

## HW#4

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Course: ECEN-621

C code for sequential programming approach :

```
#include "msp.h"

/**
 * main.c
 */

#define LED_GREEN BIT1
#define S1 BIT1
#define DELAY 500

void main(void)
{
    int i;
    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;           // stop watchdog timer
    P1->DIR &= ~S1;
    P1->REN = S1;
    P1->OUT = S1;
    P2->DIR = LED_GREEN;
    P2->OUT = 0x00;

    while(1)
    {
        if((P1->IN & S1) == 0x00)
        {
            for(i=0;i<DELAY;i++);
            if((P1->IN & S1) == 0x00)
            {
                P2->OUT ^= LED_GREEN;
                while((P1->IN & S1) == 0x00);
            }
        }
    }
}
```

C code for state machine programming approach :

```
#include "msp.h"

/**
 * main.c
 */

#define LED_GREEN BIT1
#define S1 BIT1
#define DELAY 500
int i;
enum Toggle_states {init_state, Unlit1_state, Unlit2_state, Lit1_state, Lit2_state} toggle_states;

void TicFct_Toggle_Led()
{
    switch(toggle_states)
    {
```

```

case init_state:
    toggle_states = Unlit1_state;
    break;
case Unlit1_state:
    if((P1->IN & S1) == 0x00)
    {
        for(i=0;i<DELAY;i++);
        if((P1->IN & S1) == 0x00)
        {
            toggle_states = Lit1_state;
        }
    }
    break;
case Lit1_state:
    if((P1->IN & S1) != 0x00)
    {
        for(i=0;i<DELAY;i++);
        if((P1->IN & S1) != 0x00)
        {
            toggle_states = Lit2_state;
        }
    }
    break;
case Lit2_state:
    if((P1->IN & S1) == 0x00)
    {
        for(i=0;i<DELAY;i++);
        if((P1->IN & S1) == 0x00)
        {
            toggle_states = Unlit2_state;
        }
    }
    break;
case Unlit2_state:
    if((P1->IN & S1) != 0x00)
    {
        for(i=0;i<DELAY;i++);
        if((P1->IN & S1) != 0x00)
        {
            toggle_states = Unlit1_state;
        }
    }
    break;
}
switch(toggle_states)
{
case Unlit1_state:
case Unlit2_state:
    P2->OUT &= ~LED_GREEN;
    break;
case Lit1_state:
case Lit2_state:
    P2->OUT |= LED_GREEN;
    break;
}
}

```

```

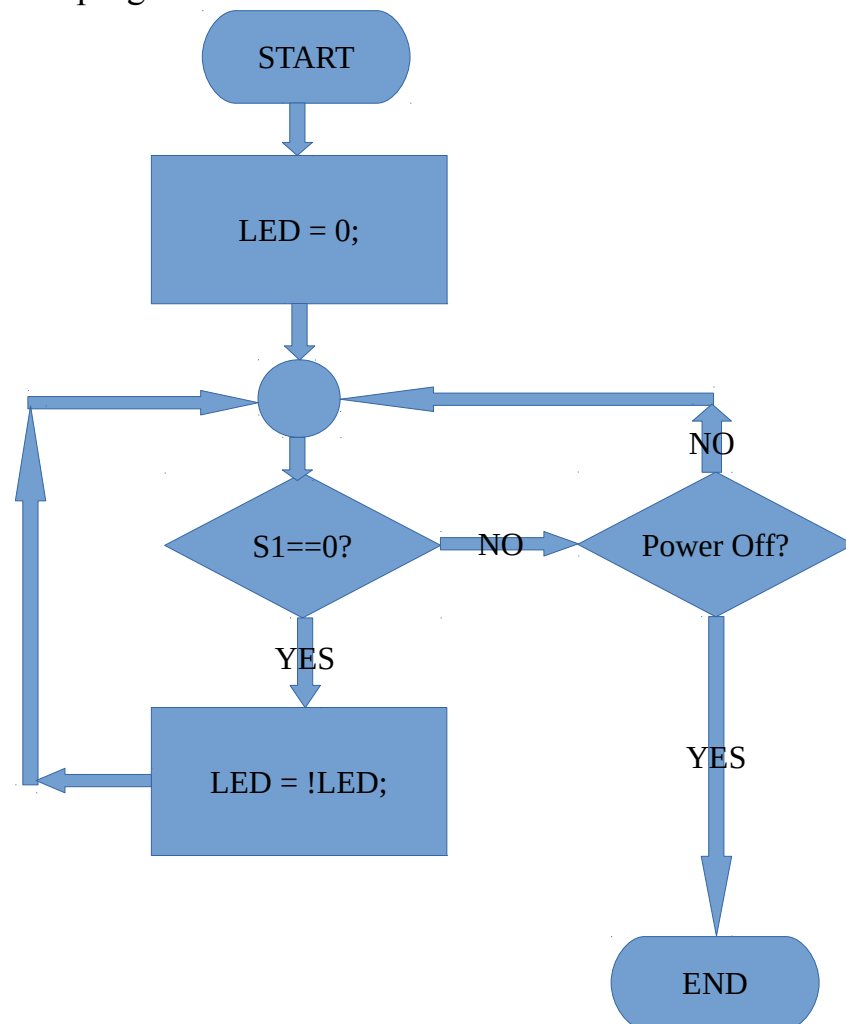
void main(void)
{
    toggle_states = init_state;

    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;           // stop watchdog timer
    P1->DIR &= ~S1;
    P1->REN = S1;
    P1->OUT = S1;
    P2->DIR = LED_GREEN;
    P2->OUT = 0x00;

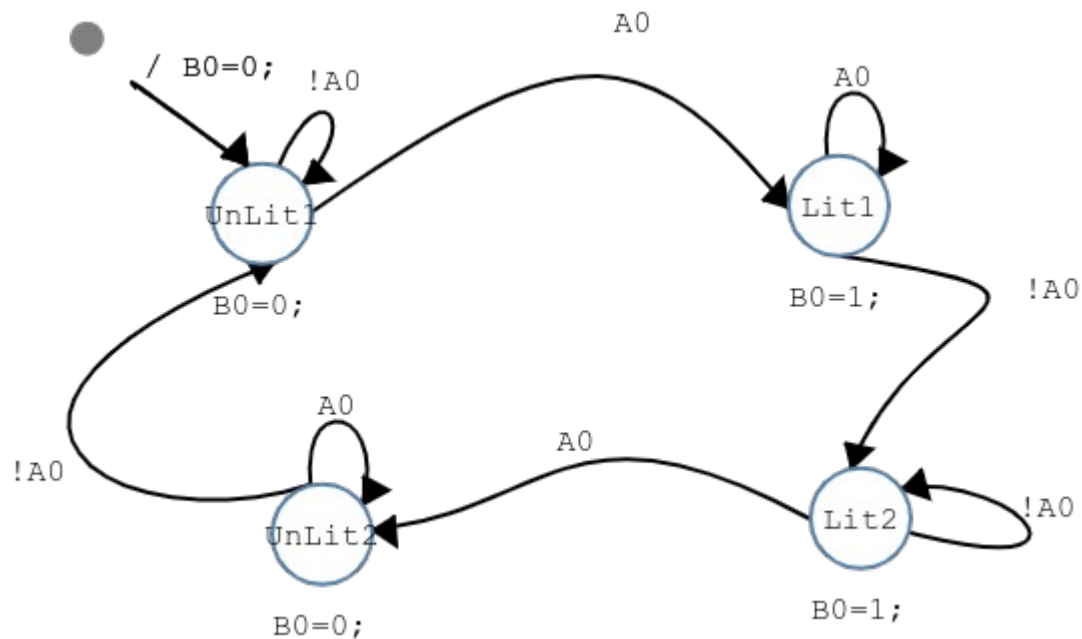
    while(1)
    {
        TicFct_Toggle_Led();
    }
}

```

Flowchart of Sequential program:



RIBS model for the SM program:



Delay in for loop:

Identity	Name	Condition	Count
Clock Cycles [H/W]	Count Event		8511
main.c, line 97 (SCSL1 + 0x8) [H/W]	Breakpoint		0 (0)
main.c, line 98 (SCSL3) [H/W BP]	Breakpoint		0 (0)

```

78 // toggle_states = init_state;
79
80 WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD; // stop watchdog timer
81 P1->DIR &= ~S1;
82 P1->REN = S1;
83 P1->OUT = S1;
84 P2->DIR = LED_GREEN;
85 P2->OUT = 0x00;
86
87 // while(1)
88 {
89     TxCtx_Toggle_Led();
90 }
91 //
92 while(1)
93 {
94     if((P1->IN & S1) == 0x00)
95     {
96         for(i=0; i<DELAY; i++)
97             if((P1->IN & S1) == 0x00)
98             {
99                 P2->OUT ^= LED_GREEN;
100                 while((P1->IN & S1) == 0x00);
101             }
102     }
103 }
104 }
105 }
106 }
107
  
```

```

SCSL3:
00000508: 480C      ldr    r0, [pc, #0x30]
00000509: 7800      ldrb   r0, [r0]
0000050a: 0800      lsr    r0, r0, #2
0000050b: D2E6      bhs    SCSL1
100
00000510: 4909      ldr    r1, [pc, #0x24]
00000511: 7808      ldrb   r0, [r1]
00000512: F0800002 eor     r0, r0, #2
00000513: 7008      strb   r0, [r1]
101
00000514:          while((P1->IN & S1) == 0x00);
SCSL4:
0000051a: 4808      ldr    r0, [pc, #0x20]
0000051b: 7800      ldrb   r0, [r0]
0000051c: 0800      lsr    r0, r0, #2
0000051d: D3FB      blo    SCSL4
93
00000522: E7DC      b       SCSL1
SCSL01:
00000524: 480C      ldr    r0, [pc, #0x30]
00000525: 7800      ldrb   r0, [r0]
SCSL02:
00000528: 4C04      ldr    r4, [pc, #0x10]
00000529: 4000      ands   r0, r0
SCSL03:
0000052c: 4C06      ldr    r4, [pc, #0x18]
0000052d: 4000      ands   r0, r0
SCSL04:
  
```

```
#define __SYSTEM_CLOCK 3000000
```

The actual delay =  $8511/3000000 = 0.002837 \text{ sec} = 2.837 \text{ ms}$