WIX1003 COMPUTER SYSTEMS AND ORGANISATION

SEMESTER 1 (2020/2021)

LAB ASSIGNMENT (TRAFFIC LIGHT)

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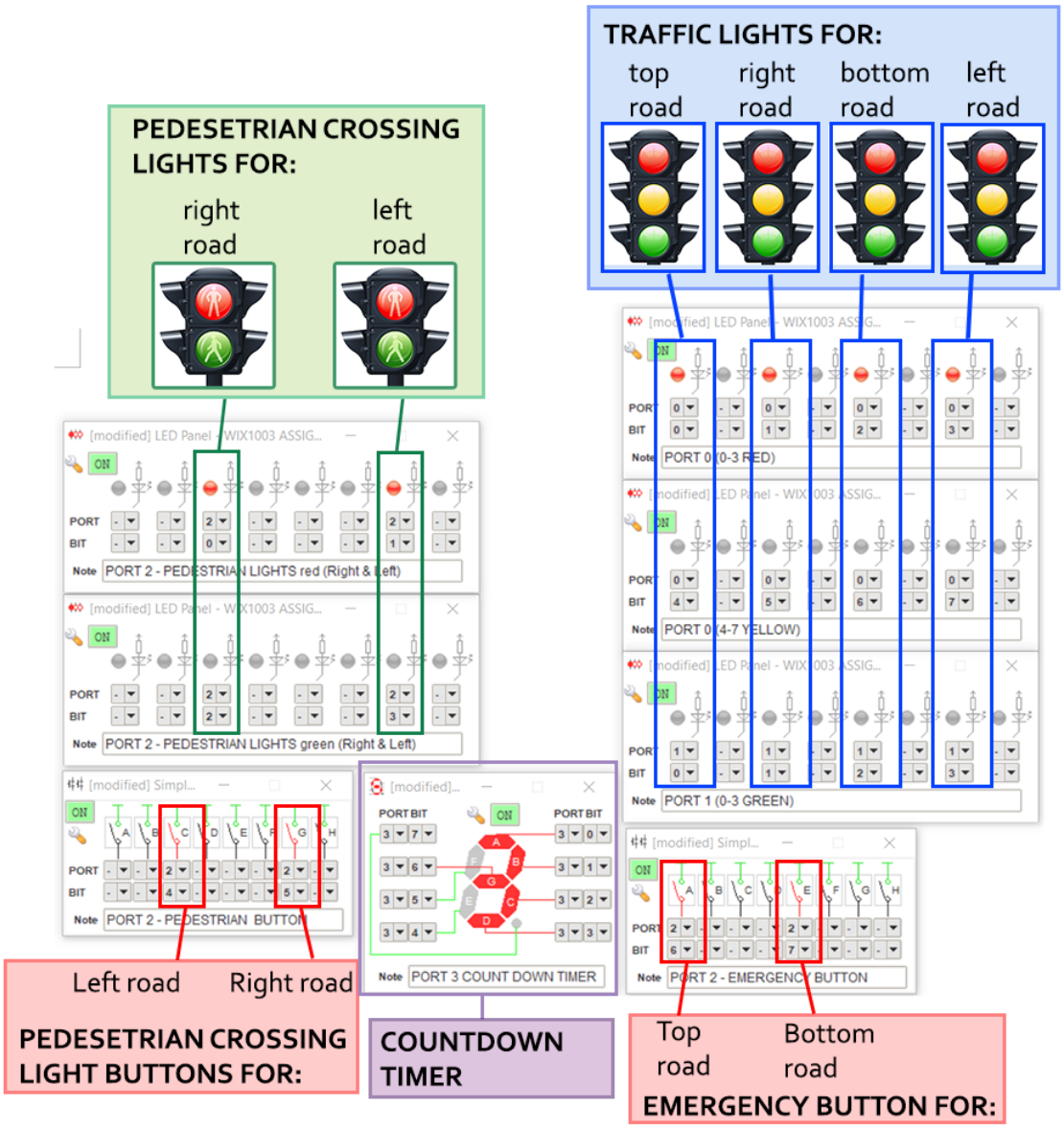
1.0 COMPONENT CONNECTION DIAGRAM



2.0 COMPLETE CODE OF THE PROGRAM

```
;***************************************************************************
; A program to control a cross junction traffic
;
; BASIC Features:
; - Equal chances for users to exit and cross the junction without causing
accident / havoc
; - Controlled by tri-colour traffic lights indicator
;   - RED     (STOP)
;   - YELLOW  (Prepare to STOP)
;   - GREEN   (Permission to GO)
;
; EXTRA Features SUGGESTIONS:
; - Emergency buttons for AMBULANCE and POLICE CARS (DONE)
; - Pedestrians press a button to cross the ROAD
; - Count Down Indicator (DONE)

                ORG     00h
                AJMP    MAIN

;***************************************************************************
; Configure all the ports before running the program
;
; PORT 0 (0-3) RED
; PORT 0 (4-7) YELLOW
;
; PORT 1 (0-3) GREEN
;
; PORT 2 (0-3) PEDESTRIAN CROSSING LIGHTS
;    0,1 - RED
;    2,3 - GREEN
; PORT 2 (4-5) PEDESTRIAN CROSSING BUTTONS
; PORT 2 (6-7) EMERGENCY BUTTONS (TOP and BOTTOM ROAD)
;
; PORT 3 (0-7) COUNT DOWN INDICATORS

MAIN:           MOV     A,#0F0h     ; 1111 0000
                MOV     P0,A        ; Turn off all YELLOW lights, Turn on
all RED lights
                MOV     A,#0FFh     ; 1111 1111
                MOV     P1,A        ; Turn off all GREEN lights, Set P1.4
to P1.7 as input ports for EMERGENCY BUTTONS
                MOV     A,#0FCh     ; 1111 1100
                MOV     P2,A        ; Set PEDESTRIAN CROSSING LIGHTS P2.0
to P2.3
                                    ; Set P2.4 to P2.7 as input ports for
PEDESTRIAN CROSSING BUTTONS and EMERGENCY BUTTONS
                MOV     A,#00h      ; 0000 0000
                MOV     P3,A        ; set PORT 3 as output port (7 segment
display)
                MOV     DPTR,#SEG   ; Move table address to Data Pointer
                MOV     B,#00h      ; initialize DELAY counter
                AJMP    TOP


;***************************************************************************
; ROAD (TOP -> RIGHT -> BOTTOM -> LEFT -> TOP)
;
```

```
; 1. Turn off RED
; 2. Turn on GREEN
; 3. TIMER count down for 9 seconds
; 4. Turn YELLOW
; 5. TIMER count down for 3 seconds
; 6. Turn RED
; 7. Wait for 3 seconds
; 8. During DELAY
;     Check if EMERGENCY BUTTONS are pressed (TOP and BOTTOM)
; 9. Check if PEDESTRIAN CROSSING LIGHTS BUTTONS are pressed (LEFT and
RIGHT)
;10. Proceed to the next ROAD

TOP:            SETB    P0.0            ; Turn off RED
                CLR     P1.0            ; Turn on GREEN
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
                SETB    P1.0            ; Turn off GREEN
                CLR     P0.4            ; Turn on YELLOW
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                SETB    P0.4            ; Turn off YELLOW
                CLR     P0.0            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                AJMP    RIGHT           ; Proceed to RIGHT ROAD

RIGHT:          SETB    P0.1            ; Turn off RED
                CLR     P1.1            ; Turn on GREEN
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
                SETB    P1.1            ; Turn off GREEN
                CLR     P0.5            ; Turn on YELLOW
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                SETB    P0.5            ; Turn off YELLOW
                CLR     P0.1            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                JNB     P2.4,WALK_RIGHT ; Check if PEDESTRIANN CROSSING
LIGHTS BUTTON is pressed
                AJMP    BOTTOM          ; Proceed to BOTTOM ROAD

BOTTOM:         SETB    P0.2            ; Turn off RED
                CLR     P1.2            ; Turn on GREEN
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
                SETB    P1.2            ; Turn off GREEN
                CLR     P0.6            ; Turn on YELLOW
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                SETB    P0.6            ; Turn off YELLOW
                CLR     P0.2            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                AJMP    LEFT            ; Proceed to LEFT ROAD

LEFT:           SETB    P0.3            ; Turn off RED
                CLR     P1.3            ; Turn on GREEN
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
```

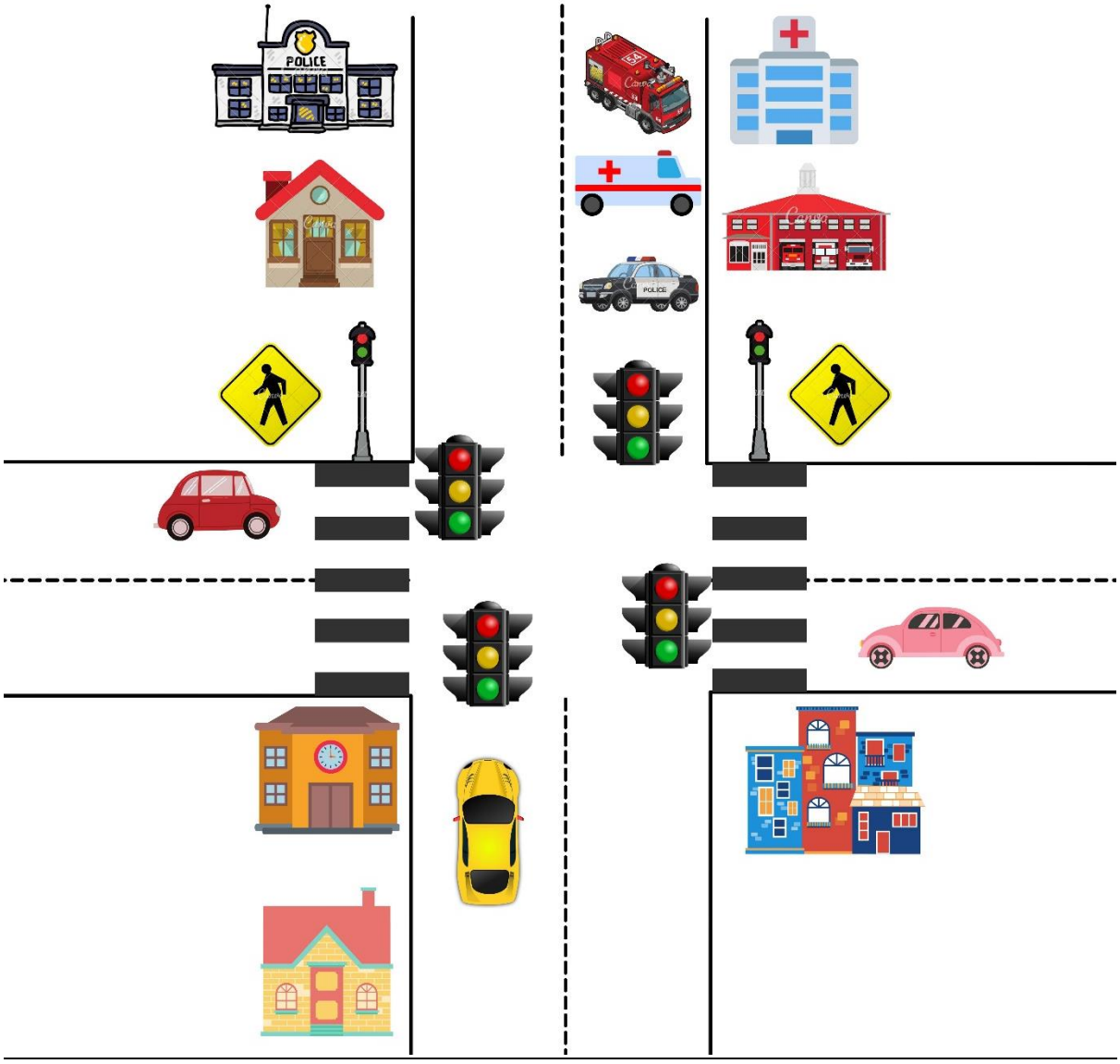
```
                SETB    P1.3            ; Turn off GREEN
                CLR     P0.7            ; Turn on YELLOW
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                SETB    P0.7            ; Turn off YELLOW
                CLR     P0.3            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY 3 seconds
                JNB     P2.5,WALK_LEFT  ; Check if PEDESTRIANN CROSSING
LIGHTS BUTTON is pressed
                AJMP    TOP             ; Back to TOP ROAD


;*************************************************************************
; PEDESTRIAN CROSSING LIGHTS SUBROUTINE
;
; PEDESTRIAN CROSSING LIGHTS are located at LEFT and RIGHT ROAD
;
; 1. After button is pressed, DELAY for 3 seconds
; 2. GREEN light turn ON for 8 seconds
; 3. Turn off GREEN light
;   COUNT DOWN TIMER

WALK_RIGHT:     SETB    P2.0            ; Turn off RED
                CLR     P2.2            ; Turn on GREEN
                MOV     B,#05h
                ACALL   DELAY           ; DELAY for 5 seconds
                SETB    P2.2            ; Turn off GREEN
                CLR     P2.0            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                AJMP    BOTTOM          ; Continue to BOTTOM ROAD

WALK_LEFT:      SETB    P2.1            ; Turn off RED
                CLR     P2.3            ; Turn on GREEN
                MOV     B,#05h
                ACALL   DELAY           ; DELAY for 5 seconds
                SETB    P2.3            ; Turn off GREEN
                CLR     P2.1            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                AJMP    TOP             ; Continue to TOP ROAD

;*************************************************************************
; EMERGENCY SUBROUTINE
;
; EMERGENCY buttons are located at TOP and BOTTOM ROAD
; Check if EMERGENCY buttons are pressed during DELAY subroutines
;
; EMERGENCY STATE:
; 1. Turn off all GREEN and YELLOW lights
; 2. Turn on all RED lights
; 3. Wait for 3 seconds

; EMERGENCY STATE
EMERGENCY:      MOV     A,#0Fh          ; 0000 1111
                MOV     P1,A            ; Turn off all GREEN lights
                MOV     A,#0F0h         ; 1111 0000
                MOV     P0,A            ; Turn off all YELLOW lights, Turn
on all RED lights
                MOV     B,#03h
```

```
                ACALL   DELAY           ; DELAY 3 seconds
                RET

; EMERGENCY AT TOP ROAD
EMERG_TOP:      ACALL   EMERGENCY
                SETB    P0.0            ; Turn off RED at TOP ROAD
                CLR     P1.0            ; Turn on GREEN at TOP ROAD
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
                SETB    P1.0            ; Turn off GREEN at TOP ROAD
                CLR     P0.4            ; Turn on YELLOW at TOP ROAD
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                SETB    P0.4            ; Turn off YELLOW
                CLR     P0.0            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                AJMP    RIGHT           ; Continue to RIGHT ROAD

; EMERGENCY AT BOTTOM ROAD
EMERG_BOTTOM:   ACALL   EMERGENCY
                SETB    P0.2            ; Turn off RED at BOTTOM ROAD
                CLR     P1.2            ; Turn on GREEN at BOTTOM ROAD
                MOV     B,#09h
                ACALL   DELAY           ; DELAY 9 seconds
                SETB    P1.2            ; Turn off GREEN at BOTTOM ROAD
                CLR     P0.6            ; Turn on YELLOW at BOTTOM ROAD
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                SETB    P0.6            ; Turn off YELLOW
                CLR     P0.2            ; Turn on RED
                MOV     B,#03h
                ACALL   DELAY           ; DELAY for 3 seconds
                AJMP    LEFT            ; Continue to LEFT ROAD


;*************************************************************************
; DELAY SUBROUTINE
;
; Control DELAY time in seconds using value stored in B
; #02h == 2 seconds
;
; USAGE:
; To delay by 1 second,
;  MOV    B,#01h
;  ACALL  DELAY
;
; YELLOW            (3 seconds)
; GREEN             (9 seconds)
; All RED           (3 seconds)
; Count Down Timer  (1 seconds)
; Pedestrian Crossing   (5 seconds)

; DELAY 1 SECOND
DELAY_1S:   MOV     R1,#03h
LOOP1:      DJNZ    R1,LOOP1
            RET

; DELAY FOR TRAFFIC LIGHTS AND COUNT DOWN TIMER
DELAY:      MOV     R2,B
```

```
TIMER:      ACALL   COUNTER             ; display current time remaining on
TIMER
LOOP2:      ACALL   DELAY_1S            ; DELAY 1 second
            DEC     R2                  ; Decrement R2 by 1
            JNB     P2.6,EMERG_TOP      ; Check if EMERGENCY BUTTON is
pressed
            JNB     P2.7,EMERG_BOTTOM
            CJNE    R2,#00h,TIMER       ; Continue to loop if time
remaining is not 0
            ACALL   COUNTER
            ACALL   DELAY_1S
            MOV     A,#00h
            MOV     P3,A                ; Clear the 7 SEGMENT DISPLAY if
time left is 0
            RET


;*************************************************************************
; COUNT DOWN TIMER SUBROUTINE
;
; To show number pattern on 7 SEGMENT LED DISPLAY for every second

COUNTER:    MOV     A,R2
            MOVC    A,@A+DPTR
            MOV     P3,A
            RET


;*************************************************************************
; lookup table for 7 segment display pattern (0-F)

SEG:        DB
3Fh,06h,5Bh,4Fh,66h,6Dh,7Dh,07h,7Fh,6Fh,77h,7Ch,39h,5Eh,79h,71h

            END
```

3.0 EXPLANATION ON THE OPERATION OF THE SYSTEM

3.1 Normal condition (without pressing pedestrian crossing button && emergency button)



At this cross-junction traffic light, the order of the road is started from Top, followed by Right, Bottom, Left, and go back to the Top road. (clockwise direction)

TrafficLight.asm

```
59 ; 8. During DELAY
60 ;      Check if EMERGENCY BUTTONS are pressed (TOP and BOTTOM)
61 ;      Check if PEDESTRAIN CROSSING LIGHTS BUTTONS are pressed (LEFT and RIGHT)
62 ; 9. Proceed to the next ROAD
63
64 TOP:          SETB    P0.0                ; Turn off RED
65              CLR     P1.0                ; Turn on GREEN
66              MOV     B,#09h
67              ACALL   DELAY               ; DELAY 9 seconds
68              SETB    P1.0                ; Turn off GREEN, set to 1 (1 is off)
69              CLR     P0.4                ; Turn on YELLOW
70              MOV     B,#03h
71              ACALL   DELAY               ; DELAY 3 seconds
72              SETB    P0.4                ; Turn off YELLOW
73              CLR     P0.0                ; Turn on RED
74              MOV     B,#03h
75              ACALL   DELAY               ; DELAY 3 seconds
76              AJMP    RIGHT               ; Proceed to RIGHT ROAD
77
```

Figure 1

At the code line 64, Port 0.0 that represents the red light at top of the road is turned off, and then Port 1.0 that represents the green light of top road will be light on. The green light will be light on for 9 seconds.

```
223 ; DELAY 1 SECOND
224 DELAY_1S:       MOV     R1,#03h
225 LOOP1:          DJNZ    R1,LOOP1   ; when R1 is 0, then just return
226                 RET
227
228 ; DELAY FOR TRAFFIC LIGHTS AND COUNT DOWN TIMER
229 DELAY:          MOV     R2,B
230 TIMER:          ACALL   COUNTER             ; display current time remaining on TIMER
231 LOOP2:          ACALL   DELAY_1S            ; DELAY 1 second
232                 DEC     R2                  ; Decrement R2 by 1
233                 JNB     P2.6,EMERG_TOP      ; Check if EMERGENCY BUTTON is pressed
234                 JNB     P2.7,EMERG_BOTTOM
235                 CJNE    R2,#00h,TIMER       ; Continue to loop if time remaining is not 0
236                 ACALL   COUNTER             ; reach here when timer = 0
237                 ACALL   DELAY_1S
238                 MOV     A,#00h
239                 MOV     P3,A                ; Clear the 7 SEGMENT DISPLAY if time left is 0
240                 RET
241
```

Figure 2

Now let's see the part of codes in Figure 2 which operate the timer counter (count down time). In figure 1, the "B" is given the value of "09h", means that the green light will be light on for 9 seconds. At the "DELAY" part, the functions of "COUNTER" at line 230 is to show the timer at the seven segment LED display. The part "DELAY_IS" to delay the count down timer for 1 seconds. At line 232, the value in "R2" will be decreased by 1 every time the code is being read. The codes at 233 and 234 is to check whether if any emergency button is being pressed (This part of code will be explained after). At line 235, if the timers run for 9 times and become 0, the 7 segment LED display will show "0" (cars now will have to stop crossing the road).

TrafficLight.asm

```
59 ; 8. During DELAY
60 ;      Check if EMERGENCY BUTTONS are pressed (TOP and BOTTOM)
61 ;      Check if PEDESTRAIN CROSSING LIGHTS BUTTONS are pressed (LEFT and RIGHT)
62 ; 9. Proceed to the next ROAD
63
64 TOP:          SETB    P0.0            ; Turn off RED
65              CLR     P1.0            ; Turn on GREEN
66              MOV     B,#09h
67              ACALL   DELAY           ; DELAY 9 seconds
68              SETB    P1.0            ; Turn off GREEN, set to 1 (1 is off)
69              CLR     P0.4            ; Turn on YELLOW
70              MOV     B,#03h
71              ACALL   DELAY           ; DELAY 3 seconds
72              SETB    P0.4            ; Turn off YELLOW
73              CLR     P0.0            ; Turn on RED
74              MOV     B,#03h
75              ACALL   DELAY           ; DELAY 3 seconds
76              AJMP    RIGHT           ; Proceed to RIGHT ROAD
77
```

Figure 3

At line 68(Figure 3), green light is turned off, and the yellow light will light on. We set the durations of yellow light blinking to 3 seconds. After that, yellow light is turned off, and red light will light on. The red light also blinking for 3 seconds. At line 76, we proceed to the right road.

```
75              ACALL   DELAY           ; DELAY 3 seconds
76              AJMP    RIGHT           ; Proceed to RIGHT ROAD
77
78 RIGHT:       SETB    P0.1            ; Turn off RED
79              CLR     P1.1            ; Turn on GREEN
80              MOV     B,#09h
81              ACALL   DELAY           ; DELAY 9 seconds
82              SETB    P1.1            ; Turn off GREEN
83              CLR     P0.5            ; Turn on YELLOW
84              MOV     B,#03h
85              ACALL   DELAY           ; DELAY 3 seconds
86              SETB    P0.5            ; Turn off YELLOW
87              CLR     P0.1            ; Turn on RED
88              MOV     B,#03h
89              ACALL   DELAY           ; DELAY 3 seconds
90              JNB     P2.4,WALK_RIGHT ; Check if PEDESTRIANN CROSSING LIGHTS BUTTON is
  pressed
91              AJMP    BOTTOM          ; Proceed to BOTTOM ROAD
92
```

Figure 4

Now is the turn for cars at the Right road to go (Figure 4). Similarly, the red light will be light off, and then the green light will light on for 9 seconds as same as the part of codes for the Top road. After that, green light will be turned off. At line 83, yellow light will light on for 3 seconds. After the 3 seconds, red light will light on, and blinking for 3 seconds to aware the car to stop crossing the road. But, at the line 90, there is a pedestrian crossing button for people who want to cross the road.

```
90                  JNB     P2.4,WALK_RIGHT         ; Check if PEDESTRIANN CROSSING LIGHTS BUTTON is
 pressed
91                  AJMP    BOTTOM                  ; Proceed to BOTTOM ROAD
92
93  BOTTOM:         SETB    P0.2                    ; Turn off RED
94                  CLR     P1.2                    ; Turn on GREEN
95                  MOV     B,#09h
96                  ACALL   DELAY                   ; DELAY 9 seconds
97                  SETB    P1.2                    ; Turn off GREEN
98                  CLR     P0.6                    ; Turn on YELLOW
99                  MOV     B,#03h
100                 ACALL   DELAY                   ; DELAY 3 seconds
101                 SETB    P0.6                    ; Turn off YELLOW
102                 CLR     P0.2                    ; Turn on RED
103                 MOV     B,#03h
104                 ACALL   DELAY                   ; DELAY 3 seconds
105                 AJMP    LEFT                    ; Proceed to LEFT ROAD
106
107 LEFT:           SETB    P0.3                    ; Turn off RED
```

Figure 5

After all the cars at Left road stop crossing the road, the cars at the bottom road are going to start crossing the road. Same as all the steps we have in the codes of Top road, red light will turn off, followed by the green light that will turned on for 9 seconds, the yellow light will light on for 3 seconds after green light and lastly the red light will light on again to stop the cars form crossing the road.

```
104                 ACALL   DELAY                   ; DELAY 3 seconds
105                 AJMP    LEFT                    ; Proceed to LEFT ROAD
106
107 LEFT:           SETB    P0.3                    ; Turn off RED
108                 CLR     P1.3                    ; Turn on GREEN
109                 MOV     B,#09h
110                 ACALL   DELAY                   ; DELAY 9 seconds
111                 SETB    P1.3                    ; Turn off GREEN
112                 CLR     P0.7                    ; Turn on YELLOW
113                 MOV     B,#03h
114                 ACALL   DELAY                   ; DELAY 3 seconds
115                 SETB    P0.7                    ; Turn off YELLOW
116                 CLR     P0.3                    ; Turn on RED
117                 MOV     B,#03h
118                 ACALL   DELAY                   ; DELAY 3 seconds
119                 JNB     P2.5,WALK_LEFT          ; Check if PEDESTRIANN CROSSING LIGHTS BUTTON is
 pressed
120                 AJMP    TOP                     ; Back to TOP ROAD
121
```

Figure 6

Now is the turn for the cars at Left road to cross the road. The processes in this part are same as the part in the Right road. There is also a pedestrian crossing button for those want to cross the road. After go through all the green light, yellow right and red light, the turns will now be passed back to the Top road.

In conclusion, all the traffic light will function normally as there are no people pressing the emergency button or pedestrian crossing button.

3.2 Pedestrian Crossing Light

The pedestrian crossing light is set to let the pedestrians cross the road safely. When the pedestrian crossing light is switched on, no other traffic light is switched on, which means there will be no car flow at all. The pedestrian crossing light will turn green for only five seconds. After it turns red again, there will be a three-second delay before the traffic light starts turning green.

Let us assume that the schools are at the end of the bottom road and the residential area is at the end of the top road. Therefore, there will be two pedestrian crossing lights, one at the left and the other on the right, connecting the top part of the area with the bottom part of it. This is to let the students and parents reach the schools safely.

Whenever the traffic light at the right road turns red, which means that the last flow of car movement from the right road has ended, the program will check if the pedestrian crossing light is switched on or not.

Referring to Figure 1, after the program runs from line 78 to line 89, the traffic light will turn red. The code at line 90 will check if the switch of the pedestrian light at port 2 bit 4 is switched on, if yes, the program will proceed with the “WALK_RIGHT” code; if not, the program will proceed with the “BOTTOM” road as usual, which turns on the green light at the bottom road.

```
78 RIGHT:       SETB    P0.1                ; Turn off RED
79              CLR     P1.1                ; Turn on GREEN
80              MOV     B,#09h
81              ACALL   DELAY               ; DELAY 9 seconds
82              SETB    P1.1                ; Turn off GREEN
83              CLR     P0.5                ; Turn on YELLOW
84              MOV     B,#03h
85              ACALL   DELAY               ; DELAY 3 seconds
86              SETB    P0.5                ; Turn off YELLOW
87              CLR     P0.1                ; Turn on RED
88              MOV     B,#03h
89              ACALL   DELAY               ; DELAY 3 seconds
90              JNB     P2.4,WALK_RIGHT     ; Check if PEDESTRIANN CROSSING LIGHTS BUTTON is pressed
91              AJMP    BOTTOM              ; Proceed to BOTTOM ROAD
```

Figure 1: the code for “RIGHT”

If the pedestrian crossing light is switched on, the code in the “WALK_RIGHT” section will run. Referring to Figure 2, the code at line 133 switch off the red light of the pedestrian crossing light by setting the value of port 2 bit 0 as 1.

Then, the code at line 134 will set the value of port 2 bit 2 as 0 to turn on the green light. The code at line 135 and 136 will let the green light to be switched on for five seconds by setting B as 5 and running the “DELAY” code.

After that, the code at line 137 turns off the green light by setting its port to value 1, and at line 138 turns on the red light by setting its port to value 0.

Then, the program will delay for three seconds with the code at line 139 and 140 to further ensure the safety of the crossing pedestrian.

After all, the program will proceed with the “BOTTOM” code that controls the traffic light at the bottom road to resume the car flow in a clockwise direction.

```
133 WALK_RIGHT:     SETB    P2.0            ; Turn off RED
134                 CLR     P2.2            ; Turn on GREEN
135                 MOV     B,#05h
136                 ACALL   DELAY           ; DELAY for 5 seconds
137                 SETB    P2.2            ; Turn off GREEN
138                 CLR     P2.0            ; Turn on RED
139                 MOV     B,#03h
140                 ACALL   DELAY           ; DELAY for 3 seconds
141                 AJMP    BOTTOM          ; Continue to BOTTOM ROAD
```

Figure 2: the code for "WALK_RIGHT"

Similarly, referring to Figure 3, after the code at "LEFT" comes to line 119, the program will check if the pedestrian crossing light at the left road is being switched on or not. If no, the program proceeds with the "TOP" code to enable the car movement from the top road; if yes, the program will jump to the "WALK_LEFT" code to enable the pedestrian crossing light to interrupt the car flow.

```
107 LEFT:           SETB    P0.3            ; Turn off RED
108                 CLR     P1.3            ; Turn on GREEN
109                 MOV     B,#09h
110                 ACALL   DELAY           ; DELAY 9 seconds
111                 SETB    P1.3            ; Turn off GREEN
112                 CLR     P0.7            ; Turn on YELLOW
113                 MOV     B,#03h
114                 ACALL   DELAY           ; DELAY 3 seconds
115                 SETB    P0.7            ; Turn off YELLOW
116                 CLR     P0.3            ; Turn on RED
117                 MOV     B,#03h
118                 ACALL   DELAY           ; DELAY 3 seconds
119                 JNB     P2.5,WALK_LEFT  ; Check if PEDESTRIANN CROSSING LIGHTS BUTTON is pressed
120                 AJMP    TOP             ; Back to TOP ROAD
```

Figure 3: the code for "LEFT"

If the pedestrian crossing light at the left road is pushed down, the "WALK_LEFT" code will run. Referring to Figure 4, the code at line 143 switches of the red light of the pedestrian crossing light, while line 144 switches on the green one. Then, there will be a five seconds delay to let the pedestrian cross the road. After that, the code at lines 147 and 148 switches the green light off and the red light on. A three seconds delay is given to further ensure the safety of the pedestrian. Then, only will the program proceed with the "TOP" code.

```
143 WALK_LEFT:      SETB    P2.1            ; Turn off RED
144                 CLR     P2.3            ; Turn on GREEN
145                 MOV     B,#05h
146                 ACALL   DELAY           ; DELAY for 5 seconds
147                 SETB    P2.3            ; Turn off GREEN
148                 CLR     P2.1            ; Turn on RED
149                 MOV     B,#03h
150                 ACALL   DELAY           ; DELAY for 3 seconds
151                 AJMP    TOP             ; Continue to TOP ROAD
```

Figure 4: the code for "WALK_LEFT"

As a short conclusion, the right pedestrian crossing light runs only after the right traffic light turns red, which means the car movement from the right has finished flowing. Similarly, the left pedestrian crossing light runs only after the left traffic light has turned back red.

3.3 Emergency Button

The emergency button is for the authorities' use to give themselves the priority to cross a junction with traffic lights. In other words, when the ambulances, police cars, or firefighter trucks are trying to cross a junction with traffic lights, they can push the emergency button to halt all the other cars' passage by turning their traffic lights red. Soon after, the traffic light of the road where the authorities are will turn green, indicating their safety to cross the junction.

Let us assume that the hospital, police station, and firefighter station are all at the end of the top road. Thus, there will be two emergency buttons included in our project. One is at the top road, while the other is at the bottom road. This is because once the top road's emergency button is pushed down and the traffic light at the top is forced green, the authorities can go to any one of the three roads since all the other traffic lights are red at the moment. This enables the authorities to reach the destination as soon as possible.

The code for the emergency button is programmed into the "DELAY" section. The "DELAY" code plays a big role in the whole program, in which the program spends most of its time in the "DELAY" part because the lights have to be switched on for a certain amount of time using the "DELAY" code. No matter which one of the four traffic lights is running nor which color is being switched on, the program is always checking for the status of the emergency button. Referring to Figure 5, as an example, the "TOP" code involves the "DELAY" in lines 67, 71, and 75, when the different color is switched on. It is similar to all the other traffic lights at the "BOTTOM", "LEFT", and "RIGHT".

```
64 TOP:     SETB    P0.0        ; Turn off RED
65          CLR     P1.0        ; Turn on GREEN
66          MOV     B,#09h
67          ACALL   DELAY       ; DELAY 9 seconds
68          SETB    P1.0        ; Turn off GREEN
69          CLR     P0.4        ; Turn on YELLOW
70          MOV     B,#03h
71          ACALL   DELAY       ; DELAY 3 seconds
72          SETB    P0.4        ; Turn off YELLOW
73          CLR     P0.0        ; Turn on RED
74          MOV     B,#03h
75          ACALL   DELAY       ; DELAY 3 seconds
76          AJMP    RIGHT       ; Proceed to RIGHT ROAD
```

Figure 5: the code for "TOP"

Referring to Figure 6, the code for "DELAY" will check for the emergency button at lines 233 and 234 for the top emergency button and bottom emergency button respectively. It does so by checking if the value at port 2 bit 6 or port 2 bit 7 is 0. If it is 0, then it signifies that the emergency button is pressed, so the program will jump to code "EMERG_TOP" for the top emergency button or "EMERG_BOTTOM" for the bottom one.

```
229 DELAY:          MOV     R2,B
230 TIMER:          ACALL   COUNTER              ; display current time remaining on TIMER
231 LOOP2:          ACALL   DELAY_1S             ; DELAY 1 second
232                 DEC     R2                   ; Decrement R2 by 1
233                 JNB     P2.6,EMERG_TOP       ; Check if EMERGENCY BUTTON is pressed
234                 JNB     P2.7,EMERG_BOTTOM
235                 CJNE    R2,#00h,TIMER        ; Continue to loop if time remaining is not 0
236                 ACALL   COUNTER
237                 ACALL   DELAY_1S
238                 MOV     A,#00h
239                 MOV     P3,A                 ; Clear the 7 SEGMENT DISPLAY if time left is 0
240                 RET
```

Figure 6: the code for "DELAY"

If the top emergency button is pushed down, then the "EMERG_TOP" code will run. Referring to Figure 7, it will first call for the "EMERGENCY" code at line 174.

```
173 ; EMERGENCY AT TOP ROAD
174 EMERG_TOP:      ACALL EMERGENCY
175                 SETB    P0.0                 ; Turn off RED at TOP ROAD
176                 CLR     P1.0                 ; Turn on GREEN at TOP ROAD
177                 MOV     B,#09h
178                 ACALL   DELAY                ; DELAY 9 seconds
179                 SETB    P1.0                 ; Turn off GREEN at TOP ROAD
180                 CLR     P0.4                 ; Turn on YELLOW at TOP ROAD
181                 MOV     B,#03h
182                 ACALL   DELAY                ; DELAY for 3 seconds
183                 SETB    P0.4                 ; Turn off YELLOW
184                 CLR     P0.0                 ; Turn on RED
185                 MOV     B,#03h
186                 ACALL   DELAY                ; DELAY for 3 seconds
187                 AJMP    RIGHT                ; Continue to RIGHT ROAD
```

Figure 7: the code for "EMERG_TOP"

Referring to Figure 8, the "EMERGENCY" code will turn off all green lights by setting the value of port 1 as #0FH. Since all green lights are connected to port 1 bit 0, 1, 2, and 3 respectively, lines 165 and 166 will cause them to have the value of 1 and be switched off. Then, the code at lines 167 and 168 will move the value of #0F0h to port 0. Since the yellow lights are connected to port 0 bit 4, 5, 6, and 7 respectively, they will receive the value of 1 and be switched off. Meanwhile, while the red lights are connected to ports 0 bit 0, 1, 2, and 3 respectively, they will receive the value of 0 and be switched on. Now, all four traffic lights will be red. After a three seconds delay, the program returns to the "EMERG_TOP" code.

```
164 ; EMERGENCY STATE
165 EMERGENCY:      MOV     A,#0Fh               ; 0000 1111
166                 MOV     P1,A                 ; Turn off all GREEN lights
167                 MOV     A,#0F0h              ; 1111 0000
168                 MOV     P0,A                 ; Turn off all YELLOW lights, Turn on all RED lights
169                 MOV     B,#03h
170                 ACALL   DELAY                ; DELAY 3 seconds
171                 RET
```

Figure 8: the code for "EMERGENCY"

Back to the "EMERG_TOP" code, referring to Figure 7, the program resumes with line 175, in which the red light at the top traffic light is switched off. Then the green one is switched on for nine seconds. After that, the green light is off and the yellow light is switched

on for 3 seconds followed by the red light. After three seconds, the program continues with the right traffic light with the “RIGHT” code.

In another case in which the “EMERG_BOTTOM” code is running; the process is similar as in “EMERG_TOP” but it ends with continuing with the “LEFT” code. The code for “EMERG_BOTTOM” is shown in Figure 9.

```
189 ; EMERGENCY AT BOTTOM ROAD
190 EMERG_BOTTOM:   ACALL   EMERGENCY
191                 SETB    P0.2                ; Turn off RED at BOTTOM ROAD
192                 CLR     P1.2                ; Turn on GREEN at BOTTOM ROAD
193                 MOV     B,#09h
194                 ACALL   DELAY               ; DELAY 9 seconds
195                 SETB    P1.2                ; Turn off GREEN at BOTTOM ROAD
196                 CLR     P0.6                ; Turn on YELLOW at BOTTOM ROAD
197                 MOV     B,#03h
198                 ACALL   DELAY               ; DELAY for 3 seconds
199                 SETB    P0.6                ; Turn off YELLOW
200                 CLR     P0.2                ; Turn on RED
201                 MOV     B,#03h
202                 ACALL   DELAY               ; DELAY for 3 seconds
203                 AJMP    LEFT                ; Continue to LEFT ROAD
```

Figure 9: the code for “EMERG_BOTTOM”

4.0 DESIGN CONSIDERATION AND SYSTEM LIMITATION

1) In this traffic light system, all of the traffic light(top, right, bottom, left) provides the same chances and time for the road users. Which is, the green light will light up for 9 seconds, after that, the yellow light will be turn on for 3 seconds, after that the red light will be turn on. When the red light is turned on, there will be a delay of 3 seconds after the green light of the next road to be turned on. This is to reduce the accidents because it ensure all the cars from the previous road has passed or stopped. After the traffic clear, the green light of the next road lights up, then the traffic light cycle continues and following the sequence of top, right, bottom, left, top … (clockwise direction).

2) We've included "**Pedestrian traffic light**" on the left and right road. When the "Pedestrian button" is pressed. (Let's say it is pedestrian button on right road). The traffic light system will detect the button and after the right road car traffic light turns red, the pedestrian green light will lights up for 5 seconds. The function of pedestrian light is to ensure pedestrian can cross the road safely, especially during busy or crowded road such as after-school time.

3) There's "**Emergency Button**" in this traffic light system. When the "Emergency Button" is pressed, the red light of all road will light up after 3 seconds, and the green light of the "emergency" road will be light up, after that, the normal traffic light cycle continues. This is to reduce the risk of accident and ensure the flow of traffic during emergency situation. When the emergency button of one of the road is pressed, the traffic system will make that road as priority to let the vehicles (ambulance, fire engine, etc…) passed first. This feature not only reduce the chaos, but also does not delay the movement of the "important cars". So when emergency happen, the other road user from the other road will know what to do because the just need to follow the instruction of traffic light. After that, the traffic light system will restore to original state.

4) In this traffic light system, we've implemented the **count down time indicator**. This is to allow road users to know the time of the traffic light. The traffic light count down timers has also proven to improve the drivers' response. This is because if there's no count down timer, driver might fall into mistakes because they are in the "dilemma zone" , which is the zone that the driver doesn't know whether to go or to stop, to accelerate or decelerate. Thus, with the count down timer, driver will have clarity on the timing of the traffic light so that they are mentally and physically prepared when it is their turn, and to decide whether to go or to stop.

System Limitations

1) The time counter of the traffic light might not realistic. For example, 10 seconds of green light might be too short for the car to pass a junction. However, the time could always be changed to match the real situation requirements.

2) In this system, there's no sensor to check which road have fewer number of vehicles to adjust the timer of the traffic light. Thus, we could not adjust the traffic light timer dynamically based on the road situation.

3) If emergency happen suddenly, the traffic light of the pedestrian crossing road will not turn red immediately, it will wait until the countdown timer reach 0. So, the pedestrian would need to be always aware of the road situation.

4) We didn't implement "camera" on this traffic light system, so it's not easy for us to know when a car break the traffic rules.