HW#7

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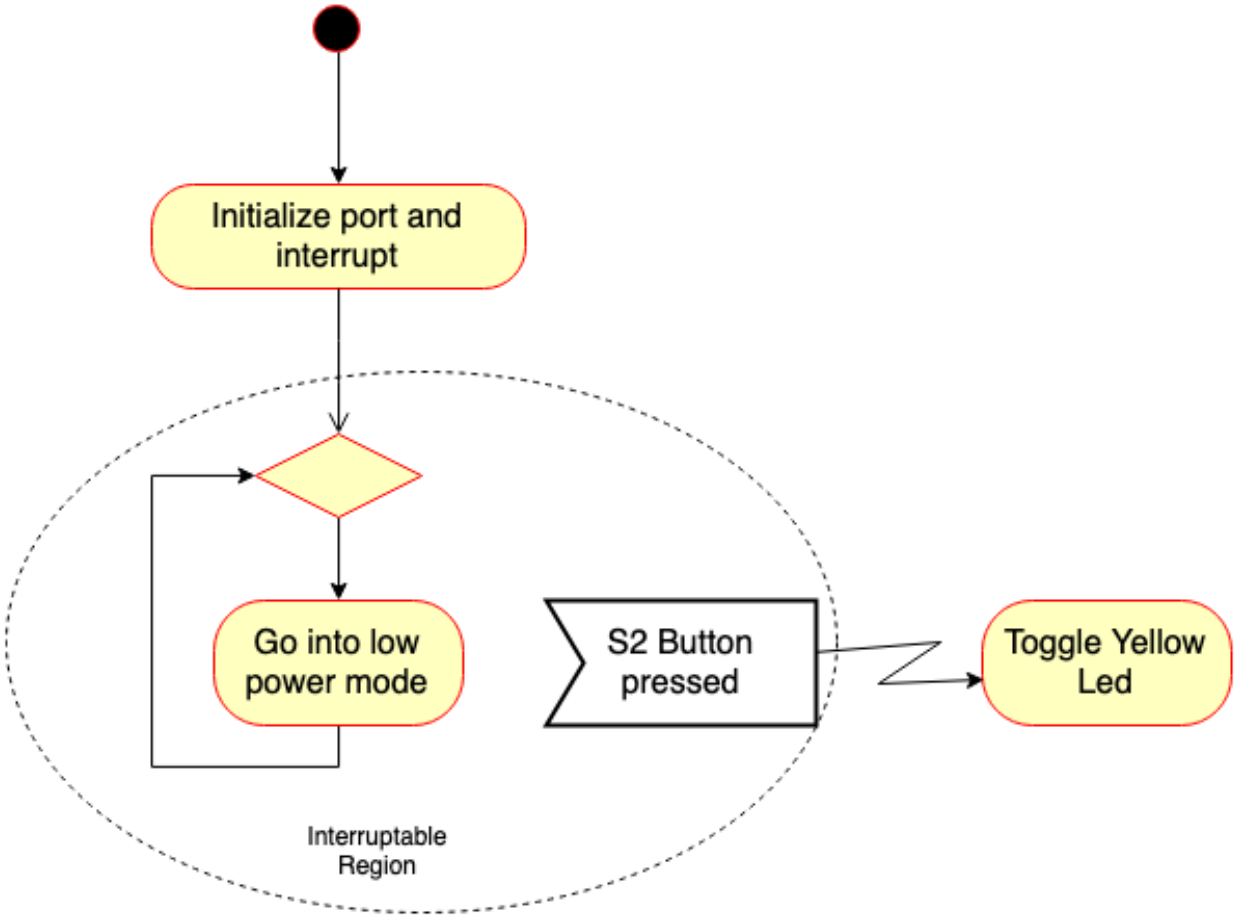
ECEN-621

Q1: Code:

```
#include "msp.h"
int main(void)
{
    // Hold the watchdog

    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;

    P2->DIR |= BIT4;     //Make P2.6 an output pin Green LED on
MKII
    P2->DIR |= BIT6;     //Make P5.6 an output pin Red LED  on
MKII
    P2->OUT &= ~BIT4;   //turn green off initially
    P2->OUT &= ~BIT6;   //Turn red LED off initially

    P3->DIR &= ~BIT5;    //Make P3.5 an input pin
    P3->REN = BIT5;     // Enable pull resistor on P3.5
    P3->OUT = BIT5;      // Connect the pull resistor to Vcc
(i.e. make it a pull-up)

    P3->IES = BIT5;      // Interrupt on high-to-low transition
(Falling edged trigger on P3.5)
    P3->IFG = 0;         // Clear all P3 interrupt flags
    P3->IE = BIT5;      // Enable interrupt for P3.5 (Pin
interrupt enable)

    // Enable Port 3 interrupt on the NVIC (Port Interrupt
Enable & Prioriterize)
    NVIC->ISER[1] =  BIT5;///This Sets the P3 interrupt enable
bit in the ISER1 register

   __enable_interrupts();           //Global Enable prioritized
interrupts

    while(1){
    // Go to LPM4 (Low Power Mode #4)
        __sleep();
    }

}
```

```c
/* Port3 ISR */
void PORT3_IRQHandler(void)
{
    // Toggling the output on the Yellow light on MKII IF P3.5
is what caused the interrupt
     if(P3->IFG & BIT5)
     {
         P2->OUT ^= BIT4;
         P2->OUT ^= BIT6;
     }


    // Delay for switch debounce
     __delay_cycles(1500000); // 1/2 second delay

    P3->IFG &= ~BIT5;       //clear the flag so that the
interrupt will not immediately happen again
}
```

Q1: UML diagram:

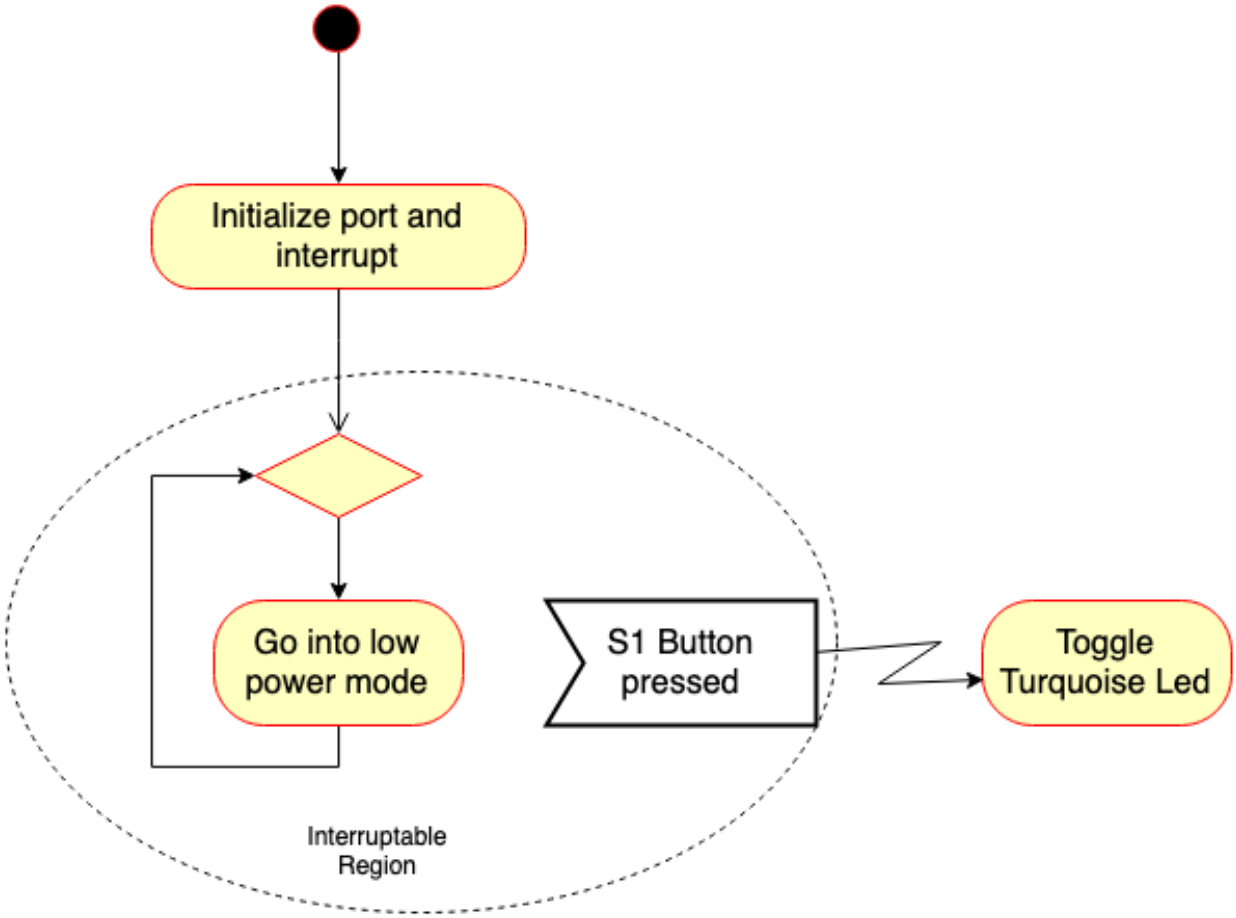


Q2:Code

```
#include "msp.h"

int main(void)
{
    // Hold the watchdog

    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;

    P2->DIR |= BIT1;     //Make P2.6 an output pin Green LED on Launchpad
    P2->DIR |= BIT2;     //Make P5.6 an output pin Blue LED  on Launchpad
    P2->OUT &= ~BIT1;   //turn green off initially
    P2->OUT &= ~BIT2;   //Turn blue LED off initially

    P1->DIR &= ~BIT1;    //Make P1.1 an input pin
    P1->REN = BIT1;     // Enable pull resistor on P1.1
    P1->OUT = BIT1;      // Connect the pull resistor to Vcc (i.e. make it a pull-up)

    P1->IES = BIT1;      // Interrupt on high-to-low transition (Falling edged trigger on P1.1)
    P1->IFG = 0;         // Clear all P1 interrupt flags
    P1->IE = BIT1;      // Enable interrupt for P1.1 (Pin interrupt enable)

    // Enable Port 1 interrupt on the NVIC (Port Interrupt Enable & Prioriterize)
    NVIC->ISER[1] =  BIT3;///This Sets the P1 interrupt enable bit in the ISER1 register

   __enable_interrupts();           //Global Enable prioritized interrupts

    while(1){
    // Go to LPM4 (Low Power Mode #4)
        __sleep();
    }

}

/* Port1 ISR */
void PORT1_IRQHandler(void)
{
```

```
    // Toggling the output on the Turquoise light on Launchpad
IF P1.1 is what caused the interrupt
     if(P1->IFG & BIT1)
     {
         P2->OUT ^= BIT1;
         P2->OUT ^= BIT2;
     }


    // Delay for switch debounce
     __delay_cycles(1500000); // 1/2 second delay

    P1->IFG &= ~BIT1;       //clear the flag so that the
interrupt will not immediately happen again
}
```

Q2: UML diagram



Q3:Code(MKII has higher priority)

```
#include "msp.h"

int main(void)
{
    // Hold the watchdog

    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;

    P2->DIR |= BIT4;     //Make P2.6 an output pin Green LED on
MKII
    P2->DIR |= BIT6;     //Make P5.6 an output pin Red LED  on
MKII
    P2->OUT &= ~BIT4;   //turn green off initially
    P2->OUT &= ~BIT6;   //Turn red LED off initially

    P3->DIR &= ~BIT5;    //Make P3.5 an input pin
    P3->REN = BIT5;     // Enable pull resistor on P3.5
    P3->OUT = BIT5;      // Connect the pull resistor to Vcc
(i.e. make it a pull-up)

    P3->IES = BIT5;      // Interrupt on high-to-low transition
(Falling edged trigger on P3.5)
    P3->IFG = 0;         // Clear all P3 interrupt flags
    P3->IE = BIT5;      // Enable interrupt for P3.5 (Pin
interrupt enable)

    // Enable Port 3 interrupt on the NVIC (Port Interrupt
Enable & Prioriterize)
    NVIC->ISER[1] =  BIT5;///This Sets the P3 interrupt enable
bit in the ISER1 register



    P2->DIR |= BIT1;     //Make P2.6 an output pin Green LED on
Launchpad
    P2->DIR |= BIT2;     //Make P5.6 an output pin Blue LED  on
Launchpad
    P2->OUT &= ~BIT1;   //turn green off initially
    P2->OUT &= ~BIT2;   //Turn blue LED off initially

    P1->DIR &= ~BIT1;    //Make P1.1 an input pin
    P1->REN = BIT1;     // Enable pull resistor on P1.1
```

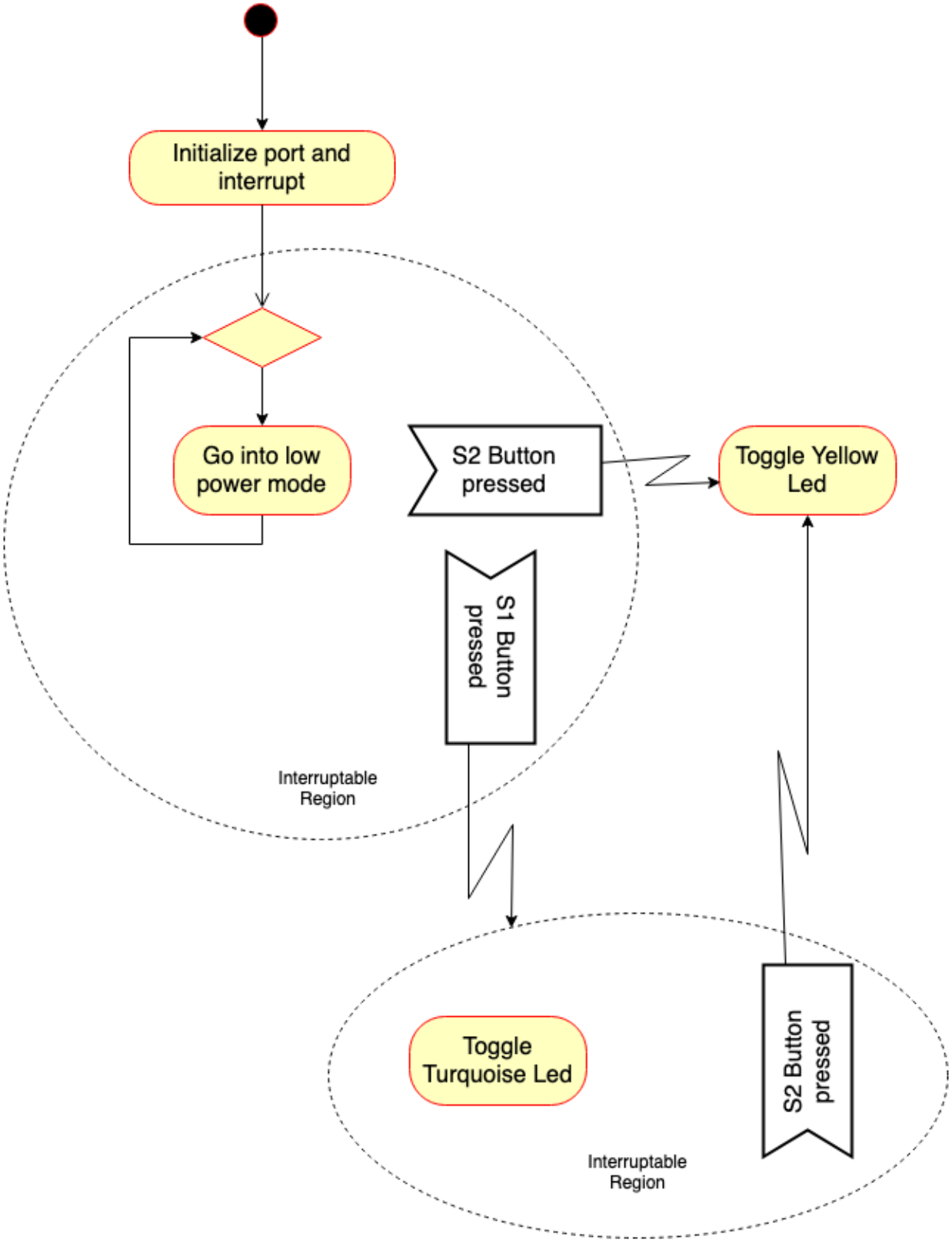
```
    P1->OUT = BIT1;      // Connect the pull resistor to Vcc
(i.e. make it a pull-up)

    P1->IES = BIT1;      // Interrupt on high-to-low transition
(Falling edged trigger on P1.1)
    P1->IFG = 0;         // Clear all P1 interrupt flags
    P1->IE = BIT1;      // Enable interrupt for P1.1 (Pin
interrupt enable)

    // Enable Port 1 interrupt on the NVIC (Port Interrupt
Enable & Prioriterize)
    NVIC->ISER[1] =  BIT3;///This Sets the P1 interrupt enable
bit in the ISER1 register

    NVIC->IP[PORT1_IRQn] = 64;//Set the interrupt priority to
64 for port P1 interrupt
    NVIC->IP[PORT3_IRQn] = 0;//Set the interrupt priority to 0
for port P3 interrupt

   __enable_interrupts();           //Global Enable prioritized
interrupts

    while(1){
    // Go to LPM4 (Low Power Mode #4)
        __sleep();
    }

}

/* Port1 ISR */
void PORT1_IRQHandler(void)
{
    // Blinking the output on the Turquoise light on Launchpad
IF P1.1 is what caused the interrupt
     if(P1->IFG & BIT1)
     {
         P2->OUT ^= BIT1;
         P2->OUT ^= BIT2;
         __delay_cycles(6000000); // 2 second delay
         P2->OUT ^= BIT1;
         P2->OUT ^= BIT2;
         __delay_cycles(6000000); // 2 second delay
     }

    P1->IFG &= ~BIT1;       //clear the flag so that the
interrupt will not immediately happen again
```

```
}

/* Port3 ISR */
void PORT3_IRQHandler(void)
{
    // Blinking the output on the Yellow light on MKII IF P3.5
is what caused the interrupt
     if(P3->IFG & BIT5)
     {
         P2->OUT ^= BIT4;
         P2->OUT ^= BIT6;
         __delay_cycles(6000000); // 2 second delay
         P2->OUT ^= BIT4;
         P2->OUT ^= BIT6;
         __delay_cycles(6000000); // 2 second delay
     }


    P3->IFG &= ~BIT5;       //clear the flag so that the
interrupt will not immediately happen again
}
```

Explanation using visually inspecting the output:

In the above code PORT3 has higher priority than PORT1. The expected output is when s2 of MKII will be pressed the yellow led in MKII will be blinked and when s1 of Launchpad will be pressed the turquoise led of Launchpad will be blinked. Now, if s1 is pressed first and then s2 is pressed, we will see both turquoise and yellow light will be turned on since there is a long delay between turning on and off of the leds and the yellow led turns off first then the turquoise led. Here, we can see that by pressing s1 the PORT1 ISR will be running and in the meantime s2 will generate another interrupt since s2 has more priority, yellow led will be turned on. Therefore, with this sequence of operation, we can understand that PORT3 has more priority than PORT1. However, if we press s2 first then s1 we will never see both led turn on simultaneously. But we will see the yellow led turns on first then it turns off and then the turquoise led turns on and off.

UML diagram:


Initialize port and interrupt
Go into low power mode
S2 Button pressed
Toggle Yellow Led
S1 Button pressed
Interruptable Region
Toggle Turquoise Led
S2 Button pressed
Interruptable Region

Q3:Code(Launchpad has higher priority)

```
#include "msp.h"

int main(void)
{
    // Hold the watchdog

    WDT_A->CTL = WDT_A_CTL_PW | WDT_A_CTL_HOLD;

    P2->DIR |= BIT4;     //Make P2.6 an output pin Green LED on
MKII
    P2->DIR |= BIT6;     //Make P5.6 an output pin Red LED  on
MKII
    P2->OUT &= ~BIT4;   //turn green off initially
    P2->OUT &= ~BIT6;   //Turn red LED off initially

    P3->DIR &= ~BIT5;    //Make P3.5 an input pin
    P3->REN = BIT5;     // Enable pull resistor on P3.5
    P3->OUT = BIT5;      // Connect the pull resistor to Vcc
(i.e. make it a pull-up)

    P3->IES = BIT5;      // Interrupt on high-to-low transition
(Falling edged trigger on P3.5)
    P3->IFG = 0;         // Clear all P3 interrupt flags
    P3->IE = BIT5;      // Enable interrupt for P3.5 (Pin
interrupt enable)

    // Enable Port 3 interrupt on the NVIC (Port Interrupt
Enable & Prioriterize)
    NVIC->ISER[1] =  BIT5;///This Sets the P3 interrupt enable
bit in the ISER1 register



    P2->DIR |= BIT1;     //Make P2.6 an output pin Green LED on
Launchpad
    P2->DIR |= BIT2;     //Make P5.6 an output pin Blue LED  on
Launchpad
    P2->OUT &= ~BIT1;   //turn green off initially
    P2->OUT &= ~BIT2;   //Turn blue LED off initially

    P1->DIR &= ~BIT1;    //Make P1.1 an input pin
    P1->REN = BIT1;     // Enable pull resistor on P1.1
```

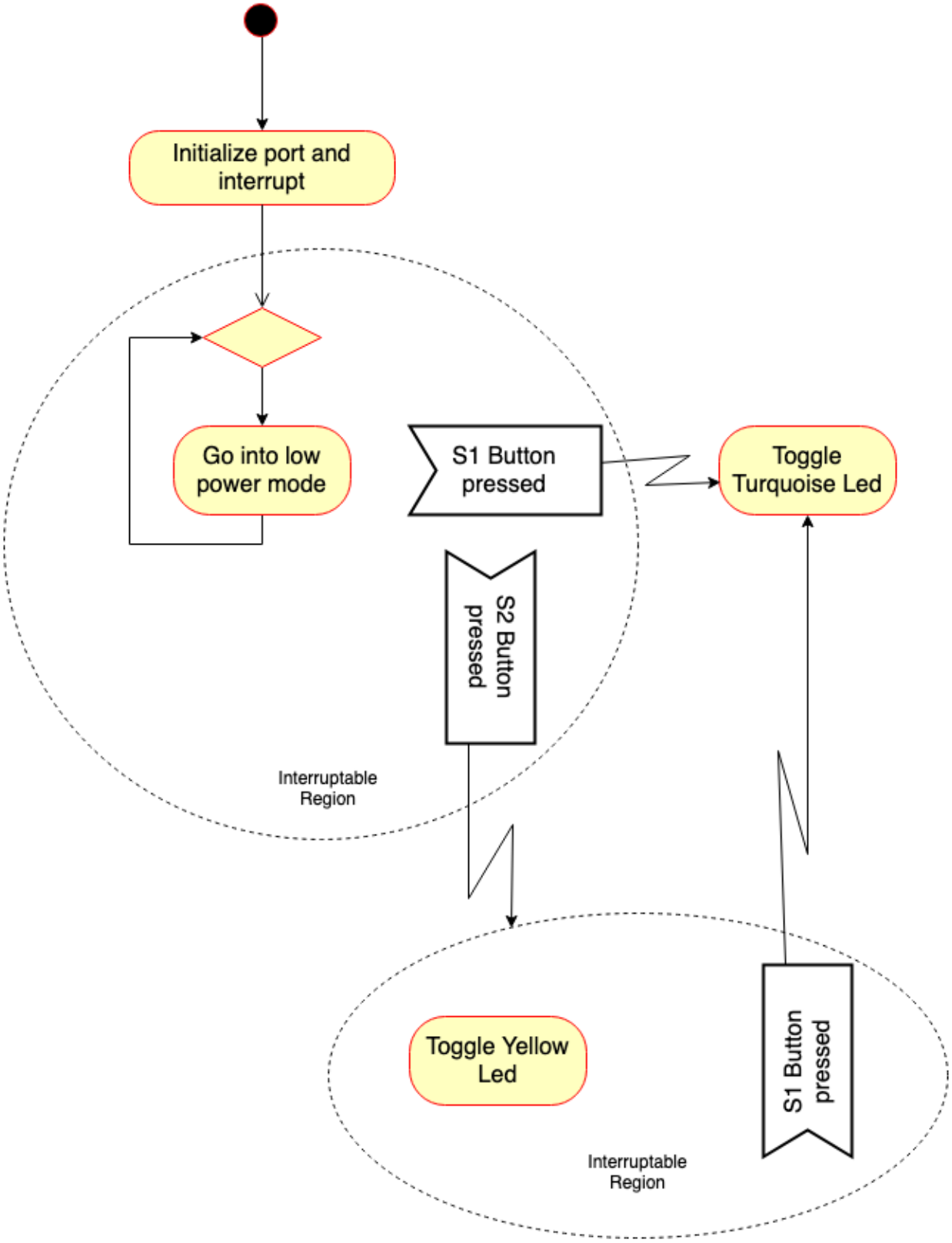
```
    P1->OUT = BIT1;      // Connect the pull resistor to Vcc
(i.e. make it a pull-up)

    P1->IES = BIT1;      // Interrupt on high-to-low transition
(Falling edged trigger on P1.1)
    P1->IFG = 0;         // Clear all P1 interrupt flags
    P1->IE = BIT1;      // Enable interrupt for P1.1 (Pin
interrupt enable)

    // Enable Port 1 interrupt on the NVIC (Port Interrupt
Enable & Prioriterize)
    NVIC->ISER[1] =  BIT3;///This Sets the P1 interrupt enable
bit in the ISER1 register

    NVIC->IP[PORT1_IRQn] = 0;//Set the interrupt priority to 0
for port P1 interrupt
    NVIC->IP[PORT3_IRQn] = 64;//Set the interrupt priority to
64 for port P3 interrupt

   __enable_interrupts();           //Global Enable prioritized
interrupts

    while(1){
    // Go to LPM4 (Low Power Mode #4)
        __sleep();
    }

}

/* Port1 ISR */
void PORT1_IRQHandler(void)
{
    // Blinking the output on the Turquoise light on Launchpad
IF P1.1 is what caused the interrupt
     if(P1->IFG & BIT1)
     {
         P2->OUT ^= BIT1;
         P2->OUT ^= BIT2;
         __delay_cycles(6000000); // 2 second delay
         P2->OUT ^= BIT1;
         P2->OUT ^= BIT2;
         __delay_cycles(6000000); // 2 second delay
     }

    P1->IFG &= ~BIT1;       //clear the flag so that the
interrupt will not immediately happen again
```

```
}

/* Port3 ISR */
void PORT3_IRQHandler(void)
{
    // Toggling the output on the Yellow light on MKII IF P3.5
is what caused the interrupt
     if(P3->IFG & BIT5)
     {
         P2->OUT ^= BIT4;
         P2->OUT ^= BIT6;
         __delay_cycles(6000000); // 2 second delay
         P2->OUT ^= BIT4;
         P2->OUT ^= BIT6;
         __delay_cycles(6000000); // 2 second delay
     }


    P3->IFG &= ~BIT5;       //clear the flag so that the
interrupt will not immediately happen again
}
```

Explanation using visually inspecting the output:

In the above code PORT1 has higher priority than PORT3. The expected output is when s2 of MKII will be pressed the yellow led in MKII will be blinked and when s1 of Launchpad will be pressed the turquoise led of Launchpad will be blinked. Now, if s2 is pressed first and then s1 is pressed, we will see both turquoise and yellow light will be turned on since there is a long delay between turning on and off of the leds and the turquoise led turns off first then the yellow led. Here, we can see that by pressing s2 the PORT3 ISR will be running and in the meantime s1 will generate another interrupt since s1 has more priority, turquoise led will be turned on. Therefore, with this sequence of operation, we can understand that PORT1 has more priority than PORT3. However, if we press s1 first then s2 we will never see both led turn on simultaneously. But we will see the turquoise led turns on first then it turns off and then the yellow led turns on and off.

UML diagram:


Initialize port and interrupt
Go into low power mode
S1 Button pressed
Toggle Turquoise Led
S2 Button pressed
Interruptable Region
Toggle Yellow Led
S1 Button pressed
Interruptable Region