

# 1 Instruction Set

## 1.1 Register Instructions

Instruction	Signification	Instruction	Signification
<b>integer addition</b>		<b>integer multiplication</b>	
ADD a b c	$R.a = R.b + R.c$	MUL a b c	$R.a = R.b * R.c$
ADDI a b ic	$R.a = R.b + ic$	MULI a b ic	$R.a = R.b * ic$
ADDIU a b uc	$R.a = R.b + uc$	MULIU a b uc	$R.a = R.b * uc$
<b>integer subtraction</b>		<b>integer division</b>	
SUB a b c	$R.a = R.b - R.c$	DIV a b c	$R.a = R.b / R.c$
SUBI a b ic	$R.a = R.b - ic$	DIVI a b ic	$R.a = R.b / ic$
SUBIU a b uc	$R.a = R.b - uc$	DIVIU a b uc	$R.a = R.b / uc$
<b>integer comparison</b>		<b>integer modulo</b>	
CMP a b c	$R.a = \text{cmp}(R.b, R.c)$	MOD a b c	$R.a = R.b \% R.c$
CMPI a b ic	$R.a = \text{cmp}(R.b, ic)$	MODI a b ic	$R.a = R.b \% ic$
CMPIU a b uc	$R.a = \text{cmp}(R.b, uc)$	MODUI a b uc	$R.a = R.b \% uc$
<b>logical or</b>		<b>logical xor</b>	
OR a b c	$R.a = R.b   R.c$	XOR a b c	$R.a = R.b \wedge R.c$
ORI a b ic	$R.a = R.b   ic$	XORI a b ic	$R.a = R.b \wedge ic$
ORIU a b uc	$R.a = R.b   uc$	XORIU a b uc	$R.a = R.b \wedge uc$
<b>logical and</b>		<b>logical bic</b>	
AND a b c	$R.a = R.b \& R.c$	BIC a b c	$R.a = R.b \& \sim R.c$
ANDI a b ic	$R.a = R.b \& ic$	BICI a b ic	$R.a = R.b \& \sim ic$
ANDIU a b uc	$R.a = R.b \& uc$	BICIU a b uc	$R.a = R.b \& \sim uc$
<b>logical shift</b>		<b>arithmetic shift</b>	
LSH a b c	$R.a = \text{lsh}(R.b, R.c)$	ASH a b c	$R.a = \text{ash}(R.b, R.c)$
LSHI a b ic	$R.a = \text{lsh}(R.b, ic)$	ASHI a b ic	$R.a = \text{ash}(R.b, ic)$
<b>bound check</b>			
CHK a c	raise an error if not $0 \leq R.a < R.c$		
CHKI a ic	raise an error if not $0 \leq R.a < ic$		
CHKIU a uc	raise an error if not $0 \leq R.a < uc$		

where

$\text{cmp}(b, c) =$  a value with the same sign as  $b - c$  but with a possibly different magnitude

$\text{lsh}(b, c) = c > 0 ? b \ll c : b \gg -c$

$\text{ash}(b, c) = c > 0 ? b \ll c : b \gg -c$

## 1.2 Load/Store Instructions

Instruction	Signification	Description
LDW a b ic	$R.a = \langle \text{word at address } R.b + ic \rangle$	load word
LDB a b ic	$R.a = \langle \text{byte at address } R.b + ic \rangle$	load byte
POP a b ic	$R.a = \langle \text{word at address } R.b \rangle$ $R.b = R.b + ic$	pop word
STW a b ic	$\langle \text{word at address } R.b + ic \rangle = R.a$	store word
STB a b ic	$\langle \text{byte at address } R.b + ic \rangle = (\text{byte})R.a$	store byte
PSH a b ic	$R.b = R.b - ic$ $\langle \text{word at address } R.b \rangle = R.a$	push word

### 1.3 Control Instructions

Instruction	Signification	Description
BEQ a oc	PC += 4 * (R.a == 0 ? oc : 1)	branch if equal
BNE a oc	PC += 4 * (R.a != 0 ? oc : 1)	branch if not equal
BLT a oc	PC += 4 * (R.a < 0 ? oc : 1)	branch if less than
BGE a oc	PC += 4 * (R.a >= 0 ? oc : 1)	branch if greater or equal
BLE a oc	PC += 4 * (R.a <= 0 ? oc : 1)	branch if less or equal
BGT a oc	PC += 4 * (R.a > 0 ? oc : 1)	branch if greater than
BSR oc	R.31 = PC + 4 PC += 4 * oc	branch to subroutine
JSR lc	R.31 = PC + 4 PC = 4 * lc	jump to subroutine
RET c	PC = R.c	jump to return address

### 1.4 Miscellaneous Instructions

Instruction	Signification	Description
BREAK	<break execution>	break execution
SYSCALL a b uc	R.a = SYS_uc(R.a,R.b)	invoke a system function

## 2 System Calls

Instruction	Signification
SYSCALL a 0 SYS_IO_RD_CHR	R.a = Unicode of read character or -1 if EOF
SYSCALL a 0 SYS_IO_RD_INT	R.a = value of read integer
SYSCALL a 0 SYS_IO_WR_CHR	write character with Unicode R.a
SYSCALL a 0 SYS_IO_WR_INT	write signed value R.a in decimal format
SYSCALL a b SYS_GC_INIT	initialize the garbage collector
SYSCALL a b SYS_GC_ALLOC	R.a = address of a newly allocated block of R.b bytes
SYSCALL a 0 SYS_GET_TOTAL_MEM_SIZE	R.a = total memory size in bytes