
References

- [AMR88] Abraham, R., Marsden, J., & Ratiu, T. (1988). *Manifolds, tensor analysis, and applications*. Springer.
- [AHW18] Alldridge, A., Hilgert, J., & Wurzbacher, T. (2018). Superorbits. *Journal of the Institute of Mathematics of Jussieu*, 17, 1065–1120.
- [Am19] Amann, H. (2019). *Linear and quasilinear parabolic problems II*. Birkhäuser.
- [AC21a] Anel, M., & Catren, G. (2021). *New spaces in mathematics – Formal and conceptual reflections*. Cambridge University Press.
- [AC21b] Anel, M., & Catren, G. (2021). *New spaces in physics – Formal and conceptual reflections*. Cambridge University Press.
- [Ap75] Apostol, T. (1975). *Calculus* (vols. 1–2, 2nd edn.). Wiley.
- [AK21] Arnold, V.I., & Khesin, B.A. (2021). *Topological methods in hydrodynamics* (2nd edn.). Springer.
- [Ar23] Artin, M. (2023). *Algebra* (2nd edn.). Pearson.
- [AD14] Audin, M., & Damian, M. (2014). *Morse theory and floer homology*. Springer.
- [Ba06] Ballmann, W. (2006). *Lectures on kähler manifolds*. European Mathematical Society.
- [BE11] Beem, J., & Ehrlich, P. (1981). *Global lorentzian geometry*. Marcel Dekker.
- [BGV92] Berline, N., Vergne, M., & Getzler, E. (1992). *Heat kernels and dirac operators*. Springer.
- [Be11] Bertram, W. (2011). *Elementary topological differential calculus*. Calvage & Mounet.
- [Bj79] Björk, J.-E. (1979). *Rings of differential operators*. North-Holland.
- [Bj93] Björk, J.-E. (1993). *Analytic \mathcal{D} -modules and applications*. Kluwer.
- [Bo91] Borel, A. (1991). *Linear algebraic groups* (2nd edn.). Springer.
- [Bo67] Bourbaki, N. (1967). *Variétés différentielles et analytiques – Fascicule de résultats*. Hermann.
- [Bo70] Bourbaki, N. (1970). *Algèbre I*. Hermann.
- [Br97] Bredon, G. E. (1997). *Sheaf theory*. Springer.
- [Bu96] Bumb, D. (1996). *Automorphic forms and representations*. Cambridge University Press.
- [CS01] Cannas da Silva, A. (2001). *Lectures on symplectic geometry*. Springer.
- [CK05] Capiński, M., & Kopp, E. (2005). *Measure, integral and probability* (2nd edn.). Springer.
- [CCF11] Carmeli, C., Caston, L., & Fioresi, R. (2011). *Mathematical foundations of supersymmetry*. European Mathematical Society.
- [Ch11] Chen, B.-Y. (2019). *Pseudo-Riemannian geometry, δ -invariants and applications*. World Scientific.
- [CS22] Clausen, D., & Scholze, P. (2022). Condensed mathematics and complex geometry.
<https://people.mpim-bonn.mpg.de/scholze/Complex.pdf>
- [Co94] Connes, A. (1994). *Noncommutative geometry*. Academic Press.

- [Co95] Coutinho, S. C. (1995). *A primer of algebraic D-modules*. Cambridge University Press.
- [CLM21] Crainic, M., Loja Fernandez, R., & Mărcuț, I. (2021). *Lectures on poisson geometry*. American Mathematical Society.
- [DM99] Deligne, P., & Morgan, J. (1999). Notes on supersymmetry (following J. Bernstein). In P. Deligne et al. (Eds.), *Quantum fields and strings: A course for mathematicians* (vol. I, pp. 41–98). American Mathematical Society.
- [Di69] Dieudonné, J. (1969). *Foundations of modern analysis*. Enlarged and corrected printing. Academic Press.
- [Di74] Dieudonné, J. (1974). *Cours de Géométrie Algébrique 2*. Presses Universitaires de France.
- [dC92] do Carmo, M. P. (1992). *Riemannian geometry*. Birkhäuser.
- [EH07] Eisenbud, D., & Harris, J. (2007). *The geometry of schemes*. Springer.
- [EN00] Engel, K.-J., & Nagel, R. (2000). *One-parameter semigroups for linear evolution equations*. Springer.
- [GM03] Gelfand, S. I., & Manin, Y. I. (2003). *Methods of homological algebra* (2nd edn.). Springer.
- [Go73] Godement, R. (1973). *Théorie des Faisceaux*. Hermann.
- [GW10] Görtz, U., & Wedhorn, T. (2010). *Algebraic geometry I*. Vieweg+Teubner.
- [Go11] Gowers, T., et al. (2011). *The Princeton companion to mathematics*. Princeton University Press.
- [GVF01] Gracia-Bondía, J., Várilly, J., & Figueroa, H. (2001). *Elements of noncommutative geometry*. Birkhäuser.
- [Gr08] Grätzer, G. (2008). *Universal algebra*. Springer.
- [GH94] Griffith, P., & Harris, J. (1994). *Principles of algebraic geometry*. Wiley.
- [Ha77] Hartshorne, R. (1977). *Algebraic geometry*. Springer.
- [Ha02] Hatcher, A. (2002). *Algebraic topology*. Cambridge University Press.
- [HE73] Hawking, S., & Ellis, G. (1973). *The large scale structure of space-time*. Cambridge University Press.
- [HS73] Herrlich, H., & Strecker, G. E. (1973). *Category theory*. Allyn and Bacon.
- [HN12] Hilgert, J., & Neeb, K.-H. (2012). *Structure and geometry of lie groups*. Springer.
- [HWZ21] Hofer, H., Wysocki, K., & Zehnder, E. (2021). *Polyfold and fredholm theory*. Springer.
- [Ho12] Holme, A. (2012). *A royal road to algebraic geometry*. Springer.
- [Ho73] Hörmander, L. (1973). *An introduction to complex analysis in several variables* (2nd edn.). North-Holland.
- [Ho83] Hörmander, L. (1983). *The analysis of linear partial differential operators I-IV*. Springer.
- [Hu05] Huybrechts, D. (2005). *Complex geometry*. Springer.
- [Iv86] Iversen, B. (1986). *Cohomology of sheaves*. Springer.
- [Iv19] Ivrii, V. (2019). *Microlocal analysis, sharp spectral asymptotics and applications*. Springer.
- [KS94] Kashiwara, M., & Shapira, P. (1994). *Sheaves on manifolds*. Springer.
- [KS06] Kashiwara, M., & Shapira, P. (2006). *Categories and sheaves*. Springer.
- [KKK86] Kashiwara, M., Kawai, T., & Kimura, T. (1986). *Foundations of algebraic analysis*. Princeton University Press.
- [Ke95] Kempf, G. (1995). *Algebraic structures*. Vieweg.
- [Kn06] Knapp, A. W. (2006). *Basic algebra*. Birkhäuser.
- [KV95] Knapp, A. W., Vogan, D. A. (1995). *Cohomological induction and unitary representations*. Princeton University Press.
- [KN96] Kobayashi, S., & Nomizu, K. (1996). *Foundations of differential geometry*. Wiley.
- [Ko97] Koch, H. (2000). *Number theory*. American Mathematical Society.
- [Ko03] Kontsevich, M. (2003). Deformation quantization of Poisson manifolds. *Letters in Mathematical Physics*, 66, 157–216.
- [La21] Land, M. (2021). *Introduction to infinity-categories*. Springer.
- [La67] Lang, S. (1967). *Algebraic structures*. Addison-Wesley.

- [La93] Lang, S. (1993). *Algebra*. Addison-Wesley.
- [LPV13] Laurent-Gengoux, C., Pichereau, A., & Vanhaecke, P. (2013). *Poisson structures*. Springer.
- [LM89] Lawson, B., & Michelsohn, M.-L. (1989). *Spin geometry*. Princeton University Press.
- [Le14] Leinster, T. (2014). *Basic category theory*. Cambridge University Press.
- [LS23] Le Stum, B. (2023). An introduction to condensed mathematics. https://perso.univ-rennes1.fr/bernard.le-stum/bernard.le-stum/Enseignement_files/CondensedBook.pdf
- [LM87] Libermann, P., & Marle, C.-M. (1987). *Symplectic geometry and analytical mechanics*. D. Reidel.
- [LS20] Lins Neto, A., and Scárdua, B. (2020). *Complex algebraic foliations*. De Gruyter.
- [ML98] Mac Lane, S. (1998). *Categories for the working mathematician*. Springer.
- [MT97] Madsen, I., & Tornehave, J. (1997). *From calculus to cohomology – De Rham cohomology and characteristic classes*. Cambridge University Press.
- [MS12] McDuff, D., & Salamon, D. (2012). *J-holomorphic curves and symplectic topology* (2nd edn.). American Mathematical Society.
- [MS17] McDuff, D., & Salamon, D. (2017). *Introduction to symplectic topology* (3rd edn.). Oxford University Press.
- [Mi08] Michor, P. W. (2008). *Topics in differential geometry*. American Mathematical Society.
- [Mi05] Milne, J. S. (2005). *Algebraic geometry: V5.0*. Taiaroa Publishing.
- [Mi17] Milne, J. S. (2017). *Algebraic groups*. Cambridge University Press.
- [MM03] Moerdijk, I., & Mrčun, J. (2003). *Introduction to foliations and Lie groupoids*. Cambridge University Press.
- [MF10] Morgan, J. W., & Fong, F. (2010). *Ricci flow and geometrization of 3-manifolds*. American Mathematical Society.
- [Mo91] Morimoto, M. (1991). *An introduction to sato's hyperfunctions*. American Mathematical Society.
- [Mu18] Munkres, S. (2018). *Topology* (2nd edn.). Pearson.
- [Na12] Naber, G. L. (2012). *The geometry of minkowski spacetime – An introduction to the mathematics of the special theory of relativity*. Springer.
- [Na15] Nakahara, M. (2015). *Differential geometry, topology and physics*. Springer.
- [Oh15] Oh, Y.-G. (2015). *Symplectic topology and floer homology*. Cambridge University Press.
- [ON83] O'Neill, B. (1983). *Semi-Riemannian geometry*. Academic Press.
- [Pe95] Perrin, D. (1995). *Algebraic geometry*. InterEditions.
- [PR94] Platonov, V., & Rapinchuk, A. (1994). *Algebraic groups and number theory*. Academic Press.
- [Po17] Pohl, A. (2017). The category of reduced orbifolds in local charts. *Journal of the Mathematical Society of Japan*, 69, 755–800.
- [Ra04] Ramanan, S. (2004). *Global calculus*. American Mathematical Society.
- [Re90] Reid, M. (1990). *Undergraduate algebraic geometry*. Cambridge University Press.
- [Re95] Reid, M. (1995). *Undergraduate commutative algebra*. Cambridge University Press.
- [Ro96] Robinson, A. (1996). *Non-standard analysis*. Reprint of the second (1974) edition. With a foreword by Wilhelmus A. J. Luxemburg. Princeton University Press.
- [Sa22] Sasane, A. (2022). *A mathematical introduction to general relativity*. World Scientific.
- [Sa56] Satake, I. (1956). On a generalization of the notion of manifold. *Proceedings of the National Academy of Sciences of the United States of America*, 42, 359–363.
- [SKK73] Sato, M., Kashiwara, M., & Kawai, T. (1973). Microfunctions and pseudo-differential equations. In *Hyperfunctions and pseudo-differential equations. Lecture notes in mathematics* (vol. 287, pp. 265–529). Springer.
- [Sch85] Schapira, P. (1985). *Microdifferential systems in the complex domain*. Springer.
- [Sch84] Schlichtkrull, H. (1984). *Hyperfunctions and harmonic analysis on symmetric spaces*. Birkhäuser.
- [Sp66] Spanier, E. (1966). *Algebraic topology*. McGraw-Hill.
- [Sp71] Spivak, M. (1971). *Calculus on manifolds*. Addison-Wesley.

- [Sp99] Spivak, M. (1999). *A comprehensive introduction to differential geometry* (3rd edn.). Publish or Perish.
- [Sp88] Springer, T. (1988). *Linear algebraic groups* (2nd edn.). Springer.
- [St23] Street, B. (2023). *Maximal subellipticity*. De Gruyter.
- [Ta02] Taylor, J.L. (2002). *Several complex variables with connections to algebraic geometry and lie groups*. American Mathematical Society.
- [Te75] Tennison, B.R. (1975). *Sheaf theory*. Cambridge University Press.
- [SP] The Stacks project – an open source textbook and reference work on algebraic geometry. <https://stacks.math.columbia.edu>
- [Tr83] Triebel, H. (1983–2020). *Theory of function spaces I–IV*. Birkhäuser.
- [Tu04] Tuynman, G. M. (2004). *Supermanifolds and supergroups*. Kluwer Academic Publishers.
- [Va94] Vaisman, I. (1994). *Lectures on the geometry of Poisson manifolds*. Birkhäuser.
- [Vo87] Vogan, D. A. (1987). *Unitary representations of reductive Lie groups*. Princeton University Press.
- [Vo16] Voisin, C. (2016). *Hodge theory and complex algebraic geometry*. The Société Mathématique de France.
- [Wa83] Warner, F. W. (1983). *Foundations of differentiable manifolds and lie groups*. Springer.
- [We15] Wedhorn, T. (2015). *Manifolds, sheaves, and cohomology*. Springer.
- [We94] Weibel, C. (1994). *An introduction to homological algebra*. Cambridge University Press.
- [We58] Weil, A. (1958). *Introduction to the study of Kähler manifolds*. Hermann.
- [We79] Wells, R. O. (1979). *Differential analysis on complex manifolds*. Springer.
- [Zw12] Zworski, M. (2012). *Semiclassical analysis*. American Mathematical Society.

Index

Symbols

- \mathbf{Ab} , category of abelian groups, 99
 $\mathbf{Alg}_R^{\text{alt}}$, category of alternating R -algebras, 126
 $\mathbf{Alg}_{\mathbb{K}}^{\text{fg}}$, category of finitely generated \mathbb{K} -algebras, 244
 \mathbf{Alg}_R , category of associative R -algebras, 100
 $\mathbf{Alg}_{R,1}$, category of associative R -algebras with identity, 110
 $\text{Alt}_R(M^q, N)$, alternating mappings, 86
alt, alternation, 87
Ann, annihilator, 268
 $\mathbf{AS}_{\mathbb{K}}$, category of \mathbb{K} -algebraic sets, 245
 $\text{Aut } R(M)$, module automorphisms, 31
 $\mathcal{B}_{X,R}$, presheaf of bounded functions, 140
 $\mathcal{C}_{X,R}^{\mathbb{K},k}(U; E)$, sections of E over U , 198
 $\mathcal{C}_X^{\mathbb{K},k}$, structure sheaf of the manifold X , 171
 $\mathcal{C}_X^{\mathbb{K},k} \otimes V$, locally free module sheaf, 169
 \mathbf{CAlg}_R , category of commutative R -algebras, 100
 $\mathbf{C}_{\mathbb{C}-\text{Vect}}^{\text{diff}}$, category, 101
 $\mathbf{C}_{\mathbb{C}-\text{Vect}}^k$, category, 101
 χ_φ , characteristic polynomial, 51
 $\mathbf{C}_{\mathbb{K}-\text{Vect}}^\omega$, category, 101
 $\mathcal{C}_{X,V}^\omega$, sheaf of analytic V -valued functions, 140
 $\mathcal{C}_{X,V}^{\mathbb{K},k}$, sheaf of differentiable V -valued functions, 140
 \mathbf{CMet} , category of complete metric spaces, 124
 $\mathbf{C}_{\Phi,\Gamma}$, category of an algebraic structure, 100
 $\mathbf{C}_{\mathbb{R}-\text{Vect}}^{\text{diff}}$, category, 101
 $\mathbf{C}_{\mathbb{R}-\text{Vect}}^k$, category, 101
 \mathbf{CRing}_1 , category of commutative rings with identity, 99
 $\mathcal{C}_{X,R}$, sheaf of continuous functions, 140
 df , differential of f , 196
 $D(f)$, standard open set in the maximal spectrum, 258
 $D(f)$, standard open set in the spectrum, 266
 D_x , directional derivative, 304
 $Df(p)$, Jacobian matrix of f , 192
 $\left(\frac{\partial y_J}{\partial x_I}\right)$, Jacobian matrix in multi-index notation, 211
 $\frac{\partial}{\partial x_j}$, basis field, 205
 $\frac{\partial}{\partial x_j}|_p$, derivation in coordinates, 185
 $\mathcal{D}(U)$, differential operators on U , 9
 ∂M , boundary of M , 223
 ∂^α , higher partial derivatives, 8
 ∂_j , partial derivatives, 8
 Δ_X , diagonal in X , 262
 $d\alpha$, exterior derivative of α , 212
 d_g , distance function, 291
 $d_f(p)$, derivative of f , 190
 dx_I , differential forms in multi-index notation, 210
 $dx_j(p)$, φ -basis for T_p^*M , 196
 $\text{Der}(A)$, derivations of A , 206
 $\text{Der}(A, B)$, derivations from $A \subseteq B$, 206
 $\text{Der}_\Phi(A, B)$, Φ -derivations from A to B , 206
 $\mathcal{Der}(\mathcal{C}_M^{\mathbb{K},k})$, derivation sheaf on M , 207
 $\mathcal{Der}(\mathcal{C}_M^{\mathbb{K},k}, \mathcal{C}_M^{\mathbb{K},k-1})$, derivation sheaf on M , 207
 $\dim_{\mathbb{K}}(X)$, dimension of X , 173
 $D_V(f)$, standard open set, 252
 $dx_1(p)$, φ -basis for the cotangent space, 197
 $\deg(f)$, degree of a polynomial, 8
 E_p , fiber of a vector bundle, 198
 $\check{E}(X, \mathbf{C})$, category of étalé spaces, 156
 \mathcal{E}_π , sheaf of sections, 199
 $\check{E}(\mathcal{F})$, étalé space of a sheaf, 155

- $\mathbf{\acute{E}Mod}_{\mathcal{O}_X}$, étalé-category of \mathcal{O}_X -modules, 167
 $\text{End } R(M)$, module endomorphisms, 31
 $\text{EndC}(X)$, endomorphisms of a category, 98
 ev , evaluation functor, 129
 ev , evaluation mapping, 92
 ev_a , evaluation mapping, 240
 ev_x , evaluation, 11
 ev_φ , evaluation homomorphism, 48
 $F(E)$, free module over E , 41
 $_R F(E)$, free left- R -module over E , 41
Field, category of fields, 100
 $\gcd(a_1, \dots, a_k)$, gcd for rings, 20
 $\mathbb{G}_{k,n}$, Grassmann manifold, 178
 $G\text{Mod}_R$, category of G -modules, 125
Grp, category of groups, 99
 Grp_{top} , category of topological groups, 101
 H^\bullet , representing functor, 128
 H_\bullet , representing functor, 129
 H_x , stalk functor in x , 145
 \mathbb{H} , quaternions, 6
 H^X , represented by X functor, 106
 H_X , represented by X functor, 106
 $\mathcal{H}ol_{X,V}$, sheaf of holomorphic V -valued functions, 140
 $\text{Hom}_R(M, N)$, module homomorphisms, 29
 $\text{HomC}(X, Y)$, morphisms of a category, 98
 Hom_A , Hom-functor, 107
 $\mathcal{H}om_{\mathcal{O}_X}(\mathcal{F}, \mathcal{G})$, \mathcal{O}_X -modules of homomorphisms, 168
 $I(X)$, vanishing ideal of a set, 241
 $\iota_{\mathfrak{X}}\alpha$, contraction, 215
 I , ideal for the alternating algebra, 84
ID, category of integral domains, 100
ID_m, subcategory of integral domains, 122
 $\text{im}(\varphi)$, image of a module homomorphism, 30
 Ind_H^G , induction functor, 125
 J , ideal for the symmetric algebra, 77
 J_q , q -part of J , 82
 $\ker(\varphi)$, kernel of a module homomorphism, 30
 $\ell_g(\gamma)$, curve length, 290
 $L(V_1, \dots, V_s; V_0)$, bundle of s -linear mappings, 203
 $L_{\mathfrak{X}}\alpha$, Lie derivative of a differential form, 215
 \mathcal{L}_X^1 , presheaf of integrable functions, 140
 $\wedge T^*M$, form bundle, 211
 $\wedge^k TM^*$, k -form bundle, 210
 $\Lambda(M)$, exterior algebra, 84
 $\Lambda(\psi)$, exterior algebra functor, 85
 $\Lambda_q(M)$, antisymmetric tensors, 81
 $\Lambda^q(M)$, q -th exterior power of M , 86
 lcm , least common multiple, 112
LieAlg_R, category of Lie algebras over R , 127
 \varprojlim , categorical limit, 113
 \varinjlim , categorical colimit, 113
 $L_R(M_1, \dots, M_n; P)$, multilinear mappings, 56
 $L_R(M_\lambda; P)$, multilinear mappings, 56
 \mathfrak{m}_a , vanishing ideal of a , 246
Man_{K,k}, category of manifolds, 172
Mat_K, category of \mathbb{K}^n 's, 136
Met, category of metric spaces, 124
Mod_{C_M^{lf}}, category of locally free module sheaves, 200
Mod_R, category of right- R -modules, 100
Mod_{O_X}, category of \mathcal{O}_X -modules, 166
R Mod, category of left- R -modules, 100
 $\nabla_{\mathfrak{X}}$, covariant derivative, 303
 $\text{ob}(\mathbf{C})$, objects of a category, 98
 Ω_M^ℓ , sheaf of ℓ -forms, 199
 $\Omega^r(M)$, differential forms of degree r , 210
 Ω_M , sheaf of differential forms, 199, 210, 212
 $\text{Or}(M)$, orientation bundle, 306
 $P(a, \varrho)$, open polycylinder, 235
 $P(a, \varrho)^-$, closed polycylinder, 235
 P^n_R , projective space over R , 272
PS(X, C), category of presheaves, 141
 φ -basis, 184, 187
 φ_{ij} , transition map, 173
 $\mathbb{P}_{\mathbb{K}}^n$, projective space, 178
 $\mathbb{P}_{\mathbb{K}}^n$, projective space, 178
PVar_K, category of prevarieties, 258
 $Q(R)$, quotient field, 15
 \mathbb{Q}_p , p -adic numbers, 118
 $\text{rad}(I)$, radical of an ideal, 245
 Res_H^G , restriction functor, 125
 $\text{rest}_{[c,d]}$, restriction, 11
 ρ_U , section functor, 149
 $\rho_{V,U}$, restriction mappings, 140
Ring, category of rings, 99
Ring₁, category of rings with identity, 99
RSp_R, category of R -ringed spaces, 160
RSp_{loc,R}, category of locally R -ringed spaces, 164
 S , section functor, 200
 $(S\varphi)_U$, section functor, 156
 $S(E, X, \pi)$, section functor, 156
 $S(X, C)$, category of sheaves, 144
Sch, category of schemes, 266
Sch^{aff}, category of affine schemes, 266
Set, category of sets, 98
Sheaf, sheafification functor, 148
 $\text{sign}(\sigma)$, signature of a permutation, 81
 $S_{k,n}$, Stiefel manifold, 178
S(M), symmetric algebra, 77
 \mathbb{S}^n , n -sphere, 175
 $\text{Spec}(R)$, spectrum of a ring, 161
 $S(\varphi)$, symmetric algebra functor, 78

- $\text{Spm}(A)$, maximal spectrum, 258
 S_q , symmetric group on q letters, 79
 $S^q(M)$, q -th symmetric power of M , 79
 $S_q(M)$, symmetric tensors, 81
 $\text{Sym}_R(M^q; N)$, symmetric mappings, 79
 sym , symmetrization mapping, 81
 TM , tangent bundle, 193
 Tf , derivative of f , 195
 $T(a, \varrho)$, determining surface of a polycylinder, 235
 T^*M , cotangent bundle, 196
 $T_p M$, geometric tangent space, 183
 $T_p^* M$, cotangent space, 196
 $T_p^{\text{alg}} M$, algebraic tangent space, 185
 $T_p^{\text{geo}} M$, geometric tangent space, 183
 $T_p^{\text{phy}} M$, physicist's tangent space, 184
 $T(M)$, tensor algebra, 73
 $T(\varphi)$, tensor algebra functor, 74
 $T^n(M)$, tensors of n -th level, 72
 T_M^* , cotangential sheaf of M , 199
 T_M , tangential sheaf of M , 199
Top, category of topological spaces, 100
 $T_\Phi(X)$, term algebra, 92
 $U(L)$, universal enveloping algebra, 127
 $\text{Unit}(R)$, units of R , 4
 $V(I)$, vanishing set in $\text{Spec}(R)$, 161
 $V(I)$, vanishing set, 258
 $V(I)$, zero set of an ideal, 240
 $V(f)$, vanishing set in the spectrum, 266
 $v_\varphi^{(j)}$, φ -basis, 184
 $\text{Var}_{\mathbb{K}}^{\text{aff}}$, category of affine varieties, 259
 $\text{Var}_{\mathbb{K}}$, category of varieties, 262
 $\text{VB}_M^{\mathbb{K}, k}$, category of vector bundles over M , 199
 $\text{Vect}_{\mathbb{K}}^{\text{fin}}$, category of finite-dimensional \mathbb{K} -vector spaces, 102
 $\mathcal{X}(M)$, vector fields on M , 205
 \mathbb{Z}_p , p -adic integers, 118
 $\mathbb{Z}[i]$, Gaussian integers, 5
 $\mathbb{Z}/n\mathbb{Z}$, residue class ring, 5
 $\langle E \rangle$, submodule generated by E , 32
 $\{\cdot, \cdot, \cdot\}$, Jordan triple product, 94
 $R[X_1, \dots, X_k]$, polynomial ring, 8
 $R[X_1, \dots, X_k]_d$, homogeneous polynomials of degree d , 8
 $R[[X_1, \dots, X_k]]$, formal power series, 7
 $[\cdot, \cdot, \cdot]$, Lie triple product, 94
 $[\cdot, \cdot]$, Lie bracket, 93
 $[\gamma]_p$, equivalence class of curves through p , 183
 $[\gamma_f]_p$, φ -basis, 183
 $[a, b]$, Lie bracket, 127
 $[m]$, equivalence class, 95
- $[s]$, germs of a section, 155
 $[x]$, coset, 12
 $[\mathbf{A}, \mathbf{B}]$, functor category, 127
 $\mathbb{K}[V]$, coordinate ring of V , 241
 $\mathbb{K}[V]_f$, localization of $\mathbb{K}[V]$ at f , 252
 $\mathbb{K}[\varphi]$, subalgebra of $\text{End}_{\mathbb{K}}(V)$, 48
 $\sigma \cdot t$, permutation of a tensor, 81
 $g \cdot m$, group action, 96
 $G \circ F$, functor composition, 107
 $X \cong_{\mathbf{C}} Y$, isomorphism in a category, 103
 \cong , isomorphism, 13
 $A_X(U)$, locally constant A -valued functions on U , 143
 E_x , fiber in étale space, 154
 \mathcal{X}_x , value of \mathfrak{X} at x , 205
 φ_U , presheaf morphism, 141
 φ_x , induced morphism of stalks in x , 145
 s_x , germ of s in x , 145
 $\mathcal{F}_\pi(U)$, section sheaf of an étale space, 154
 \mathcal{F}_x , stalk in x , 145
 1_X , identity (morphism), 98
 φ^\flat , sheaf morphism, 153
 $\widehat{D}(i)$, diagram presheaves, 150
 $f^{-1}(\mathcal{F}')$, inverse image of a sheaf, 151
 $f^{<-1>}(\mathcal{F}')$, inverse presheaf image, 151
-
- , adjoint functors, 122
-
- , natural transformation, 127
 $F \dashv G$, adjoint functors, 122
 $I \trianglelefteq R$, ideal in a ring, 10
 $\mathbf{S} \hookrightarrow \mathbf{C}$, subcategory, 100
 $\mathbf{S} \overset{v}{\hookrightarrow} \mathbf{C}$, full subcategory, 100
 $\bigoplus_{\lambda \in \Lambda} M_\lambda$, direct sum of modules, 36
 $M \otimes_R N$, tensor product over R , 58
 $M^{\otimes n}$, tensor power of M , 72
 $\bigotimes_r^s TM$, tensor bundle, 202
 $\bigotimes_r T_p M$, tensor space, 202
 $\bigotimes_r^s \mathcal{T}_M^{(r,s)}$, tensor sheaf of level (r, s) , 203
 $\varphi \otimes \psi$ tensor product of homomorphisms, 59
 $\mathcal{F} \otimes_{\mathcal{O}_X} \mathcal{G}$, tensor product of \mathcal{O}_X -modules, 168
 $\bigotimes_{\lambda \in \Lambda} M_\lambda$, tensor product of the M_λ , 65
 $f(\mathfrak{m})$, evaluation of a ring element, 258
 $\mathbf{C}(X)$, endomorphisms of a category, 98
 $\mathbf{C}(X, Y)$, morphisms of a category, 98
 $x + I$, coset, 12

- $\coprod_{i \in I} X_i$, categorical sum, 109
 $\prod_{i \in I} X_i$, categorical product, 108
 $\prod_{\lambda \in \Lambda} M_\lambda$, direct product of modules, 36
 ψ^\sharp , sheaf morphism, 153
 $F \simeq F'$, naturally isomorphic functors, 128
 M_\sim , space of equivalence classes, 95
 \sim_x , stalk relation in x , 145
 M/N , quotient module, 31
 $f_*\mathcal{F}$, direct image of a presheaf, 142
 $f'(p)$, derivative of f , 190
 $\mathbf{A} \times \mathbf{B}$, product category, 103
 $(\tilde{U}, \tilde{\varphi})$, associated chart on TM , 195
 $(\tilde{U}, \tilde{\varphi})$, associated chart on T^*M , 197
 $(\tilde{U}, \tilde{\varphi})$, associated chart on $\bigotimes_r^s TM$, 202
 $\tilde{\mathfrak{X}}$, vector field as differential operator, 206
 $E \times_X E'$, fiber product, 158
 $X_1 \times \dots \times X_n$, categorical product, 108
 F^{op} , opposing functor, 113
 M^0 , the set $\{\emptyset\}$, 91
 M^G , G -invariants, 125
 M^{adj} , adjoint matrix, 247
 $S^{-1}R$, localization, 17
 \mathbf{C}^{op} , opposite category, 102
 \mathcal{F}^+ , sheafification of \mathcal{F} , 145
 M^\vee , dual module, 85, 107
 φ^\vee , dual morphism, 107
 $m \vee m'$, infimum of m and m' , 112
 \mathcal{F}^\vee , dual module sheaf, 169
 $^\vee$, duality functor, 107
 $|\alpha|$, length of the multi-index α , 8
 \wedge , exterior product for differential forms, 212
 \wedge , exterior product, 84
 $m \wedge m'$, supremum of m and m' , 112
- A**
- Abelian
category, 281
- Action, 97
trivial, 97
- Addition, 3
pointwise, 4
- Adjoint action, 292
- Adjoint matrix, 247
- Affine
connection, 303
scheme, 266
subset, 260
variety, 258
- Algebra
associative, 71
commutative, 71
- homomorphism, 72
over a commutative ring, 71
over a ring, 246
symmetric, over a module, 76
- Algebraic
analysis, 314
field extension, 249
group, 284
set, 240
structure, 92
topology, 279
- Algebraically
closed, 51
independent, 247
- Almost-complex structure, 293
canonical, 294
integrable, 294
- Alternating, 126
forms, 210
mapping, 86
- Analytic mappings, 174
- Antisymmetric
mapping, 86
tensor, 81
- Arrows of a category, 98
- Associated
chart
of the cotangent bundle, 197
of the tangent bundle, 195
elements of a ring, 20
- Atiyah, Michael (1929–2019), 313
- Atiyah-Singer index theorem, 313
- Atlas, 173
oriented, 217, 221
for a manifold with boundary, 224
- Automorphism in a category, 103
- B**
- Basis
field, 205
of a module, 33
of a topology, 171
- Bimodule, 60
homomorphismus, 61
- Boundary of a manifold, 223
- Bundle
associated, 309
horizontal, 310
of k -forms, 210
trivial, 306
vertical, 310

- C**
- Cartan, Henri (1904–1986), [215](#)
 - Cartan-identity, [215](#)
 - Categorical
 - coproduct, [109](#)
 - product, [108](#)
 - sum, [109](#)
 - Category, [98](#)
 - abelian, [281](#)
 - derived, [283](#)
 - exact, [281](#)
 - locally small, [128](#)
 - opposite, [102](#)
 - preadditive, [281](#)
 - small, [102](#)
 - Cauchy, Augustin Louis (1789–1857), [229](#)
 - integral
 - formula, [234](#)
 - formula, in several variables, [235](#)
 - theorem, [231](#)
 - product, on formal power series, [7](#)
 - Cauchy-Riemann differential equations, [229](#)
 - Center of a polycylinder, [235](#)
 - Chain complex, [282](#)
 - Characteristic
 - class, [313](#)
 - polynomial, [51](#)
 - Chart
 - of a manifold, [172](#)
 - neighborhood, [172](#)
 - Chern, Shiing-shen (1901–2004), [313](#)
 - Chern-Weil
 - form, [313](#)
 - Chevalley, Claude (1909–1984), [53](#)
 - Chinese remainder theorem, [12](#)
 - Class of a mapping, [172](#)
 - Clausen, Dustin, [283](#)
 - Closed differential form, [213](#)
 - Co-adjoint action, [292](#)
 - Cofunctor, [107](#)
 - Cokernel of a morphism, [281](#)
 - Colimit, [113](#)
 - Commutator product, [127](#)
 - Complex structure, [293](#)
 - Composition of morphisms, [98](#)
 - Condensed mathematics, [283](#)
 - Congruence relation, [95](#)
 - Connected, [179](#)
 - component, [180](#)
 - topological space, [173](#)
 - Connection, [310](#)
 - Constant sheaf, [143](#)
 - Contraction of a differential form, [215](#)
 - Contravariant functor, [107](#)
 - Coordinate
 - neighborhood, [172](#)
 - ring of an algebraic set, [241](#)
 - Coprime, [20](#)
 - Coproduct, [109](#)
 - Coset, [5, 96](#)
 - Cotangent
 - bundle, [196](#)
 - sheaf, [199](#)
 - space, [196](#)
 - Covariant
 - derivative, [303](#)
 - functor, [107](#)
 - Curvature, [305](#)
 - form, [312](#)
 - Cyclic
 - module, [26](#)
 - vector, [50](#)
- D**
- Darboux, Gaston (1842–1917), [294](#)
 - D*-cocone, [113](#)
 - D*-colimit, [113](#)
 - D*-cone, [112](#)
 - Degree
 - of a differential form, [210](#)
 - function, [19](#)
 - of a polynomial, [8](#)
 - De Rham cohomology, [281](#)
 - De Rham, Georges (1903–1990), [209](#)
 - Derivation, [185](#)
 - of an algebra, [206](#)
 - Derived category, [283](#)
 - Determinant, [86](#)
 - Determining surface of a polycylinder, [235](#)
 - Diagram
 - commutative, [35](#)
 - of the form **I**, [112](#)
 - Differentiable structure, [174](#)
 - Differential
 - form, [85, 199, 210](#)
 - of a mapping, [190](#)
 - operators
 - with constant coefficients, [9](#)
 - with smooth coefficients, [9](#)
 - Dimension of a manifold, [173](#)
 - Direct
 - image of presheaves, [142](#)
 - image of sheaves, [150](#)
 - product of modules, [37](#)
 - sum of modules, [37](#)
 - Distributions, [315](#)
 - Distributivity, [3](#)

- Division ring, 6
 Division with remainder in a Euclidean ring, 19
 Divisor, 20
 D -limit, 113
 Dolbeault cohomology, 297
 Dolbeault, Pierre (1924–2015), 297
 Dual module, 107
- E**
 Ellipticity, 316
 Epimorphism, 103
 Equationally defined class, 92
 equivalence of categories, 134
 Essentially surjective, 134
 étalé space, 153
 Euclid (ca. 325–265 BC), 19
 Euclidean
 ring, 19
 space, 290
 Evaluation of a ring homomorphism, 49
 Exact
 category, 281
 Exterior
 algebra, 83
 derivative, 212
 power of a module, 86
- F**
 Factor module, 31
 Faithful functor, 131
 Fiber
 bundle, 306
 product, 115
 of a vector bundle, 198
 Field
 of fractions, 15
 Finitely
 generated ideal, 255
 generated R -algebra, 246
 Finite R -algebra, 246
 Floer, Andreas (1956–1991), 294
 Floer homology, 294
 Foliation, 286
 Formal
 deformation, 301
 star product, 301
 Formality theorem, 301
 Frölicher, Alfred (1927–2010), 312
 Frölicher-Nijenhuis bracket, 312
 Frame bundle
 of a vector bundle, 307
- Free group action, 307
 Fubini, Guido (1897–1943), 296
 Fubini-Study metric, 296
 Full
 functor, 131
 subcategory, 99
 Fully faithful functor, 132
 Functor
 category, 127
 contravariant, 107
 covariant, 107
 fully faithful, 132
 opposite, 113
 Functoriality, 59
 Fundamental theorem
 of algebra, 52
 of arithmetic, 21
 of calculus, 225
 on finitely generated abelian groups, 45
- G**
 G -action, 97
 Galois, Evariste (1811–1832), 279
 Galois theory, 279
 Gauß, Carl Friedrich (1777–1855), 5
 Gaussian integers, 5
 Geodesic, 291, 304
 Germ of a presheaf, 145
 Gluing, 116
 data, 144
 of sheaves, 144
 G -module, 125
 Gradient, 291
 symplectic, 292
 Grassmann, Hermann (1809–1877), 178
 Grassmann manifolds, 178
 Greatest common divisor, 20
 Group, 93
 algebraic, 284
 object, 284
 structure, 93
 Groupoid, 286
 G -set, 96
 G -structure, 308
- H**
 Hamilton, William Rowan (1805–1865), 7
 equations of motion, 292
 function, 291
 vector field, 292, 299
 Harmonic, 297
 Hermite, Charles (1822–1901), 295

- Hermitian structure, 296
 Hilbert, David (1862–1943), 246
 basis theorem, 256
 Nullstellensatz, 246
 Hodge structure, 298
 Hodge, William (1903–1975), 297
 Hörmander, Lars (1931–2012), 314
 Holonomy group, 312
 Homogeneous polynomial, 8
 Homological algebra, 280
 Homology, 279
 Homomorphism
 of local rings, 164
 of modules, 29
 of rings, 9
 Homotopy, 279
 category, 283
 of chain complexes, 283
 Hopf, Heinz (1894–1971), 291
 Horizontal
 bundle, 310
 form, 313
 Hyperfunctions, 314
 Hyperplane, 177
- I**
- Ideal, 10
 in an algebra, 72
 finitely generated, 255
 generated by a set, 11
 maximal, 17
 prime, 17
 Identity
 as functor, 104
 of a group, 5
 in a ring, 6
 I -holomorphic curve, 294
 Image of a module homomorphism, 30
 Inclusion of a categorical sum, 109
 Independence in a module, 33
 Induction, 125
 Inductive
 limit, 116
 system, 116
 Infimum in a partially ordered set, 112
 Integrable sub-bundle, 312
 Integral domain, 14
 Integral of a differential form, 222
 Internal direct sum, 40
 Invariance of basis length, 35
 Inverse
 additive, 6
 image
- of an étale space, 159
 of a sheaf, 151
 multiplicative, 6
 Irreducible
 components of an algebraic set, 272
 element of an integral domain, 23
 topological space, 272
 Isomorphism
 of algebraic sets, 242
 of categories, 103, 134
 of modules, 29
 of rings, 10
 Isomorphism theorem for modules, 32
- J**
- Jacobi, Carl-Gustav (1804–1851), 93
 Jacobi identity, 93
 Jordan
 algebra, 94
 block, 51
 identity, 94
 normal form, 52
 triple system, 94
 Jordan, Camille (1838–1922), 51
 Jordan-Chevalley decomposition, 53
 Jordan, Pascual (1902–1980), 94
- K**
- Kähler, Erich (1906–2000), 296
 Kähler manifold, 296
 Kashiwara, Masaki (*1947), 314
 Kawai, Takahiro (*1945), 314
 Kernel
 of a module homomorphism, 30
 of a morphism, 281
 of a ring homomorphism, 10
 Kontsevich, Maxim (*1964), 301
 \mathbb{K} -rational points, 274
 \mathbb{K} -valued points, 274
- L**
- Laplace operators, 297
 Laplace, Pierre-Simon (1749–1827), 297
 Lattice, 112
 Laurent, Pierre (1813–1854), 271
 Laurent polynomials, 271
 Leading coefficient, 8
 Left ideal, 26
 Level
 of a tensor bundle, 202
 of a tensor field, 202

- Levi-Civita connection, 305
 Levi-Civita, Tullio (1873–1941), 305
 Lie, Sophus (1842–1899), 93
 algebra, 93
 of vector fields, 208
 derivative of differential forms, 215
 groups, 284
 supergroups, 285
 triple system, 94
 Lift of a G -structure, 309
 Limit, 113
 direct, 116
 inductive, 116
 inverse, 116
 projective, 116
 Line
 bundle, 306
 integral, 229
 Linear combination in a module, 32
 Line integral
 complex, 231
 Local
 ring, 163
 ring homomorphism, 164
 trivialization, 306
 Locally
 closed, 263
 finite covering, 220
 ringed space, 163
 Lorentz, Hendrik (1853–1928), 290
 manifold, 290
 metric, 290
- M**
- Manifold, 171
 with boundary, 223
 differentiable, 171
 oriented, 218
 Microdifferential operators, 316
 Microfunctions, 317
 Minimal polynomial, 49
 Minkowski, Hermann (1864–1909), 290
 Minkowski space, 290
 Module, 26
 cyclic, 26
 dual, 107
 finitely generated, 33
 free, 33
 homomorphism, 29
 left, 26
 right, 28
 sheaf, 166
 Möbius, August Ferdinand (1790–1868), 218
 Möbius strip, 218
 Monic polynomial, 8
 Monomorphism, 103
 Morphism, 160, 164
 of a category, 98
 of étalé spaces, 156
 of locally ringed spaces, 164
 of manifolds, 172
 of module sheaves, 166
 of presheaves, 141
 of ringed spaces, 160
 of sheaves, 144
 of vector bundles, 199
 Multi-index, 7, 8
 Multilinear
 form, 56
 mapping, 56
 Multiplication, 3
 pointwise, 4
 Multivector field, 299
- N**
- n -ary operation, 91
 Natural
 isomorphism, 128
 transformation, 127
 Newlander, August, 294
 Nijenhuis, Albert (1926–2015), 312
 Nijenhuis tensor, 294
 Nirenberg, Louis (1925–2020), 294
 Noether
 normalization, 248
 property, 255
 ring, 255
 spaces, 257
 Noether, Emmy (1882–1935), 255
 Noether, Max (1844–1921), 248
 Non-commutative geometry, 286
 Non-standard analysis, 314
 Normalized polynomial, 8
 Normal subgroup, 96
 Nullstellensatz, 246
- O**
- Object of a category, 98
 \mathcal{O}_X -module
 dual, 169
 free, 169
 locally free, 169
 of finite type, 169
 1-form, 85, 198

-
- operation
 - n-ary, 91
 - Opposite
 - category, 102
 - functor, 113
 - Orbifold, 286
 - Orbit, 97
 - Orientation, 222
 - bundle, 306
 - induced, 225

 - P**
 - p -adic
 - integers, 118
 - numbers, 118
 - Paracompact, 220
 - Parallel transport, 304
 - Parametrization of a manifold, 172
 - Partition of unity, 218
 - subordinate to a cover, 218
 - Perelman, Grigori (*1966), 305
 - Poincaré, Henri (1854–1912), 181
 - Pointwise
 - addition, 4
 - multiplication, 4
 - Poisson, Siméon (1781–1840), 289
 - bracket, 298
 - manifold, 298
 - tensor, 299
 - Polycylinder, 235
 - Polyfold, 295
 - Polynomial, 8
 - division, 18
 - function, 241
 - homogeneous, 8
 - mapping, 242
 - normalized, 8, 49, 52
 - Polyradius, 235
 - Power series, 7
 - Preadditive, 281
 - Presheaf, 140
 - Prevariety, 255, 258
 - Prime element, 20
 - Principal
 - fiber bundle, 307
 - ideal, 11
 - Principal ideal
 - domain, 19
 - Product
 - categorical, 108
 - category, 103
 - of manifolds, 177
 - in a module, 33
 - topology, 109
 - Projection
 - canonical, on submodules, 40
 - of a categorical product, 108
 - stereographic, 175
 - Projective
 - limit, 116
 - space, 178
 - over a ring, 272
 - system, 116
 - Pseudo-differential operators, 317
 - Pseudo-holomorphic curve, 294
 - Pseudo-Riemannian
 - manifold, 290
 - metric, 290
 - Pullback, 115
 - of differential forms, 216
 - of a fiber bundle, 310
 - Pushout, 116

 - Q**
 - Quaternions, 7
 - Quotient
 - group, 26
 - module, 31
 - ring, 12
 - structure, 95

 - R**
 - Radical, 245
 - ideal, 245
 - Radius of a polycylinder, 235
 - Rank
 - of a module, 36
 - of a vector bundle, 198
 - Rational normal form of a linear mapping, 50
 - Reduced, 241
 - Reduction of the structure group, 308
 - Refinement of a cover, 220
 - Regular function, 259
 - Regular mapping
 - of affine varieties, 260
 - of prevarieties, 260
 - Residue
 - class, 5
 - ring, 5
 - field of a local ring, 163
 - Restriction, 140
 - Riemann, Bernhard (1826–1866), 229
 - surface, 180

- Riemannian
 curvature, 305
 manifold, 290
 metric, 290
- Right ideal, 30
- Ring, 3
 commutative, 4
 Euclidean, 19
 extension, 29
 factorial, 21
 with identity, 4
 Noetherian, 255
- Ringed space, 160
- Rinow, Willi (1907–1979), 291
- S**
- Sato, Mikio (1928–2023), 314
- Scheme, 266
 affine, 266
 over a ring, 274
- Scholze, Peter (*1987), 283
- Schouten, Jan (1883–1971), 299
- Schouten-Nijenhuis bracket, 299
- Section
 of a fiber bundle, 306
 functor, 149
 of a presheaf, 140
 sheaf, 154
 of a vector bundle, 198
- Separated prevariety, 262
- Sheaf, 143
 of sections, 199
- Short exact sequence, 43
- Singer, Isadore (1924–2021), 313
- Singular set, 317
- Skew-field, 6
- Skew-symmetric
 mapping, 86
- Skyscraper sheaf, 144
- Small category, 102
- Smooth function, 174
 on singular sets, 223
- Solution curve, 27
- Spectrum of a ring, 161
- Sphere, 175
- Spin structure, 309
- Stack, 286
- Stalk
 functor, 145
 of a presheaf, 145
- Standard open set, 252
 of an affine scheme, 266
- Stiefel, Eduard (1909–1978), 178
- Stiefel manifold, 178
- Stokes, George Gabriel (1819–1903), 225
 theorem, 225
- Structure
 algebraic, 92
 constants of a Lie algebra, 300
 group of a principal fiber bundle, 307
 local, 137
 sheaf of a ringed space, 160
- Study, Eduard (1862–1930), 296
- Subalgebra, 72
- Subcategory, 99
 full, 99
- Submanifold, 178
- Submodule, 29
 generated by a set, 32
- Subring, 29
- Sum
 categorical, 109
 topological, 110
- Supremum in a partially ordered set, 112
- Symbol, 316
- Symmetric
 mapping, 79
 power of a module, 79
 tensor, 81
- Symplectic
 coordinates, 293
 foliation, 300
 form, 291
 gradient, 292
 manifold, 291
 topology, 294
 vector space, 293
- T**
- Tangent
 bundle, 193
 functor, 196
 sheaf, 199
 space
 algebraic, 185
 geometric, 183
 physicist's, 184
 vector, 184
- Tensor, 199
 algebra over a module, 72
 bundle, 202
 field, 75, 202
 product
 of algebras, 110
 of modules, 57, 64
 of \mathcal{O}_X -modules, 168

Terminal object of a category, 284

Theorem

of Darboux, 293

of de Rham, 283

of Hodge, 297

of Hopf-Rinow, 291

of Newlander-Nirenberg, 294

Thurston, Bill (1946–2012), 305

Topological sum, 110

Transition function, 201, 308

Transitive group action, 307

Type of a manifold, 171

U

Unital ring homomorphisms, 122

Unit of a ring, 4

Universal algebra, 32

Universal property

direct sum of modules, 37

exterior algebra, 84

free modules, 34

product of modules, 37

symmetric algebra, 76

tensor algebra, 72

tensor product, 57, 64

Universe, 128

V

Vanishing ideal, 241

Variety, 262

affine, 258

projective, 265

quasiprojective, 265

Vector

bundle, 198

field, 27, 203, 205

subbundle, 209

Vector-valued differential forms, 312

Vertical

bundle, 310

vector, 310

Volterra, Vito (1860–1940), 181

W

Wavefront set, 317

Weak solution, 316

Weil, André (1906–1998), 313

Weyl algebra, 9

Weyl, Hermann (1885–1955), 9

Y

Yoneda, Nobuo (1930–1996), 130

embedding, 132

lemma, 130

Z

Zariski, Oscar (1899–1986), 161

Zariski topology, 161, 240, 242, 258

Zero

of an additive group, 5

divisor, 14

object, 281

Zorn, Max (1906–1993), 33

Zorn's lemma, 33