**ESCUELA SUPERIOR POLITÉCNICA DEL LITORAL**

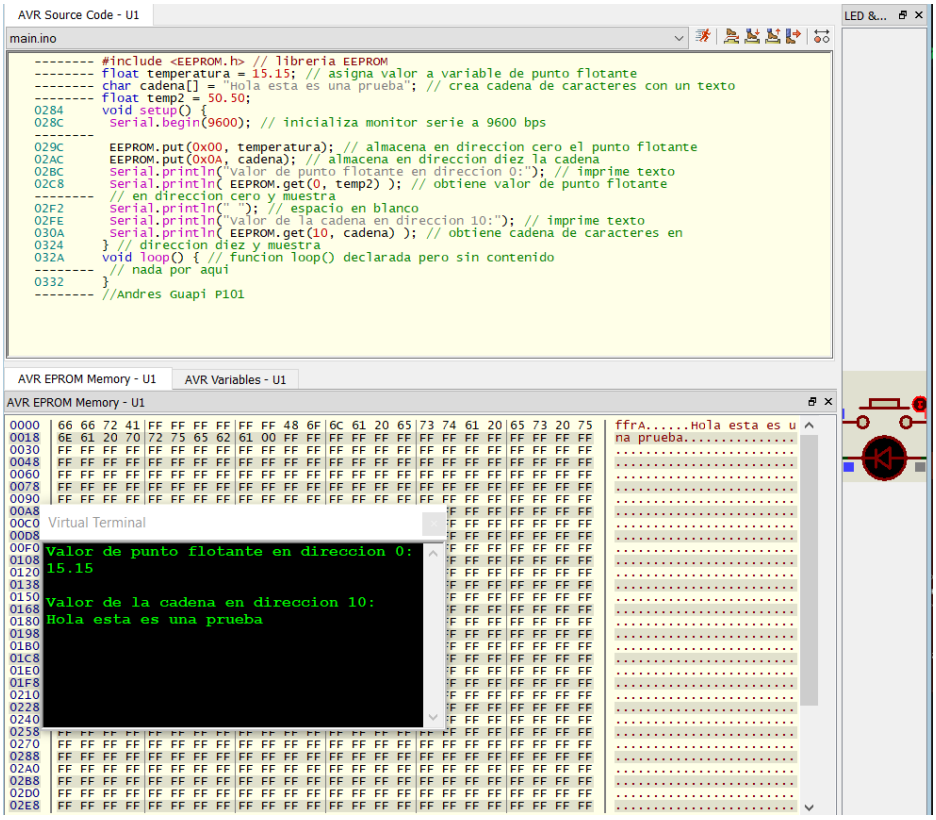
**Facultad de Ingeniería en Mecánica y Ciencias de la Producción**

# PRACTICA #5

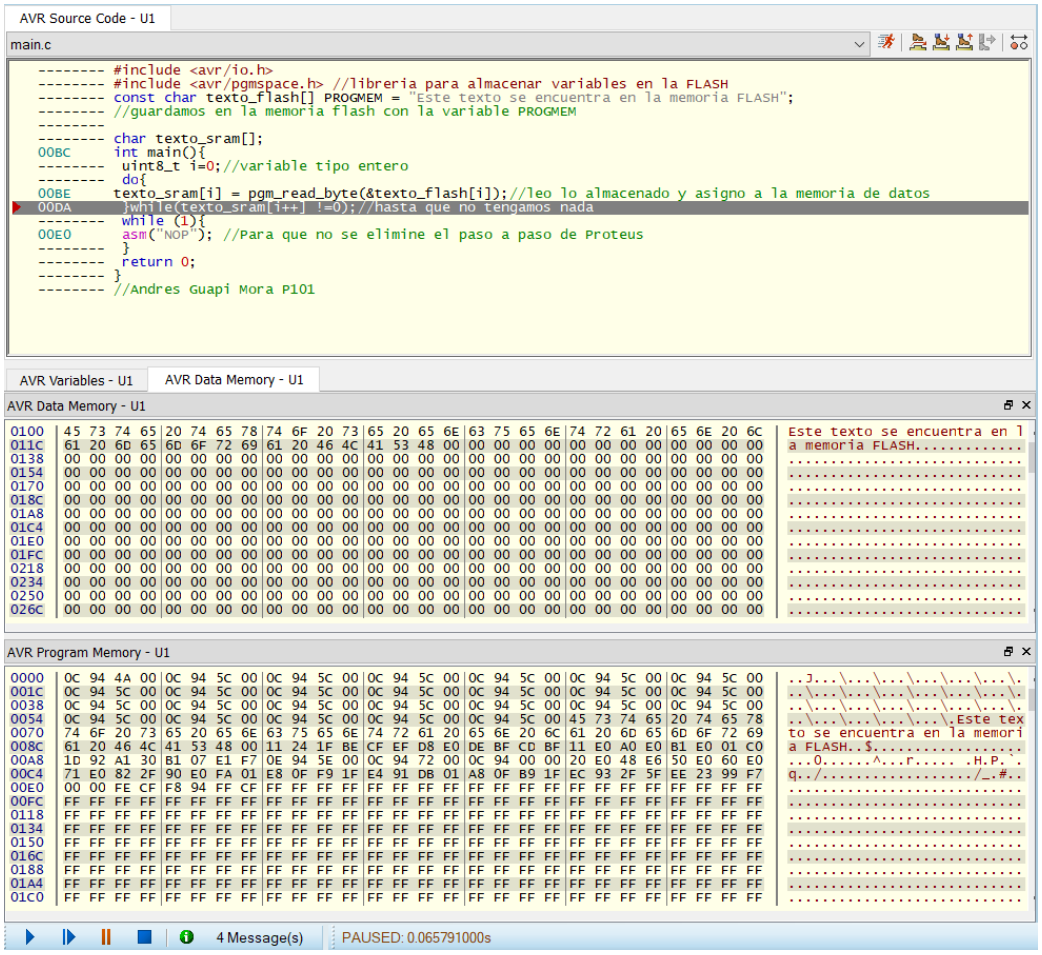
Fecha: 14/06/2021

Oscar Andres Guapi Mora
oguapi@espol.edu.ec

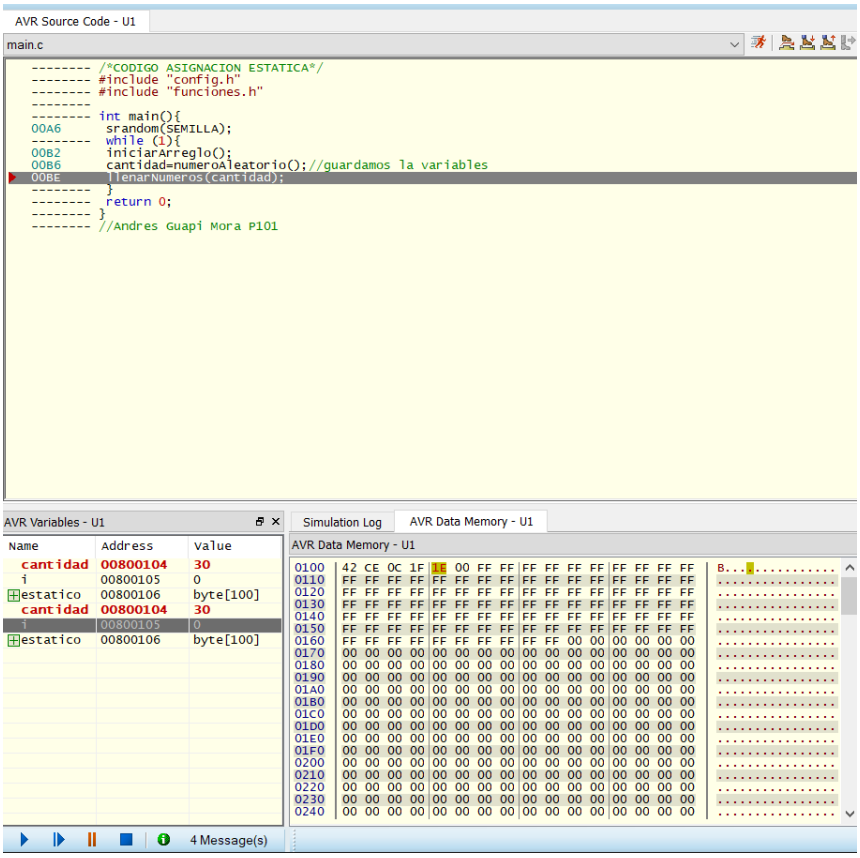
# EEPROM en lenguaje Arduino

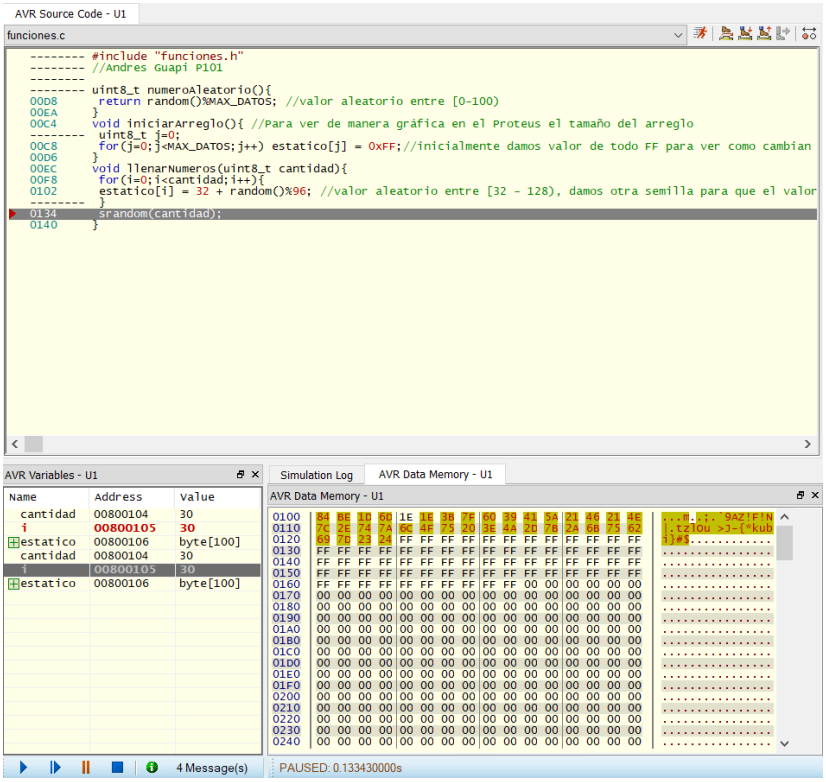


Memoria FLASH



## Memoria Estática



## Asignación Dinámica

AVR Source Code - U1

funciones.c

```
-------- #include "funciones.h"
-------- #include "config.h"
-------- //Andres Guapi P101
--------
-------- uint8_t numeroAleatorio(){
00C0      return random()%MAX_DATOS; //valor aleatorio entre [0-100)
00D2     }
00D4     void llenarNumeros(uint8_t cantidad){
00DC      ptr = (char * )malloc(cantidad*sizeof(char));//adquiere la cantidad de espacio de memoria a utilizar
00EA      for(i=0;i<cantidad;i++){
00F4       ptr[i]=32 + random()%96; //valor aleatorio entre [32 - 128)
--------  }
0124      free(ptr);//liberar la memoria los espacios de memoria para usar por otra u la misma
0130     srandom(cantidad); //cambia la semilla de los numeros aleatorios
013C     }
```

AVR Data Memory - U1

```
0100 | 20 00 12 01 00 00 FB 5E B9 01 14 01 1E 01 32 01 00 00 1E 00 3B 00 00 00 00 00 00 00 | .....^..  ...2.....;.....
011C | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0138 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0154 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0170 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
018C | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01A8 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01C4 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01E0 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01FC | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0218 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0234 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0250 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
026C | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0288 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02A4 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02C0 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02DC | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
```

AVR Variables - U1

| Name | Address | Value |
|---|---|---|
| i | 0080010D | 1 |
| ptr | 0080010A | 0x0114 |
| cantidad | 0080010C | 30 |
| i | 0080010D | 0x01 |
| ptr | 0080010A | 0x0114 |
| cantidad | 0080010C | 0x1E |
| i | 0080010D | 0x01 |
| ptr | 0080010A | 0x0114 |
| cantidad | 0080010C | 0x1E |

main.c

```
-------- /*CODIGO ASIGNACION DINAMICA*/
-------- #include "funciones.h"
-------- #include "config.h"
--------
-------- //conf();
-------- //uint8_t cantidad,i;
-------- //char *ptr; //usamos un puntero
--------
-------- int main()
-------- {
00A6      srandom(SEMILLA);
--------  while (1){
00B2      cantidad=numeroAleatorio();
00BA      llenarNumeros(cantidad);
-------- }
--------  return 0;
-------- }
-------- //Andres Guapi Mora P101
```

AVR Data Memory - U1

```
0100 | 20 00 12 01 00 00 7E 10 7E 28 34 01 46 2E 7A 01 12 01 1E 00 00 00 60 39 41 5A 21 46 |  .....~.~(4.F.z.....`9AZ!F
011C | 21 4E 5A 00 00 00 5C 71 7F 53 23 41 4F 2A 22 22 6E 35 6F 38 66 6A 46 00 6B 21 48 79 | !NZ...\q.S#AO*""n5o8fjF.k!Hy
0138 | 32 50 52 64 4B 53 77 60 34 3E 6B 6C 2A 33 48 3A 30 27 5B 58 57 6E 62 54 4D 63 7B 32 | 2PRdKSw`4>kl*3H:0'[XWnbTMc{2
0154 | 7E 7B 4D 24 29 47 35 58 49 71 37 28 6A 5E 49 2B 26 52 70 42 77 52 45 32 7A 52 0A 00 | ~{M$)G5XIq7(j^I+&RpBwRE2zR..
0170 | 00 00 79 6B 56 31 78 4E 22 7B 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ..ykV1xN"{..................
018C | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01A8 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01C4 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01E0 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
01FC | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0218 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0234 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0250 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
026C | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
0288 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02A4 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02C0 | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
02DC | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................................
```

AVR Variables - U1

| Name | Address | Value |
|---|---|---|
| i | 0080010D | 46 |
| ptr | 0080010A | 0x0134 |
| cantidad | 0080010C | 70 |

Memoria EEPROM

AVR Source Code - U1

main.c

```
-------- #include <avr/eeprom.h> //archivo de cabecera para la utilización de la EEPROM AVR
-------- #include <util/delay.h>
-------- #include <avr/io.h>
--------
-------- uint8_t EEMEM dato0 = 0x0A; //creación de la variable dato de 8 bits en la EEPROM AVR
-------- uint16_t EEMEM dato1 = 0xAABB;
-------- uint8_t EEMEM dato2 = 0x55;
-------- uint8_t EEMEM texto[] = "Hola Mundo";
-------- uint8_t valor;// variable en la data memori
--------
-------- int main(void)
-------- {
0090       DDRD=0xFF; //como salidas digitales, para desafio
0094       PORTD=0x00; //se inicia a 0
0096       DDRB &= ~(1 << 0); //PIN 8 DE ARDUINO COMO ENTRADA
00A0       DDRB |= (1 << 3); //pin 11 del Arduino como salida
00A6       valor = eeprom_read_byte(&dato2); //en la variable dato de la EEPROM AVR
--------    //leemos lo de dato2 y guarda en valor
00B2       eeprom_write_byte(0xF0,0xAB);//le digo la direccion y el valor
00BC       eeprom_write_byte(&dato0,0x5);//la variable y le asignamos el valor
--------
--------   while(1) //ciclo del programa
--------   {
00C6         asm("NOP");
--------   }
-------- }
-------- //Andres Guapi Mora P101
```

AVR EPROM Memory - U1

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0000 | 0A | BB | AA | 55 | 48 | 6F | 6C | 61 | 20 | 4D | 75 | 6E | 64 | 6F | 00 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ...UHola Mundo..... |
| 001C | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0038 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0054 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0070 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 008C | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 00A8 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 00C4 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 00E0 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | AB | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 00FC | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0118 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0134 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0150 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 016C | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 0188 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 01A4 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 01C0 | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |
| 01DC | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | FF | ..... |

AVR Variables - U1

| Name | Address | Value |
|---|---|---|
| dato1 | 00810001 | 0 |
| dato2 | 00810003 | 0 |
| ⊞texto | 00810004 | byte[11] |
| valor | 00800100 | 85 |
| **dato0** | **00810000** | **0x02** |

Como podemos apreciar en AVR Variables se asignó a una variable de memoria de datos (valor=85) que es el valor de dato2 mostrado en forma decimal.

## Conclusiones

- Fue posible familiarizarse con los distintos tipos de memorias presentes en los microcontroladores específicamente el ATmega328p, ya que conocimos las distintas librerías que necesita cada memoria para almacenar en ella.

- Conocimos la diferencia entre la programación en lenguaje Arduino y en C nativo para el almacenamiento en la memoria EEPROM en la cual vimos que las funciones get y set de Arduino son más cortas, pero estas consumen más memorias al procesarlas.
- Conocimos las distintas formas de asignar valores en la memoria de datos (SRAM) que son asignación estática que ocurre en tiempo de compilación donde establecemos una cantidad máxima de memoria, o asignación dinámica que ocurre en tiempo de ejecución donde hacemos uso de punteros.

**Recomendaciones**

- En el archivo con las funciones asegurarse de llamar el archivo donde se encuentran creadas las variables del proyecto para evitar errores por no declaración de variables.
- Es recomendable que a la hora de simular no tan solo tener abierto la ventaba de Data Memory si no también AVR Variables para poder apreciar de mejor manera como van cambiando los datos.