x^4}{3} \right] dx = \left( \frac{x^8}{24} + \frac{x^5}{15} \right) \Big|_0^1 = \frac{13}{120} \end{aligned}$$



**Solution (b).**

$$\begin{aligned} \int_0^{\pi/3} \int_0^{\cos y} x \sin y dx dy &= \int_0^{\pi/3} \left[ \int_0^{\cos y} x \sin y dx \right] dy = \int_0^{\pi/3} \left. \frac{x^2}{2} \sin y \right|_{x=0}^{\cos y} dy \\ &= \int_0^{\pi/3} \left[ \frac{1}{2} \cos^2 y \sin y \right] dy = \left. -\frac{1}{6} \cos^3 y \right|_0^{\pi/3} = \frac{7}{24} \end{aligned}$$



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**Scott C. Dulebohn**



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