

Notation Index

Symbols and acronyms in normal alphanumeric form are listed first and in alphabetical ordering. If a symbol contains generic variables, they are subsumed to parts of the notation that are not variable. Thus \bar{N} is treated as “bar” because of the bar above the variable “N.” In addition, symbols are treated as “look-alikes” for the purposes of finding them in the notation index and are placed under an appropriate letter, after the ordinary symbols. For instance, \longrightarrow is found under “arrow.” These symbols are grouped together and such groups begin with the symbol \blacktriangleright and end with \blacktriangleleft . Notation index is not an exact science, thus the reader is advised to treat it as a somewhat fuzzy index.

- $1_A = id_A$, identity arrow on A , **1**
- $1_{\mathcal{A}}$, identity functor on \mathcal{A} , **2**
- Ab**, the category of Abelian groups, **3**
- AbSem**, the category of commutative semigroups, **11**
- AC, Axiom of Choice, **237**
- AFunct**(\mathcal{C} , **Ab**), subcategory of additive functors, **37**
- \aleph_{α} , α th cardinal, **240**
- $\text{Ann}(x)$, annihilator of element x , **46**
- $\text{Ann}_R(M)$, annihilator of object M , **198**
- $\text{Assoc}_R(M)$, the associator, **194** \blacktriangleright
- $(\leftarrow i]$, left interval, **105**
- \longrightarrow , natural transformation, **5**
- $F \longrightarrow G$, natural transformation from F to G , **5**
- $*$: **Rings** \longrightarrow **LtMod**, a contravariant functor, **3**
- α_*M , an α -induced module structure, **3**
- $\alpha_*R_1\mathbf{Mod}$, an α -induced subcategory of R_1 -modules, **3**
- A_* , the purification of A , **153**, **183**
- M^* , algebraic dual of M , **55**
- $\mu_1 * \mu_2$, convolution of measures, **223**
- V^* , algebraic dual of V , **76**
- R_* complete integral closure of R , **201**
- $N \leq_* M$, N pure subobject of M , **151**
- $N \leq_{\kappa*} M$, N κ -pure subobject of M , **153** \blacktriangleleft
- $[\kappa]^{<\lambda}$, set of subsets of κ of cardinality $< \lambda$, **244**
- $B(M)$, Bohr compactification of M , **155**
- $\mathcal{B}(\mathbb{R}^n)$, bounded subsets of \mathbb{R}^n , **244**

- Ban**, category of real Banach spaces, 21
- βX , Stone–Čech compactification, 81 ▶
- \bar{N} , closure of an object N , 45, 50
- $C|U$, the restriction presheaf, 104
- $x||y$, x and y are incomparable, 238
- $[\alpha]$, induced morphism of polynomial rings, 196
- $R[S]$, semigroup algebra, 222
- $S[[X_1, \dots, X_n]]$, formal power series ring, 57 ◀
- C**, Axiom of Choice, 237
- C^* , category of commutative C^* -algebras, 6
- CAb**, category of compact Abelian (topological groups), 6
- Cat**, category of categories, 2
- $A \equiv B$, equivalent posets, 238
- \coprod , coproduct, 9
- $\coprod f_i$, coproduct morphism, 17
- C^∞ , smooth manifold, 73
- $C^\infty(M, \mathbb{C})$, the ring of complex analytic maps, 225
- $C^\infty(M, \mathbb{R})$, the ring of real analytic maps, 225
- $C(M)$, all Cauchy nets on M , 53
- $C(X) = C(X, \mathbb{R})$, the set of continuous real-valued functions, 72
- $C_0(M)$, the null Cauchy nets on M , 53
- $C_b(X)$, the ring of bounded functions on X , 72
- $C_b(X, \mathbb{R})$, the ring of real-valued bounded functions, 228
- $C_b(X, N)$, the ring of continuous bounded functions, 232
- $C^n(r)$, n -dimensional cube of side $2r$, centered at 0, 75
- $C^r(X, \mathbb{R})$, 233
- $C^t(X, \mathbb{R})$, the ring of real functions from manifold of class t , 228
- $cd I$, cohomological dimension, 102
- cf , cofinality, 239–240
- CH**, Continuum Hypothesis, 240
- $Char_U^R$, character modules, 22
- Coim**, coimage, 9, 10
- coker** α , cokernel morphism of α , 9
- Coker** α , cokernel object of α , 9
- Comp**, category of compact Hausdorff spaces, 3, 6
- $\mathbb{C}P^n$, complex projective space, 74
- $csupp(x)$, the zero set of x , 60
- $ct(A)$, cofinal type of A , 243 ▶
- $M^c = \text{Hom}_{\mathbb{Z}}(M, \mathbb{R}/\mathbb{Z})$, 178
- $A^\circ = \text{Hom}_{\mathbf{CAb}}(A, U)$, the character group of A , 6
- $\mathbf{E}^\circ = \text{Hom}_{\mathbb{Z}}(\mathbf{E}, \mathbb{Q}/\mathbb{Z})$, 152
- $M^\circ, M^{\circ\circ}$, pure injective envelope, 155; dual module, 181
- $\phi_{\alpha\beta} = \phi_\beta \phi_\alpha^{-1}$, transition functions, 73 ◀
- $\delta_1, \delta_2, \delta_3, \delta_4$, limit commuting transformations, 31
- $\delta h_1, \delta h_2, \delta h_3, \delta h_4$, limit commuting maps, 31
- $\Delta_A : A \times A \rightarrow A$, codiagonal map, 11
- $Dir(\mathcal{I}, \mathcal{X})$, the category of all direct systems, 29 ▶
- $V : x = \{r \in R : rx \in V\}$, 45
- $I : s$, 44 ◀
- $E[\alpha, \beta]$, short exact sequence, 9
- $e : M \hookrightarrow \tilde{M}$, completion embedding, 53
- $\mathbf{e}_X : \prod_{i \in X} A_i \rightarrow \prod_{i \in I} A_i$ embedding, 123
- es , exact sequence, 9
- \mathcal{F}_0 , cofinite filter, 42
- fca , first countability axiom, 46
- \mathcal{F}_F , κ -Fréchet filter, 43
- $\phi_\alpha(p)$, local coordinates, 73
- \mathcal{F}_κ , co- κ filter, 43

\mathcal{F}_x , the principal ultrafilter generated by x , **43**
 FCS, fundamental characterization of slenderness, 138
Fun(I, \mathcal{C}), the category of I -inverse systems, **102**
Func(\mathcal{A}, \mathcal{B}), the category of functors $\mathcal{A} \rightarrow \mathcal{B}$, **5**
 $F(Y, R), F(Y, M)$, the sets of restricted maps **230** ▶
 V_f , the functional space of V , **76**
 M^b , greatest multiplicative subset of R , **234** ◀
G-Sets, the category of G -sets, **99**
 $\Gamma(U, -)$, the evaluation functor of sections, **105**
 $gcf(I)$, general cofinality of I , **242**
 GCH, the General Continuum Hypothesis, **240**
 gldim, global dimension, 135
 $GL(n, K)$, the group of non-singular matrices over K , **79**
Grps, the category of groups, **3** ▶
 $D \gg E$, cofinal finer, **243** ◀
 $H_n(\mathbf{C})$, the homology of \mathbf{C} , **13**
 $H^n(\mathbf{C}, G)$, the cohomology of \mathbf{C} with coefficients in G , **13**
 $H^n(FQ) = R^n(M)$, n th right derived functor of F , **35**
 $H_n(I, -)$, Čech group, 105
 $H^n(I, -)$, cohomology group 105
 $H(X)$, pure hull, **155**
 h_1, h_2, h_3, h_4 , limit commuting maps, **31**
 hd, homological dimension, 183
 $\text{Hom}_{\mathcal{A}}(A, B)$, the Hom-set, **2, 5**
 $\text{Hom}_{\mathcal{C}}(-, -)$, the Hom-bifunctor, **5**
 $\text{Hom}_{\mathcal{C}}(A, -)$, the covariant Hom-functor, **5**
 $\text{Hom}_{\mathcal{C}}(-, B)$, the contravariant Hom-functor, **5**

$\text{Hom}_R(M, E)$, the Hom of a pure exact sequence E , 152
 $\text{Hom}_{\mathcal{C}}(f, g)$, arrow of Hom bifunctor set, **5**
 $ht(T)$, height of tree T , **242**
 $ht(x, T)$, the height of x in T , **242** ▶
 \hat{A} , Hausdorff completion of A , **51**
 $\hat{\mathbb{Z}}$, the \mathbb{Z} -adic completion of \mathbb{Z} , **58** ◀
 $id_R M$, injective dimension, 159
 Im, the image of a morphism, **9**
 In , inclusion functor, **2**
 $\inf(x, y) = x \wedge y$, greatest lower bound, 241
Inv(\mathcal{I}, \mathcal{X}), category of all I -inverse systems, **29, 105** ▶
 $\bigcap_{i \in I} V_i$, the intersection of subobjects, **20**
 $M \cap N$, the intersection of subobjects, **10**
 $S^{-1}R, R[S^{-1}], S^{-1}M$, localizations, 80, 190, 234 ◀
 J_p , the group of (integral) p -adic integers, **51**
 $K[t; \sigma, \delta]$, Ore ring, 213
 $\text{Kdim}(R)$, Krull dimension, **57**
 ker, kernel morphism of a morphism, **9**
 Ker, Kernel object of a morphism, **9**
 kG , group algebra, 71
 $L(\mathcal{C})$, lattice of subobjects, **15, 32**
 $\text{Lev}_{\alpha}(T)$, α th level of a tree, 242
 $\lim \mathcal{F}$, limit of filter \mathcal{F} 52
 $\varinjlim F$, direct limit, **23**
 $\varprojlim F$, inverse limit, **23**
 $\varprojlim^{(n)}$, the n th derived functor of \varprojlim , **35, 102**
 $L\Pi$, a Hom defined category of objects, 39

- $L(\rho)$, first-order predicate logic of signature ρ , 162
- $L\Sigma$, a Hom defined category of objects, 39
- L_T^i , lifting functors, **30**
- LtMod**, the category of categories of left modules, 3 ▶
- $A \prec B$, precedence for sets, **238**
- \leq_ℓ , lexicographic partial order, **239**
- \leq_π , the product partial order, **239**
- $\mathcal{M}_1 \prec \mathcal{M}_2$, elementary embedding, **163** ◀
- $(M, \mathcal{A}, \phi_{\alpha\beta})$, topological manifold, **73**
- $M^1(G)$, the ring of bounded measures on G , **223**
- $M_c(G)$, the set of measures with compact support 223–224
- $M_f(G)$, measures with relatively compact f -image of supp, **223**
- $\mathfrak{M}_m(2)$, the class of two-valued measurable cardinals, **248**
- $m_m(2)$, the smallest cardinal in $\mathfrak{M}_m(2)$, **248**
- $M_n(D)$, the matrix ring, 22
- $M_n^f(\mathbb{Z}) \cong \text{End}(\mathbb{Z}^n)$, The ring of vertically finite integer matrices, 143
- ModR**, the category of right R -modules, **3**
- Mor \mathcal{A} , class of morphisms, **1**
- $\text{Nat}(F_1, F_2) = \text{Hom}(F_1, F_2)$, the set of natural transformations between F_1 and F_2 , **5** ▶
- $\nabla_A : A \rightarrow A \times A$, diagonal map, **11** ◀
- NGB, von Neumann–Gödel–Bernays axiomatic system, 237
- Obj \mathcal{A} , class of objects, **1**
- $\omega = \omega_0$, the smallest infinite ordinal, **240**
- ω_α , α -th initial ordinal, **240**
- $\mathcal{O}(M)$, $\mathcal{O}(M, N)$, holomorphic functions, **74**
- $O(n)$, a group of matrices, 79
- \mathcal{A}^{op} , opposite (dual) category, **2**
- f^{op} , reversed morphism, **2**
- $ot(A)$, order type of A , **238**
- $\mathcal{O}(X)$, the category of open subsets of X , **104**
- p_i , coproduct injection, 9
- Posets**, category of posets, **4**
- $P(X)$, Power set of X , **230, 241**
- P_X , subproduct, **122, 123**
- π_X , subproduct projection, 123
- π_i , product projection, 9
- Pext, pure extension bifunctor, 158, 169
- PSh**, **PSh**(X, \mathcal{C}), category of presheaves, 104
- purgld, pure global dimension, 135, 169, 184–185, 212 ▶
- V^\perp , orthogonal space, 55
- $f + g$, sum of morphisms, **11**
- $M + N = M \cup N$, the sum of subobjects, **10**
- κ^+ , successor cardinal of κ , 240
- $A^{(I)}$, I th (coproduct) copower of A , **10**
- A^I , I th (product) power of A , **10**
- $\alpha^\mathbb{N}$, the product morphism, **193**
- $F^{(n)}$, the n th derived functor of F , **35**
- $\mathcal{C}^{\mathcal{D}}$, a functor category, **17**
- M' , topological dual of M ; the set of continuous linear functionals $M \rightarrow R$, **55**
- $\Pi(\varphi)$, φ -subproduct, **60**
- \prod , product, 9
- $\prod_{\alpha \in A}^\varphi = \prod(\varphi)$, the φ -subproduct, **60**
- $\prod_{\alpha \in A}^\kappa$, κ -subproduct, **60**
- $\Pi(\mathcal{F})/\Pi(\mathcal{G}) = \prod^{\mathcal{F}} / \prod^{\mathcal{G}}$, filter quotient, **161**

- Π/\mathcal{F}_F , Fréchet reduced product, **162**
 Π/\mathcal{F}_0 , filter quotient, **162**
 $\prod_{\alpha \in A} M_\alpha/\mathcal{F}$, filter quotient, 167–168 ◀
- \mathbb{Q}/\mathbb{Z} , cointegral object in **Ab**, 11
 B/A , quotient object, **8**
 $M^A/M^{(A)}$, reduced ultrapower, **161**
- Rings**, category of unital rings, **3**
RMod, category of left R -modules, **3**
 RII, Hom defined objects, 39
 $R\Sigma$, Hom defined objects, 39
RtMod, the category of categories of right modules, **3** ▶
 $R_{(p)}$, localization at p , 178–179
 $R(1/p_1, 1/p_2, \dots)$, subring of \mathbb{Q} , 175
 $R[S]$, semigroup ring, 194 ◀
- $s(0)$, filter of ideals, **47**
 $s(I)$, filter of ideals, **46**
 $s(R)$, filter of ideals, **47**
 sca, second countability axiom, **46**
 scdI, surjective cohomological dimension, **102**
 ses, short exact sequence, **9**
Sets, category of sets, **3**
Sh($I, R\text{Mod}$), category of sheaves of R -modules, 105
Sh(X, \mathcal{C}), category of sheaves on X , **104**
 $\Sigma(\varphi)$, the φ -subproduct, 60
 $\sum_{i \in I} V_i = \cup_{i \in I} V_i$ the sum of subobjects, **20**
 $SL(n, K)$, the group of matrices over K , with determinant 1, 79
 $SO(n)$, orthogonal matrices, 79
 Soc, the socle, **201**
 Spec R , the prime spectrum, 207
 $st(A)$, subset type of A , **238**
 $SU(n)$, unitary matrices, $\det=1$, 79
- $sup(x, y) = x \vee y$, lattice operation, **214**; the least upper bound, **241**
 $\text{supp}(x)$, the support set of x , **60** ▶
 (U_α, ϕ_α) , coordinate chart, **73**
 $\{A_i, f_{ij}\}$, an inverse system, **4** ◀
- $M \otimes_R \mathbf{E}$, tensor product with pure exact sequence, 152
 $T_1V, T_\infty V, T_\kappa V$, functorial topologies, **47–48**, 77
 $T(M)$, torsion part/submodule, 19
 $t(A) + t(B)$, sum of types, 239
 $\tau(\varphi)$, topology induced by $\mathcal{F}(\varphi)$, **60**
Top, Category of topological spaces, **3**
TopAb, category of topological Abelian groups, **47**
TopRMod, category of topological R -modules, **44**
TopRing, category of topological rings, **43** ▶
 \sim : **TopRMod** \longrightarrow **TopRMod**, completion functor, 55
 \tilde{A}, \hat{A} , (Hausdorff) completion, **51**
 $\tilde{\mathcal{C}}$, completions of objects in \mathcal{C} , **136**
 $\tilde{\mathcal{R}}_m$, the set of completions of R in metrizable topologies, **141**
 \widetilde{cyc} , class of completions of cyclic modules, **63**
 \widetilde{cyc}_m , class of completions of metrizable cyclic modules, **63**
 \tilde{A} , a (the), completion, **50–51**
 $\tilde{M} = C(M)/C_0(M)$, the completion, 53–54 ◀
- $U = \mathbb{R}/\mathbb{Z}$, multiplicative group of complex numbers of modulus (the circle groups), **6**
 $U(A)$, the Ulm subgroup of A , 181
 $U(n)$, unitary matrices, 79
 $U(X)$, the group of units of X , 201
 $u : \prod_{i \in I} A_i \longrightarrow \prod_{i \in I} A_i$, coproduct-to-product (ctp) morphism, **16**

- $(U_\alpha, \varphi_\alpha) = \mathcal{A}$, atlas, **73**
 $M \cup N = M + N$, the sum of sub-objects, **10**
Vect, category of vector spaces, **3**
wfcd, weak flabby cohomological dimension, **108**
zero(x), the zero set of x , **60**
 ZF, Zermelo–Fraenkel axiomatic system, 237
 ZFC, Zermelo–Fraenkel axiomatic system + axiom of choice, 237
 $\mathbb{Z}(m)$, $Z(m)$, the group of integer remainders mod m (the residue class ring), 19
 $Z(p^\infty)$, Prüfer’s quasi-cyclic group; p^n th roots of unity, **19**
 $\hat{\mathbb{Z}}_n$, the completion of \mathbb{Z} in the n -adic topology, **51**
 $\mathbb{Z}_{(p)}$, localization of \mathbb{Z} at p , **175**

Name Index

What's in a name?
 (Shakespeare)

The name means everything.
 (Anonymous)

If an author used different names then we usually list the name appearing in the earliest papers of that author. Thus, for instance, transliteration Tychonoff is used instead of Tychonov. “von Neumann” is listed under “Neumann” and similarly other names with such prefixes. Life span is provided for the lives that have been completed, as much as we knew it. For names that are originally in the Cyrillic alphabet, the Cyrillic original is provided as well. Additional name references may be found in the subject index, tied to a term, such as, “Dedekind domain,” etc.

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