## Indices (Index of Notation, General Index), 147-151

DOI: $10.3792 /$ euclid/9781429799881-6

## from

Stokes's Theorem and Whitney Manifolds:
A Sequel to
Basic Real Analysis
Anthony W. Knapp

Full Book DOI: 10.3792/euclid/9781429799881 ISBN: 978-1-4297-9988-1


Distributed by Project Euclid.
For copyright information, see the following page.

```
Anthony W. Knapp
81 Upper Sheep Pasture Road
East Setauket, N.Y. 11733-1729, U.S.A.
Email to: aknapp@math.stonybrook.edu
Homepage: www.math.stonybrook.edu/~aknapp
```

Title: Stokes's Theorem and Whitney Manifolds. A Sequel to Basic Real Analysis.
Cover: An example of a Whitney domain in two-dimensional space. The green portion is a manifold-with-boundary for which Stokes's Theorem applies routinely. The red dots indicate exceptional points of the boundary where a Whitney condition applies that says Stokes's Theorem extends to the whole domain.

Mathematics Subject Classification (2020): 58-01, 58A05, 58A35, 58C35, 26B20.

Original Digital Edition, not to be sold, no ISBN
(C)2021 Anthony W. Knapp

Published by the Author
All rights reserved. This file is the original digital edition of the above named book. The text, images, and other data contained in this file, which is in portable document format (PDF), are proprietary to the author, and the author retains all rights, including copyright, in them. The use in this file of trade names, trademarks, service marks, and similar items, even if they are not identified as such, is not to be taken as an expression of opinion whether they are subject to proprietary rights.

The file is made available for limited noncommercial use for purposes of education, scholarship, and research, and for these purposes only, or for fair use as understood in the United States copyright law. Users may freely download this file for their own use and may store it, post it online, and transmit it digitally for purposes of education, scholarship, and research. They may not convert it from PDF to any other format (e.g., EPUB), they may not edit it, and they may not do reverse engineering with it. In transmitting the file to others or posting it online, users must charge no fee, nor may they include the file in any collection of files for which a fee is charged.

Each user of this file is granted permission to make one printed copy of the entire book for personal use toward education, scholarship, and research, and for these purposes only. This personal printed copy must not be sold in whole or part. Any exception to these rules concerning the file and its printing requires written permission from the author.
Except as provided by fair use provisions of the United States copyright law, no extracts or quotations from this file may be used that do not consist of whole pages unless permission has been granted by the author.

The permission granted for use of the whole file and the prohibition against charging fees extend to any partial file that contains only whole pages from this file, except that the copyright notice on this page must be included in any partial file that does not consist exclusively of the front cover page. Such a partial file shall not be included in any derivative work unless permission has been granted by the author.

## INDEX OF NOTATION

This list indexes recurring symbols introduced in Chapters I through III (pages $1-125$ ). In the list below, each piece of notation is regarded as having a key symbol. The first group consists of those items for which the key symbol is a fixed Latin letter, and the items are arranged roughly alphabetically by that key symbol. The next group consists of those items for which the key symbol is a Greek letter. The final group consists of those items for which the key symbol is a variable or a nonletter, and these are arranged by type. To locate an item below, first proceed on the assumption that the key symbol is a Latin or Greek letter; if the item does not appear to be in the list, then treat it as if its key symbol is a variable or a nonletter.

A, 18
$B^{\delta}, 111$
$c_{X}(\omega), 50$
$C^{\infty}, 4,63,99$
$C_{\text {com }}^{\infty}, 5,64,99$
$\mathcal{C}_{p}(M), 7,64,99$
curl, 29, 76
d, 28
$d f, 11$
$(d f)_{p}, 11$
D, 9, 65, 99
$(D F)_{p}, 9,99$
$D(x, E), 106$
div, 29, 76
grad, 29, 76
$\mathbb{H}^{m}, 59$
$\mathbb{H}_{+}^{m}, 59$
$I^{\prime}, 13$
$\mathbf{i}, \mathbf{j}, \mathbf{k}, 75$
$\mathcal{M}^{\ell}(E), 109$
n, 77
$N(E, \delta), 111$
$N_{\text {sep }}(E, \delta), 111$
$\mathbb{Q}^{m}, 93$
$\mathbb{Q}_{+}^{m}, 93$
$\partial \mathbb{Q}^{m}, 93$
$S^{n}, 2$
$S_{k}(M), 100$
$\mathfrak{S}_{n}, 18$
$T(V), 13$
$T^{n}(V), 13$
$T_{p}(M), 7,64,99$
$T_{p}^{*}(M), 10,65,99$

## Greek

$\Phi^{*}, 22$
$\Phi^{*} \omega, 23$
$\Phi_{p}^{\#}, 23$
$\Omega^{k}(M), 22$

Unary operations
$M_{+}, 61$
дM, 61
จ, 76
| • |, 106
Binary operations
$\otimes, 13$
$\wedge, 13$
$\times, 76$

Other symbols
$\wedge(E), 13$
$\wedge^{n}(E), 13$
$\widetilde{\bigwedge}^{n}(E), 18$
$\left[\frac{\partial}{\partial x_{j}}\right]_{p}, 7,64,99$
$\int_{M} f \omega, 39$
$E^{\delta}, 111$
( $M_{\alpha}, \alpha$ ), 2, 60, 95, 119
( $U, B, E$ ), 107

## INDEX

alternating, 13
antisymmetrized tensor, 18
antisymmetrizer operator, 18
atlas, 2, 60, 95, 119
boundary, 61
boundary point, $61,96,119$
Bourbaki, xiii
Brouwer Fixed-Point Theorem, 91
bundle
cotangent, 11
exterior $k, 21$
tangent, 8

Cartan, Elie, xiii
Cartan, Henri, xii
chart, 2, 60, 95
about a point, $60,95,119$
compatible, 2, 60, 95, 119
positive compatible, 37
circle, 48
compact convex polyhedron, 122
compatible chart, $2,60,95,119$
positive, 37
contraction, 50
convex polyhedron, 122
coordinate system, local, 4
corner point, 96
cotangent bundle, 11
cotangent space, 65,99
cotangent vector, 10
countable, xvi
cross product, 76
curl, 29, 76
curve, 75
degree of differential form, 21
derivation, 7
derivative, 65, 99
exterior 28
of smooth function, 9
smooth map, 9
diffeomorphism, 6, 60, 94
differential, 11
of function, 65
differential form, 21
degree of, 21
differential 0 form, 22
differential 1 form, 11
smooth, 12
differential $k$ form, 21
differential $m$ form, everywhere positive, 42
differentiation, exterior, 28
dimension, 2, 60, 95, 119
distance to set, 106
divergence, 29, 76
Divergence Theorem, xi, 81, 123
Whitney's form, 106
elementary smooth $k$ form, 50
embedded submanifold, 53
embedding, 53
everywhere positive $m$ form, 42
exceptional point, 119
exhausting sequence, 3 , 48
extent, 125
exterior algebra, 13
exterior derivative, 28
exterior differentiation, 28
exterior $k$ bundle, 21
exterior product, 14
flux, 27
function, smooth, 4,6
Fundamental Theorem of Calculus, x, 74

Gauss-Ostrogradsky Theorem, xi
generalized quadrant, 93
germ, 7, 64, 99
gradient, x, 29, 76
graph, 53
Grassmann algebra, 13
Green's Theorem, x, 80
half space, 59
immersion, 47
implicitly, 54
index of a point, 94,96
indicator function, 33
induced orientation, 68, 70, 102
integration of differential along a curve, 88
integration of smooth $m$ form, 39

Kelvin-Stokes Theorem, xii, 84, 90
Kronecker delta, xvi
line integral, x
Lipschitz condition, 112
local coordinate system, 4
local Whitney domain, 119
locally finite, 35
manifold, 2
defined implicitly, 54
defined parametrically, 54
smooth, 2
-with-boundary, 60
-with-corners, 95
manifold point, $61,96,100$
map, 6
smooth, 6
Minkowski content, 109, 124
Minkowski content zero, 114
minor, 117
Möbius band, 37, 47
Möbius strip, 37
negative, xvi
normal vector, 77
not orientable, 36
on the left, 78
open subset, 59, 93
opposite orientation, 43
orientable, 36, 66, 102
orientation, $36,38,43$
induced, 68, 70
opposite, 43
orientation preserving, 46
orientation reversing, 46
oriented, 36, 66, 102, 120
outward pointing unit normal, 78
parametrically, 54
partition of unity, $33,65,100,120$
piecewise smooth function, 124
polyhedron, compact convex, 122
polytope, 114
positive, xvi
positive compatible chart, 37
product of manifolds, 49
projective space, 49
pullback of 1 form, 23
pullback of differential form, 65
pullback of function, 22
pullback of $k$ form, 25, 99
quadrant, 93
retraction, 91
separable, 2
singular set, 115
skew symmetry, 14
smooth differential form, 21
smooth differential 1 form, 12
smooth function, 4, 6, 59
derivative of, 9
piecewise, 124
smooth manifold, 2
smooth map, 6, 60, 93
derivative of, 9
smooth partition of unity, $33,65,100,120$
smooth real-valued function, 63, 93, 98
smooth structure, 2
smooth vector field, 9
sphere, 2
Stokes's Theorem, xii
for manifold without boundary, 57
for manifold-with-boundary, 71
for manifold-with-corners, 102
for Whitney manifold, 118
stratum, 100
submanifold, 53
subordinate, $33,100,120$
support, 5, 63, 99
surface, 75
surface integral, 78
tangent bundle, 8
tangent space, 7, 64, 99
Taylor's Theorem, 8
tensor algebra, 13
triangulation, 33, 96, 97
unit normal to a subspace, 79
universal mapping property
of exterior algebra, 15
of exterior power, 15
vector field, 8,75
smooth, 9
vector product, 76
wedge product, 14
Weil, André, xii
Whitney, Hassler, xiv
Whitney chart, 119
Whitney domain, 107
Whitney's form of Divergence Theorem, 106
Whitney's form of Stokes's Theorem, 118
zero $\ell$ extent, 125

