Computer Technology I

Lab. 2 : Subroutines

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Area: Computer Science
Course code: 1DT301

Contents

1 Task 1 - Switch – Ring counter / Johnson counter

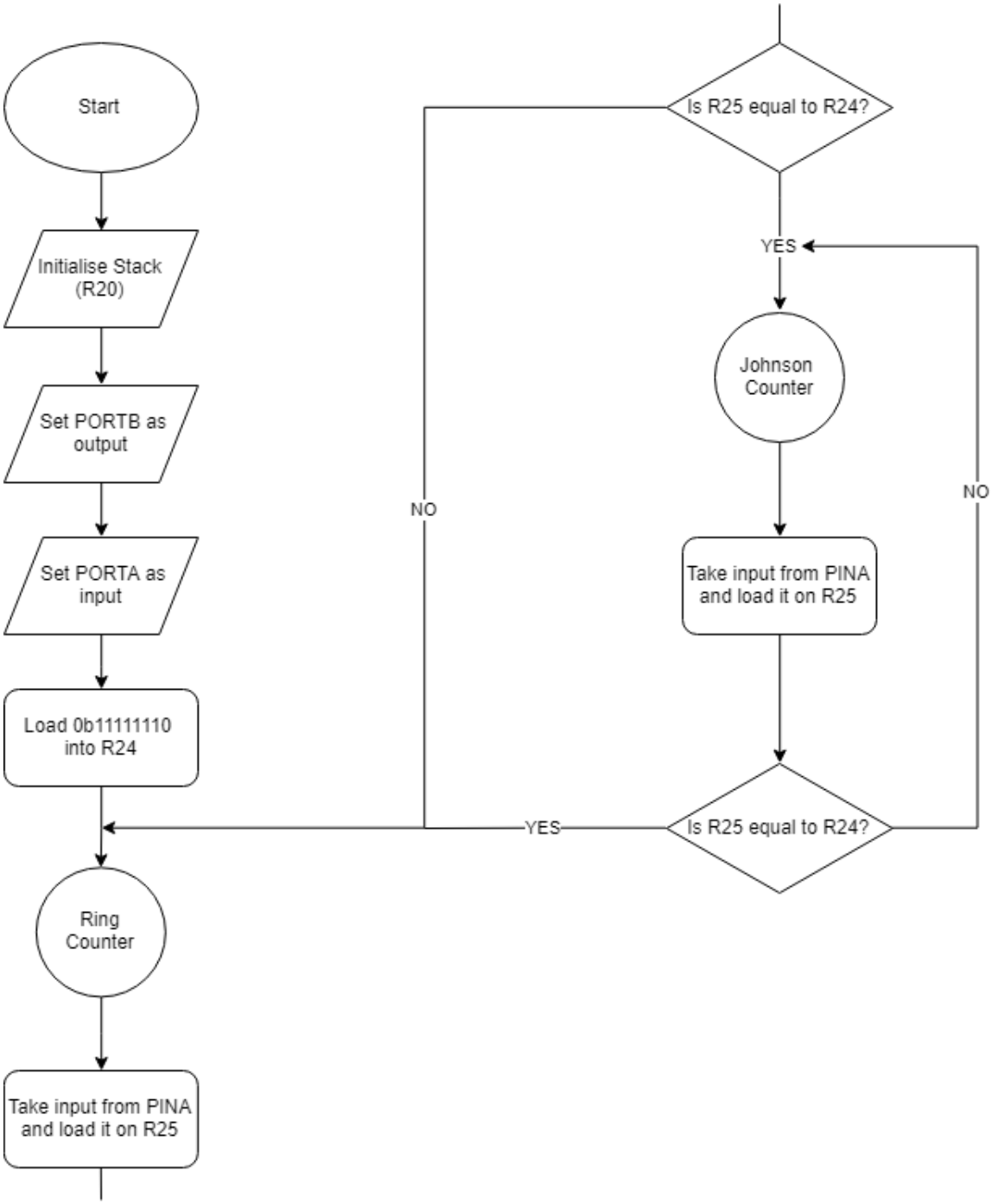
Write a program which switch between Ring counter and Johnson counter. You should not use Interrupt in this lab. The pushbutton must be checked frequently, so there is no delay between the button is pressed and the change between Ring/Johnson. Use SW0 (PA0) for the button. Each time you press the button, the program should change counter.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Program that when the Switch number 0 is pressed, it will
   change between the Ring Counter and the Johnson Counter.
;
; Input ports: PORTA will be used as input to be able to get the
   information from the switches.
;
; Output ports: PORTB will be used as output to be able to light up the
    LEDs in the corresponding manner.
;
; Subroutines: To be able to do the delay
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.includes "m2560def.inc"
; Initialize SP, Stack Pointer
ldi r20, HIGH(RAMEND) ; R20 = high part of RAMEND address
out SPH,R20 ; SPH = high part of RAMEND address
ldi R20, low(RAMEND) ; R20 = low part of RAMEND address
out SPL,R20 ; SPL = low part of RAMEND address

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output
ldi r16, 0x00   ;Set the data direction register port A
out DDRA, r16   ;Set portA as input

ldi r24, 0b11111110     ;Desired switch

RC:     ;Ring Counter Code
        ldi r21, 0b11111111; inital LED state
        out portB, r21  ;Turn off all the lights
        mov r17, r21    ;Copy r21 into r17
        ldi r22, 0xFF   ;To compare to make it restart when all the
           lights turn off
        RC_loop:
                out portB, r17  ;Show the corresponding lights
                rol r17 ;rotate the bits to make them go left
                CALL Delay1     ;Delay of 0.5 seconds
                in r25, PINA    ;Read the input from the switch
                cp r25,r24      ;Compare the switches with the desired
```

```
                    switch
                breq JC ;If they are =, go to Johnson Counter
                cp r17, r22             ;Check if all the lights are
                    turned off
                breq RC_light   ;
        rjmp RC_loop
        RC_light:
                rol r17 ;do a rol here because we are not supposed to
                    see it appear.
                out portB, r17  ;light up the desired LEDs
                rjmp RC_loop    ;go back to the loop to make it
                    continue
rjmp RC

JC:     ;Johnson Counter Code
        ldi r21, 0b11111110     ;r21 = to light up the LEDs
        ldi r22, 0b11111111 ;Desired condituon
        ldi r23, 0b00000000     ;Desired condition

        my_loop1:       ;Loop to do the going left part of the Johnson
            Counter
                out portB, r21  ;Light up the corresponding LEDs
                LSL r21 ;Logical shift to the left of R21
                CALL Delay1     ;Delay of 0.5s
                in r25, PINA    ;Get the input from PINA
                cp r25,r24      ;Compare input and desired switch
                breq RC If equal go back to Ring Counter
                cp r21, r23 ;compare  info with desired one
                breq light      ;If equal go to "light" where it is
                    going right.
        rjmp my_loop1

        light:  ;initialisation process to be able to go right
                out portB, r23  ;Turn on all the lights
                CALL Delay1     ;Delay of 0.5s
                ldi r21, 0b10000000     ;Set up the first iteration to
                    make sure it goes right correctly
                out portB, r21  ;output to PortB
                Second_loop:    ;Action of going right here
                        in r25, PINA    ;check info from switches
                        cp r25,r24      ;Compare switches with desired
                            switch
                        breq RC ;If equal go back to Ring Counter
                        out portB, r21  ;Output it to r21
                        ASR r21 ;Arithmetic Shift right to be able to
                            shift the bits to the right.
                        CALL Delay1     ;Delay of 0.5s
                        cp r21, r22 ;compare  info with desired one
                        breq my_loop1   ;if equal go back my_loop1 and
                            go right again
                rjmp Second_loop
rjmp JC
Delay1:
; Generated by delay loop calculator
; at http://www.bretmulvey.com/avrdelay.html
; Delay 1 950 500 cycles
; 500ms at 3.901 MHz
    ldi  r18, 10
    ldi  r19, 230
```

```
    ldi  r20, 22
L1: dec  r20
    brne L1
    dec  r19
    brne L1
    dec  r18
    brne L1
RET
```

This is the flowchart of the task 1:



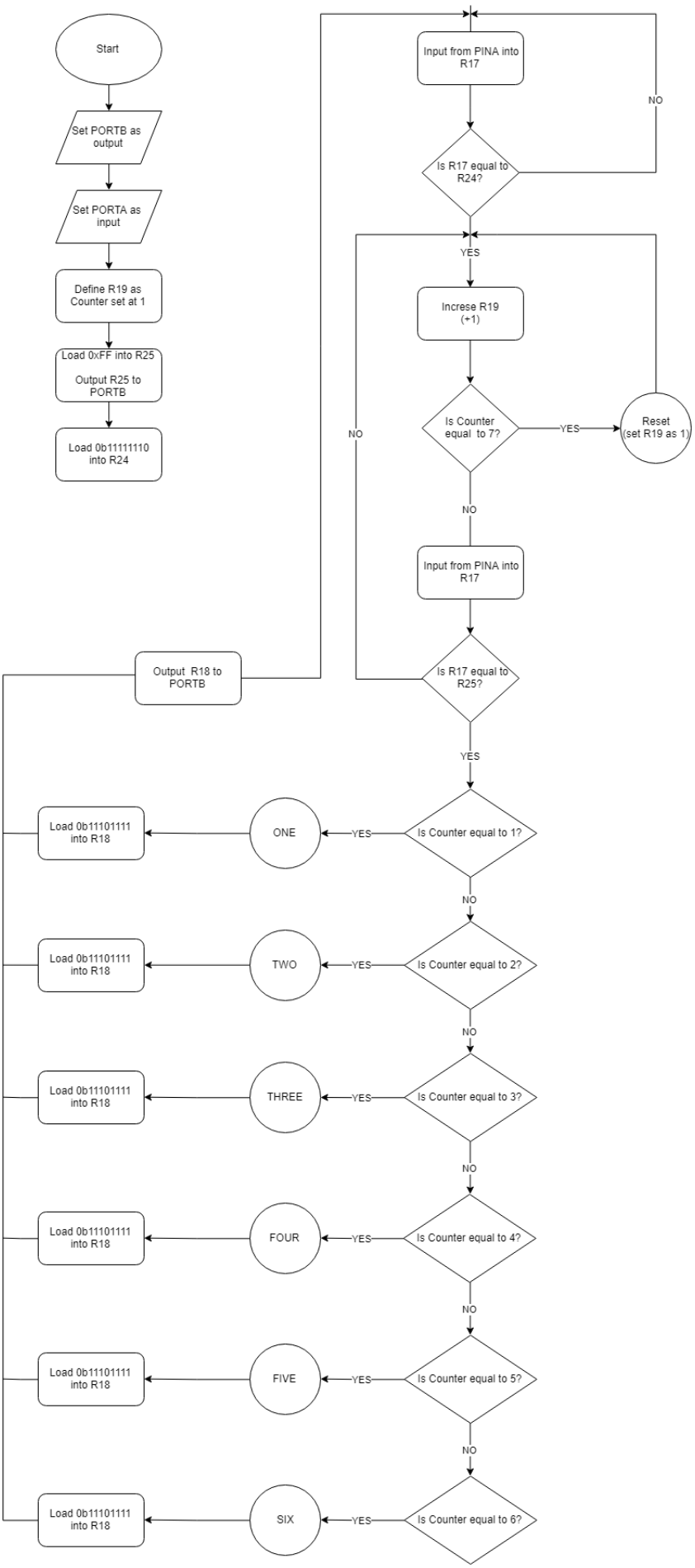
2 Task 2 - Electronic dice

You should create an electronic dice. Think of the LEDs placed as in the picture below. The number 1 to 6 should be generated randomly. You could use the fact that the time you press the button varies in length.

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function:Program that represent an electronic dice. The number 1 to 6
     will be choose randomly every time we click on the button
;
; Input ports: PORTA will be used as input to get the information from
    the switches.
; Output ports: PORTB will be used as output to light up the LEDs when
    needed.
;
; Subroutines: None needed here.
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"

ldi r16, 0xFF ;setting up the data direction register PORTB
out DDRB, r16 ;Set PORTB as output

ldi r16,0x00    ;setting up the data direction register PORTA
out DDRA, r16   ;Set PORTA as input

ldi r19,1; Counter for the number of the dice
ldi r25, 0xFF   ;To turn off all the LEDs
out PortB,r25
ldi r24,0b11111110      ;Desired Switch Binary Code

Listening_For_Switch_Press:     ;Listening when the switch will be
    pressed.
        in r17,PINA     ;Get info from switches
        cp r17,r24      ;Compare the switches and the desired switch
            binary code.
        breq Listening_For_Switch_Release       ;If equal goes to the
            loop below.
rjmp Listening_For_Switch_Press

Listening_For_Switch_Release:   ;Listening when the switch will be
    released
        inc r19 ;increase r19 by 1 every time it comes into this loop
        cpi r19,7       ;compare to a constant (7) as we only want
            numbers from 1 to 6
        breq reset      ;if equal reset the counter
```

```
        in r17,PINA     ;Check the info from the switches
        cp r17,r25      ;Check if user has released the switches
        breq RD ;If yes go to RD loop
rjmp Listening_F        or_Switch_Release

reset:  ;to reset the counter
ldi r19,1
rjmp Main

RD:     ;This is where the random will happen
        cpi r19,1       ;When it will be sent to this loop
        breq ONE        ;It will stop on one of those numbers
        cpi r19,2       ;Depending on which number is
        breq TWO        ;r19 right now it will decide which
        cpi r19,3       ;number it will gets
        breq THREE
        cpi r19,4
        breq FOUR
        cpi r19,5
        breq FIVE
        cpi r19,6
        breq SIX
rjmp RD

ONE:                    ;If r19 was equal to 1 it will come here
ldi r18,0b11101111      ;Load to r18 the corresponding binary code to
   make it look like a 1
out PortB,r18           ;Output it to PORTB
rjmp Listening_For_Switch_Press ;and go back to the first loop
TWO:
ldi r18,0b10111011
out PortB,r18
rjmp Listening_For_Switch_Press
THREE:
ldi r18,0b10101011
out PortB,r18
rjmp Listening_For_Switch_Press
FOUR:
ldi r18,0b00111001
out PortB,r18
rjmp Listening_For_Switch_Press
FIVE:
ldi r18,0b00101001
out PortB,r18
rjmp Listening_For_Switch_Press
SIX:
ldi r18,0b00010001
out PortB,r18
rjmp Listening_For_Switch_Press
```

This is the flowchart of the task 2:


Start
Set PORTB as output
Set PORTA as input
Define R19 as Counter set at 1
Load 0xFF into R25
Output R25 to PORTB
Load 0b11111110 into R24
Input from PINA into R17
Is R17 equal to R24?
NO
YES
Increse R19 (+1)
Is Counter equal to 7?
YES
Reset (set R19 as 1)
NO
Input from PINA into R17
Is R17 equal to R25?
NO
Output R18 to PORTB
YES
Is Counter equal to 1?
YES
ONE
Load 0b11101111 into R18
NO
Is Counter equal to 2?
YES
TWO
Load 0b11101111 into R18
NO
Is Counter equal to 3?
YES
THREE
Load 0b11101111 into R18
NO
Is Counter equal to 4?
YES
FOUR
Load 0b11101111 into R18
NO
Is Counter equal to 5?
YES
FIVE
Load 0b11101111 into R18
NO
Is Counter equal to 6?
YES
SIX
Load 0b11101111 into R18

3 Task 3 - Change counter

Write a program that is able to count the number of changes on a switch. As a change we count when the switch SW0 goes from 0 to 1 and from 1 to 0, we expect therefore positive and negative edges. We calculate the changes in a byte variable and display its value on PORTB.

```
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; Date: 2016-09-15
; Author:
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; Leonardo PEDRO
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function:Program that count every time the switch number 0 is pressed
    or released. it will show the count with binary code on the LEDs
;
; Input ports: PORTA will be used as input to get information from the
   switches
;
; Output ports: PORTB will be used as output to light up the LEDs
;
; Subroutines: None needed in this Task
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output

ldi r16,0x00    ;setting up the data direction register PORTA
out DDRA, r16   ;Set PORTA as input

ldi r25, 0      ;Counter

ldi r17, 0b11111111
out PORTB, r17  ;Turn off all the LEDs

ldi r18, 0b11111110     ;Desired switch binary code

my_loop:
        in r19, PINA    ;Check input from swiches
        cp r18,r19      ;compare input with desired switch
        breq counter_when_switch_pressed
rjmp my_loop
;The switch is now pressed
counter_when_switch_pressed:
        inc r25 ;increase r25 by 1
        mov r20,r25     ;Copy r25 into r20
        com r20 ;COM it to make it show the binary code, so that when
           the light turns on it represent the 1 of binary code
        out portB,r20   ;Show the result on the LEDs
```
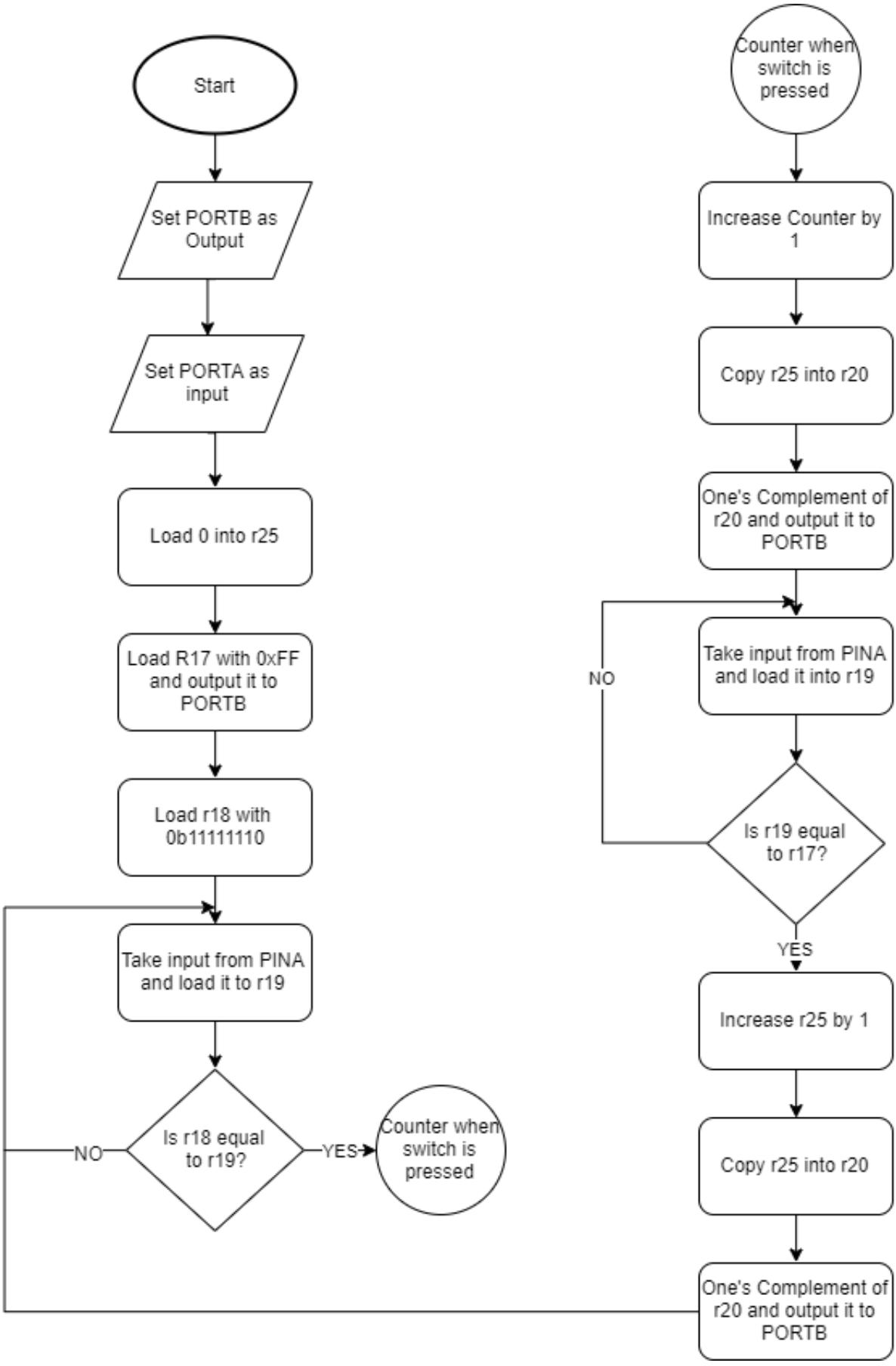

```
                loop:   ;To check when the switch will be release
                        in r19,PINA     ;Get information from the
                            switches
                        cp r19,r17      ; Compare input with desired
                            switch
                        breq counter_when_switch_released
                rjmp loop
;Go here when switch is released
counter_when_switch_released:
        inc r25 ;Increase r25 by 1
        mov r20,r25     ;Copy register r25 into r20
        com r20 ;One's Complement of r20 to get the count in binary
            number to light up the LEDs
        out portB,r20   ;Show the result on the LEDs by light them
        rjmp my_loop
```

This is the flowchart of the task 3:



4 Task 4 - Delay subroutine with variable delay time

```
;>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
; 1DT301, Computer Technology I
; Date: 2016-09-15
; Author:
; Loic GALLAND
; Leonardo PEDRO
;
; Lab number: 2
; Title: Subroutines
;
; Hardware: STK600, CPU ATmega2560
;
; Function: Create a Delay that can be changed depensidng on what the
   user chooses
;
; Input ports: NO input will be needed
;
; Output ports: PORTB will be used as output to control the LEDs
;
; Subroutines: Used to create the Delay
; Included files: m2560def.inc
;<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
.include "m2560def.inc"
.equ INPUT= 1000        ;Used this to set how long is the delay.

; Initialize SP, Stack Pointer
ldi r20, HIGH(RAMEND) ; R20 = high part of RAMEND address
out SPH,R20 ; SPH = high part of RAMEND address
ldi R20, low(RAMEND) ; R20 = low part of RAMEND address
out SPL,R20 ; SPL = low part of RAMEND address

ldi r16, 0xFF ;setting up the data direction register port B
out DDRB, r16 ;Set port B as output

ldi r21, 0b11111111; inital LED state
out portB, r21  ;Light up the corresponding LEDs
mov r17, r21    ;Copy the register r21 into r17
ldi r22, 0xFF   ;Desired state of the LEDs
ldi r23, 0b11111110     ;Iniatialize the LEDs
RC_loop:
        out portB, r17  ;Light up the corresponding LEDs
        rol r17 ;Rotate all the bits to the left
        CALL Delay              ;Delay of 0.5s
        cp r17, r22             ;Compare the LEDs with the desired one
        breq RC_light
rjmp RC_loop

RC_light:
        rol r17 ;rol again without output to skip the state where all
           the LEDs are turn off
        out portB, r17  ;Show corresponding LEDs to PORTB
        rjmp RC_loop    ;Jump back to the main loop

Delay:
        ldi r24, low(INPUT)     ;Use r24 and r25 to create a 16bit
           register. Set r24 with the Low end
```

```
        ldi r25, high(INPUT)    ;And r25 for the high end of the
           register
        wait_milliseconds:      ;Will go into this loop the amount of
           time we have
                call ms_delay   ;Call method ms_delay that will last
                   only 1ms
                sbiw r25:r24,1  ;Reduce the count by 1 of the 16bits
                   register
                cpi r25, high(0)        ;Compare when the r25 is equal
                   and therefore the
                breq reset              ;Delay is finished
        rjmp wait_milliseconds
reset:
RET     ;to make it go back to the loop "RC_loop"

ms_delay:       ;Delay of 1ms
        ; Generated by delay loop calculator
        ; at http://www.bretmulvey.com/avrdelay.html
        ; Delay 1 000 cycles
        ; 1ms at 1 MHz
        ldi  r18, 2
        ldi  r19, 75
L1: dec  r19
        brne L1
        dec  r18
        brne L1
        rjmp PC+1
RET
```

This is the flowchart of the task 4: