



# ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ

ΣΧΟΛΗ ΗΜ&ΜΥ  
Εργαστήριο Μικροϋπολογιστών

7<sup>η</sup> Εργαστηριακή Άσκηση  
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*Ομάδα C07:*

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## Άσκηση (i)

Κυρίως κώδικας:

```
1  /*Includes for compatibility with GNU toolchain*/
2  #define __SFR_OFFSET 0
3  #include <avr/io.h>
4  #include <avr/interrupt.h>
5  .global main
6  /*
7   * AVR_3h_ask1.asm
8   *
9   * Created: 10/2/2012 10:01:52 ??
10  * Author: Valia
11  */
12
13
14  /*
15  * AVR_ask1.asm
16  *
17  * Created: 10/2/2012 9:24:48 ??
18  * Author: Valia
19  */
20
21  ;//.def r24 = r24
22  ;//.def r28 = r28
23  ;//.def r27 = r27
24  ;//.def r25 = r25
25  ;//.def r29 = r29
26  ;//.def r26 = r26
27  ;//.def r30 = r30
28
29  main:
30      ldi r24, hi8(RAMEND)
31      out SPH, r24
32      ldi r24, lo8(RAMEND)
33      out SPL, r24
34
35      ser r24
36      out DDRB, r24
37
38      clr r24
39      out DDRA, r24
40
41      clr r29
42      out DDRC, r29
43  start:
44      clr r30
45      in r29, PINC
46      lsr r29
47      brcc syn1
48  etik1:    ;//perimenei mexri na ginei 0 (button)
49      in r26, PINC
50      lsr r26
51      brcs etik1
52      ori r30, 1
53
54  syn1:
55      lsr r29
56      brcc syn2
57  etik2:    ;//perimenei mexri na ginei 0 (button)
58      in r26, PINC
59      lsr r26
60      lsr r26
61      brcs etik2
62      ori r30, 2
63
64  syn2:
65      lsr r29
66      brcc syn3
67  etik3:    ;//perimenei mexri na ginei 0 (button)
68      in r26, PINC
69      lsr r26
70      lsr r26
71      lsr r26
72      brcs etik3
```

```

73     ori r30, 4
74
75     syn3:
76         lsr r29
77         brcc syn4
78     etik4:      ;//perimenei meaxri na ginei 0 (button)
79         in r26, PINC
80         lsr r26
81         lsr r26
82         lsr r26
83         lsr r26
84         brcs etik4
85         ori r30, 8
86
87     syn4:
88         lsr r29
89         brcc syn5
90     etik5:      ;//perimenei meaxri na ginei 0 (button)
91         in r26, PINC
92         lsl r26
93         lsl r26
94         lsl r26
95         lsl r26
96         brcs etik5
97         ori r30, 0x010
98
99     syn5:
100         lsr r29
101         brcc syn6
102     etik6:      ;//perimenei meaxri na ginei 0 (button)
103         in r26, PINC
104         lsl r26
105         lsl r26
106         lsl r26
107         brcs etik6
108         ori r30, 0x020
109
110     syn6:
111         lsr r29
112         brcc syn7
113     etik7:      ;//perimenei meaxri na ginei 0 (button)
114         in r26, PINC
115         lsl r26
116         lsl r26
117         brcs etik7
118         ori r30, 0x040
119
120     syn7:
121         lsr r29
122         brcc synexise
123     etik8:      ;//perimenei meaxri na ginei 0 (button)
124         in r26, PINC
125         lsl r26
126         brcs etik8
127         ori r30, 0x080
128
129     synexise:
130
131         in r28, PINA
132         clr r25 ;//mhdenismos exodun
133         clr r27
134
135     gate_1:
136         lsr r28
137         brcc exit_gate1 ;//an to lsb == 0 feugoume
138         lsr r28
139         brcc exit_gate1 ;//an to 2o lsb == 0 feugoume
140         inc r25
141
142     exit_gate1:
143
144     gate_2:
145         lsr r28
146         brcc exit_gate2 ;//an to 3o lsb == 0 feugoume
147         lsr r28

```

```

148     brcc exit_gate2 ;//an to 4o lsb == 0 feugoume
149     ori r27, 2
150
151 exit_gate2:
152     or r27, r25 ;//exodos sta 2 prwta lsb bit
153
154 gate_3:
155     lsr r28
156     brcs exit_gate3 ;//an to 5o lsb == 1 feugoume
157     lsr r28
158     brcs exit_gate3 ;//an to 6o lsb == 1 feugoume
159     ori r27, 4 ;// or me 100
160
161 exit_gate3:
162
163 gate_4:
164     lsr r28
165     brcs one ;//an einai 1 psaxnoumt an kai to allo einai 0
166     lsr r28 ;//an einai to 1o 0, tsekaroyme an kai to 2o einai 1
167     brcc exit_gate4
168     rjmp setting
169
170 one:
171     lsr r28
172     brcs exit_gate4 ;// an to allo einai 0 feugoyme
173
174 setting:
175     ori r27, 8
176
177 exit_gate4:
178     eor r27, r30 ;//xor
179     out PORTB, r27
180     rjmp start

```

## Άσκηση (ii)

Κυρίως κώδικας:

```
1  /* .....  
2  
3  * File Name : part2.c  
4  
5  * Purpose :  
6  
7  * Creation Date : 07-02-2012  
8  
9  * Last Modified : Wed 08 Feb 2012 12:09:50 AM EET  
10  
11 * Created By : Greg Liras <regliras@gmail.com>  
12  
13 .....*/  
14  
15  
16 #include<avr/io.h>  
17  
18 int f0 ( int c )  
19 {  
20     for( ; c > 0 ; c >=1 )  
21         if ( ( c & 3 ) == 3 )  
22             return 0;  
23     return 1;  
24 }  
25 int f1 ( int c )  
26 {  
27     if ( c <= 15 || c == 31 )  
28         return 1;  
29     return 0;  
30 }  
31 int main(void)  
32 {  
33     DDRA = 0xff;  
34     DDRC = 0x00;  
35     int f_0;  
36     int f_1;  
37     int c;  
38     for( ;; )  
39     {  
40         c = PINC & 31;  
41         f_0 = f0( c );  
42         f_1 = f1( c );  
43         PORTA = f_0 | ( f_1 << 1 ) | ( ( f_0 | f_1 ) << 2 );  
44     }  
45 }
```

### Άσκηση (iii)



Σχήμα 1: Διάγραμμα ροής

Κυρίως κώδικας:

```
1  #define __SFR_OFFSET 0
2  #include <avr/io.h>
3
4  .data
5  _tmp_: .byte 2
6  .text
7  .global main
8  main:
9  reset:
10     ldi r24,lo8(RAMEND)
11     out SPL,r24
12     ldi r24,hi8(RAMEND)
13     out SPH,r24
14     ser r24
15     out DDRA,r24
16     ;// PORTA output
17     ldi r24,(1 << PC7) | (1 << PC6) | (1 << PC5) | (1 << PC4)
18     out DDRC,r24
19     ;// 4x4 pad input
20     rcall scan_keypad_rising_edge
21     ;// initialize
22 lock:
23     ;//reset the memory
24     ldi r24,0x00
25     ldi r25,0x00
26     ldi r26,lo8(_tmp_)
27     ldi r27,hi8(_tmp_)
28     st X+,r24
```

```

29     st X ,r25
30     ldi r24, 0x14
31     rcall scan_keypad_rising_edge
32     cpi r24, 0x00
33     ;//first test failed
34     brne lock
35     ldi r24, 0x14
36     rcall scan_keypad_rising_edge
37     ;//second test failed
38     cpi r24, 0x12
39     brne lock
40     rjmp pass
41
42     pass:
43         ldi r24,0xff
44         out PORTA, r24
45         ldi r24,lo8(2000)
46         ldi r25,hi8(2000)
47         rcall wait_msec
48         ;//reset the leds
49         ldi r24,0x00
50         out PORTA, r24
51         rjmp lock
52
53
54     scan_row:
55         ldi r25 ,0x08
56     back_: lsl r25
57         dec r24
58         brne back_
59         out PORTC ,r25
60         nop
61         nop
62         in r24 ,PINC
63         andi r24 ,0x0f
64         ret
65
66
67
68     scan_keypad:
69         ldi r24 ,0x01
70         rcall scan_row
71         swap r24
72         mov r27 ,r24
73         ldi r24 ,0x02
74         rcall scan_row
75         add r27 ,r24
76         ldi r24 ,0x03
77         rcall scan_row
78         swap r24
79         mov r26 ,r24
80         ldi r24 ,0x04
81         rcall scan_row
82         add r26 ,r24
83         movw r24 ,r26
84         ret
85
86
87     scan_keypad_rising_edge:
88         mov r22 ,r24
89         rcall scan_keypad
90         push r24
91         push r25
92         mov r24 ,r22
93         ldi r25 ,0
94         rcall wait_msec
95         rcall scan_keypad
96         pop r23
97         pop r22
98         and r24 ,r22
99         and r25 ,r23
100        ldi r26 ,lo8(_tmp_)
101        ldi r27 ,hi8(_tmp_)
102        ld r23 ,X+
103        ld r22 ,X

```

```

104     st X ,r24
105     st -X ,r25
106     com r23
107     com r22
108     and r24 ,r22
109     and r25 ,r23
110     ret
111
112
113
114     wait_usec:
115         sbiw r24,1
116         nop
117         brne wait_usec
118         ret
119
120     wait_msec:
121         in r27,PINB
122         ror r27
123         brcs wait_msec
124         push r24
125         push r25
126         ldi r24,lo8(998)
127         ldi r25,hi8(998)
128         rcall wait_usec
129         pop r25
130         pop r24
131         sbiw r24,1
132         brne wait_msec
133         ret

```



## Άσκηση (iv)

Κυρίως κώδικας:

1

## Άσκηση (v)

Κυρίως κώδικας:

```
1  #define __SFR_OFFSET 0
2  #include <avr/io.h>
3
4  .global main
5  main:
6  reset:
7      ldi r24,lo8(RAMEND)
8      out SPL,r24
9      ldi r24,hi8(RAMEND)
10     out SPH,r24
11     ser r24
12     out DDRA,r24
13
14 loop:
15     rjmp loop
16
17
18
19 alarm:
20     push r24
21     ldi r24,0xff
22     out PORTA,r24
23     pop r24
24     ret
```

## Άσκηση (vi)

Κυρίως κώδικας:

1