Κυριακόπουλος Γιώργος – el18153
Τζελέπης Σεραφείμ – el18849

1η Άσκηση:

C version

```c
#include <avr/io.h>

unsigned char A, B, C, D, notA, notB, F0, F1, answer, temp;

int main(void) {
    DDRC = 0x00;                    // input from C
    DDRB = 0xFF;                    // output at B

    while(1) {
        A = PINC & 0x01;           // keep LSB
        B = PINC & 0x02;           // keep 2nd LSB
        B = B >> 1;                // shift it to LSB so LSB(B) = B
        C = PINC & 0x04;           // keep 3rd LSB
        C = C >> 2;                // shift it to LSB so LSB(C) = C
        D = PINC & 0x08;           // keep 4th LSB
        D = D >> 3;                // shift it to LSB so LSB(D) = D

        notA = A ^ 0x01;           // complement A
        notB = B ^ 0x01;           // complement B

        temp = ((notA & B) |
                (notB & C & D));   // temp = (A'B + B'CD)
        F0 = temp ^ 0x01;          // complement temp to get F0

        F1 = ((A & C) &
              (B | D));            // F1 = (AC)(B+D)
        F1 = F1 << 1;              // shift F1 to 2nd LSB
        answer = F0 + F1;          // add F1 and F0 to get output
        PORTB = answer;            // output answer at B
    }
}
```

Assembly version

```asm
.include "m16def.inc"

.DEF A = r16
.DEF B = r17
.DEF C = r18
.DEF D = r19
.DEF F0 = r20
.DEF F1 = r21
.DEF TEMP = r22
.DEF ANSWER = r23

stack:
        ldi r24, low(RAMEND)     ; initialize stack pointer
        out SPL, r24
        ldi r24, high(RAMEND)
        out SPH, r24
IO_set:
        clr r24
        out DDRC, r24            ; input from C
        ser r24
        out DDRB, r24            ; output at B
main:
        in A, PINC               ; load input on A
        mov TEMP, A              ; backup input on TEMP
        andi A, 0x01            ; LSB(A) = A

        mov B, TEMP             ; load input on B
        andi B, 0x02
        lsr B                   ; LSB(B) = B

        mov C, TEMP             ; load input on C
        andi C, 0x04
        lsr C
        lsr C                   ; LSB(C) = C

        mov D, TEMP             ; load input on D
        andi D, 0x08
        lsr D
        lsr D
        lsr D                   ; LSB(D) = D
```

```asm
mov TEMP, A            ; TEMP = A
com TEMP               ; TEMP = A'
and TEMP, B            ; TEMP = A'B
mov F0, TEMP           ; F0 = A'B

mov TEMP, B            ; TEMP = B
com TEMP               ; TEMP = B'
and TEMP, C            ; TEMP = B'C
and TEMP, D            ; TEMP = B'CD

or F0, TEMP            ; F0 = A'B + B'CD
com F0                 ; F0 = (A'B + B'CD)'

mov TEMP, A            ; TEMP = A
and TEMP, C            ; TEMP = AC
mov F1, TEMP           ; F1 = AC

mov TEMP, B            ; TEMP = B
or TEMP, D             ; TEMP = B+D
and F1, TEMP           ; F1 = (AC)(B+D)

andi F0, 0x01          ; keep only LSB
andi F1, 0x01          ; keep only LSB
lsl F1                 ; move F1 to 2nd LSB
mov ANSWER, F1         ; ANSWER = 000000(F1)0
or ANSWER, F0          ; ANSWER = 000000(F1)(F0)
out PORTB, ANSWER      ; output ANSWER at B

rjmp main              ; restart the program
```

2η Άσκηση:

```
.org 0x0
    rjmp reset
.org 0x4
    rjmp ISR1

.DEF COUNTER = r20
.DEF TEMP = r21

reset:
    ldi r24 , low(RAMEND)                 ; initialize stack pointer
    out SPL , r24
    ldi r24 , high(RAMEND)
    out SPH , r24

    ldi r23, (1 << ISC11)|(1 << ISC10)    ; rising edge of INT1
    out MCUCR, r23
    ldi r23, (1 << INT1)                   ; enable INT1
    out GICR, r23
    sei                                   ; enable interrupts
IO_set:
    clr r26
    out DDRA, r26                         ; input from A
    ser r26
    out DDRC, r26                         ; output at C
    out DDRB, r26                         ; output at B (INT COUNTER)
    clr r26                               ; initialize counter
    clr COUNTER                           ; initialize INT COUNTER
loop:
    out PORTC, r26                        ; sent counter to output
    inc r26                               ; increase counter
    rjmp loop                             ; repeat until interrupt

ISR1:
    push r26                              ; save r26
    in r26, SREG
    push r26                              ; save SREG

    inc COUNTER                           ; increase INT COUNTER
    in TEMP, PINA                         ; load input to TEMP
    andi TEMP, 0xC0                       ; keep only A7 and A6
    cpi TEMP, 0xC0                        ; check if A7 and A6 are on
```

```asm
        brne EXITINT                    ; if they are not exit

        out PORTB, COUNTER              ; display it on PORTB LEDs
EXITINT:
        pop r26                         ; restore SREG
        out SREG, r26
        pop r26                         ; restore r26
        reti                            ; return to loop
```

3η Άσκηση:

```c
#include <avr/io.h>
#include <avr/interrupt.h>

volatile unsigned char A, B, counter, flag = 1;

ISR(INT0_vect) {
    A = PINA & 0x04;                    // keep only PA2
    B = PINB;                           // load input from B

    if(A) {                            // if PA2 is ON
        counter = 0x00;               // initialize counter
        for (int i = 0; i < 8; i++) {  // for loop 8 times
            if(B & 0x01) {            // if LSB is 1
                counter++;             // increase counter
            }
            B = B >> 1;                // rotate input right
        }
        PORTC = counter;               // output counter to C
    }
    else {                            // if PA2 is OFF
        counter = 0x00;               // initialize counter
        for (int i = 0; i < 8; i++) {  // for loop 8 times
            if(B & 0x01) {            // if LSB is 1
                counter = counter << 1; // shift counter left
                counter++;             // increase counter
            }
            B = B >> 1;                // rotate input right
        }
        PORTC = counter;               // output counter to C
    }
}

int main(void) {
    MCUCR = 0x03;                      // rising edge of INT0
    GICR = 0x40;                       // enable INT0

    DDRA = 0x00;                       // input from A
    DDRB = 0x00;                       // input from B
    DDRC = 0xFF;                       // output at C

    while(flag) {                      // infinite loop
```

```
        sei();                                    // enable interrupts
    }
}
```