

Structure & Flow

Basic Program Structure

```
void setup() {  
  // Runs once when sketch starts  
}  
void loop() {  
  // Runs repeatedly  
}
```

Control Structures

```
if (x < 5) { ... } else { ... }  
while (x < 5) { ... }  
for (int i = 0; i < 10; i++) { ... }  
break;    // Exit a loop immediately  
continue; // Go to next iteration  
switch (var) {  
  case 1:  
    ...  
    break;  
  case 2:  
    ...  
    break;  
  default:  
    ...  
}  
return x; // x must match return type  
return;  // For void return type
```

Function Definitions

```
<ret. type> <name>(<params>) { ... }  
e.g. int double(int x) {return x*2;}
```

Operators

General Operators

=	assignment		
+	add	-	subtract
*	multiply	/	divide
%	modulo		
==	equal to	!=	not equal to
<	less than	>	greater than
<=	less than or equal to		
>=	greater than or equal to		
&&	and		or
!	not		

Compound Operators

```
++ increment  
-- decrement  
+= compound addition  
-= compound subtraction  
*= compound multiplication  
/= compound division  
&= compound bitwise and  
|= compound bitwise or
```

Bitwise Operators

&	bitwise and		bitwise or
^	bitwise xor	~	bitwise not
<<	shift left	>>	shift right

Pointer Access

```
& reference: get a pointer  
* dereference: follow a pointer
```

Built-in Functions

Pin Input/Output

Digital I/O - pins 0-13 A0-A5

```
pinMode(pin,  
  {INPUT|OUTPUT|INPUT_PULLUP})  
int digitalRead(pin)  
digitalWrite(pin, {HIGH|LOW})
```

Analog In - pins A0-A5

```
int analogRead(pin)  
analogReference(  
  {DEFAULT|INTERNAL|EXTERNAL})
```

PWM Out - pins 3 5 6 9 10 11

```
analogWrite(pin, value) // 0-255
```

Advanced I/O

```
tone(pin, freq_Hz, [duration_msec])  
noTone(pin)  
shiftOut(dataPin, clockPin,  
  {MSBFIRST|LSBFIRST}, value)  
shiftIn(dataPin, clockPin,  
  {MSBFIRST|LSBFIRST})  
unsigned long pulseIn(pin,  
  {HIGH|LOW}, [timeout_usec])
```

Time

```
unsigned long millis()  
  // Overflows at 50 days  
unsigned long micros()  
  // Overflows at 70 minutes  
delay(msec)  
delayMicroseconds(usec)
```

Math

```
min(x, y)    max(x, y)    abs(x)  
sin(rad)    cos(rad)    tan(rad)  
sqrt(x)     pow(base, exponent)  
constrain(x, minval, maxval)  
map(val, fromL, fromH, toL, toH)
```

Random Numbers

```
randomSeed(seed) // long or int  
long random(max) // 0 to max-1  
long random(min, max)
```

Bits and Bytes

```
lowByte(x)    highByte(x)  
bitRead(x, bitn)  
bitWrite(x, bitn, bit)  
bitSet(x, bitn)  
bitClear(x, bitn)  
bit(bitn)    // bitn: 0=LSB 7=MSB
```

Type Conversions

```
char(val)      byte(val)  
int(val)       word(val)  
long(val)      float(val)
```

External Interrupts

```
attachInterrupt(interrupt, func,  
  {LOW|CHANGE|RISING|FALLING})  
detachInterrupt(interrupt)  
interrupts()  
noInterrupts()
```

Libraries

Serial - comm. with PC or via RX/TX

```
begin(long speed) // Up to 115200  
end()  
int available() // #bytes available  
int read()    // -1 if none available  
int peek()    // Read w/o removing  
flush()  
print(data)   println(data)  
write(byte)   write(char * string)  
write(byte * data, size)  
SerialEvent() // Called if data rdy
```

SoftwareSerial.h - comm. on any pin

```
SoftwareSerial(rxPin, txPin)  
begin(long speed) // Up to 115200  
listen()          // Only 1 can listen  
isListening()    // at a time.  
read, peek, print, println, write  
  // Equivalent to Serial library
```

EEPROM.h - access non-volatile memory

```
byte read(addr)  
write(addr, byte)  
EEPROM[index] // Access as array
```

Servo.h - control servo motors

```
attach(pin, [min_usec, max_usec])  
write(angle) // 0 to 180  
writeMicroseconds(us)  
  // 1000-2000; 1500 is midpoint  
int read()    // 0 to 180  
bool attached()  
detach()
```

Variables, Arrays, and Data

Data Types

bool	true false
char	-128 - 127, 'a' '\$' etc.
unsigned char	0 - 255
byte	0 - 255
int	-32768 - 32767
unsigned int	0 - 65535
word	0 - 65535
long	-2147483648 - 2147483647
unsigned long	0 - 4294967295
float	-3.4028e+38 - 3.4028e+38
double	currently same as float
void	return type: no return value

Strings

```
char str1[8] =  
  {'A','r','d','u','i','n','o','\0'};  
  // Includes \0 null termination  
char str2[8] =  
  {'A','r','d','u','i','n','o'};  
  // Compiler adds null termination  
char str3[] = "Arduino";  
char str4[8] = "Arduino";
```

Numeric Constants

123	decimal
0b01111011	binary
0173	octal - base 8
0x7B	hexadecimal - base 16
123U	force unsigned
123L	force long
123UL	force unsigned long
123.0	force floating point
1.23e6	1.23*10^6 = 1230000

Qualifiers

static	persists between calls
volatile	in RAM (nice for ISR)
const	read-only
PROGMEM	in flash

Arrays

```
byte myPins[] = {2, 4, 8, 3, 6};  
int myInts[6]; // Array of 6 ints  
myInts[0] = 42; // Assigning first  
               // index of myInts  
myInts[6] = 12; // ERROR! Indexes  
               // are 0 though 5
```



Wire.h - I²C communication

```
begin() // Join a master  
begin(addr) // Join a slave @ addr  
requestFrom(address, count)  
beginTransmission(addr) // Step 1  
send(byte) // Step 2  
send(char * string)  
send(byte * data, size)  
endTransmission() // Step 3  
int available() // #bytes available  
byte receive() // Get next byte  
onReceive(handler)  
onRequest(handler)
```