Uses of Greek Letters and Other Symbols in CMPSCI 501

letter	name	typical uses in CMPSCI 501
α	alpha	
β	beta	
γ	gamma	
Γ	Gamma	alphabet
δ	delta	transition function
Δ	Delta	
ϵ	epsilon	empty string, $\epsilon \in \Sigma^\star$, $\lvert\epsilon\rvert = 0$
ζ	zeta	
η	eta	
θ	theta	
Θ	Theta	
ι	iota	
κ	kappa	
λ	lambda	function abstraction, e.g., $\lambda x(x^2)$
μ	mu	
ν	nu	
ξ	xi	
o	omicron	
π	pi	$3.14159265\cdots$
Π	Pi	
ρ	rho	
σ	sigma	symbol in Σ
Σ	Sigma	alphabet
τ	tau	
Υ	Upsilon	
φ	phi	formula
Φ	Phi	
χ	chi	characteristic function
ψ	psi	
Ψ	Psi	
ω	omega	
Ω	Omega	lower bound $\Omega(f(n))$

symbol	name	typical meaning or uses in CMPSCI 501
$\#$	number sign	separator, $\#_a(w) =$ number of a's in w
$\star$	star	$\Sigma^\star =$ set of all finite words from Σ
$\leq$	less than or equal	less than or equal; is reducible to; substructure of
$\cap$	intersection	intersection
$\cup$	union	union
$\bot$	bottom	FALSE in a logical formula
$\Box$	box	end of proof, definition, etc.
$\cdot$	cdot	indicates place for an argument, multiplication
$\circ$	circ	composition or concatenation
$\Rightarrow\Leftarrow$	Contradiction	contradiction in informal (metamathematical) statement
$\cong$	iso	isomorphic
$\downarrow$	downarrow	$M(w)\downarrow$ means M converges on input w
$\emptyset$	emptyset	emptyset
$\equiv$	equiv	equivalent
$\hookrightarrow$	is an abbreviation for	e.g., $(\alpha \to \beta) \hookrightarrow (\neg\alpha \vee \beta)$
$\exists$	exists	there exists
$\forall$	forall	for all
$\lceil\cdot\rceil$	ceiling	smallest integer greater than or equal to
$\lfloor\cdot\rfloor$	floor	largest integer less than or equal to
iff	iff	if and only if
$\wedge$	land	logical and
$\vee$	lor	logical or
$\neg$	lnot	logical not
$\to$	rightarrow	implies in a logical formula
$f : A \to B$	rightarrow	f is a function from A to B
$\mapsto$	mapsto	$a \mapsto b$ means that the map takes a to b
$\Rightarrow$	Rightarrow	implies in informal (metamathematical) statement
$\leftrightarrow$	leftrightarrow	iff in a logical formula
$\Leftrightarrow$	Leftrightarrow	iff in informal (metamathematical) statement
$\log$	log	log base 2
$\models$	models	$\mathcal{A} \models \varphi$ means "φ is true in $\mathcal{A}$"
$\vdash$	proves	$\Gamma \vdash \varphi$ means "φ can be proved from Γ"
$\nearrow$	nearrow	$M(w) = \nearrow$ means M diverges on input w
$\oplus$	oplus	exclusive or, sum mod 2
$\sim$	sim	has same cardinality, is equivalent to
$\wp$	power set	$\wp(S) = \{A \mid A \subseteq S\}$
$\sqcup$	sqcup	space symbol on TM tape
$\subseteq$	subseteq	subset or equal to
$\subsetneq$	psubset	proper subset of
$\top$	top	TRUE in a logical formula
$\triangleright$	triangleright	left marker on TM tape

other letters	name	typical meaning or uses in CMPSCI 501
$\mathcal{C}$	cal C	complexity class
$\mathcal{L}$	cal L	language, $\mathcal{L}(M) =$ language accepted by M
Q	bf Q	the set of rational numbers
R	bf R	the set of real numbers
Z	bf Z	the set of integers, $\mathbf{Z} = \{\ldots, -2, -1, 0, 1, 2, \ldots\}$
N	(bf N)	the set of natural numbers, $\mathbf{N} = \{0, 1, 2, \ldots\}$
$\mathbf{Z}^+$	(bf Z)$^+$	the set of positive integers, $\mathbf{Z}^+ = \{1, 2, \ldots\}$
$\aleph_0$	aleph 0	cardinality of **N**

name	Complexity Measures
DSPACE	deterministic space
NSPACE	nondeterministic space
DTIME	deterministic time
NTIME	nondeterministic time
ASPACE	alternating space
ATIME	alternating time

name	Complexity Classes
r.e.	recursively enumumerable sets
co-r.e.	sets whose complements are r.e.
Recursive	recursive sets
Primitive Recursive	primitive recursive sets
EXPTIME	exponential time DTIME$[2^{n^{O(1)}}]$
PSPACE	polynomial space DSPACE$[n^{O(1)}]$
PH	polynomial-time hierarchy
NP	nondeterministic polynomial time, NTIME$[n^{O(1)}]$
P	polynomial time, DTIME$[n^{O(1)}]$
NL	nondeterministic logspace, NSPACE$[\log n]$
L	logspace, DSPACE$[\log n]$
CFL	context-free languages
Regular	regular languages