LABFILE
(CEN 691) EMBEDDED SYSTEMS LAB

SUBMITTED BY : **YASH VINAYVANSHI**
B.TECH COMPUTER ENGINEERING (6th SEMESTER)
ROLL NO. 19BCS081
JAMIA MILLIA ISLAMIA FET, NEW DELHI

SUBMITTED TO : **DR. WASEEM AHMAD**
PROFESSOR
DEPARTMENT OF COMPUTER ENGINEERING
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10	**Design and implement an Embedded System that toggle only pin P 1.5 continuously every 250ms using 8051 board. Take crystal frequency=11.0592 MHz.** **1. Using timer 0, mode 1** **2. Using timer 1, mode 2**	01/05/2022 35–38

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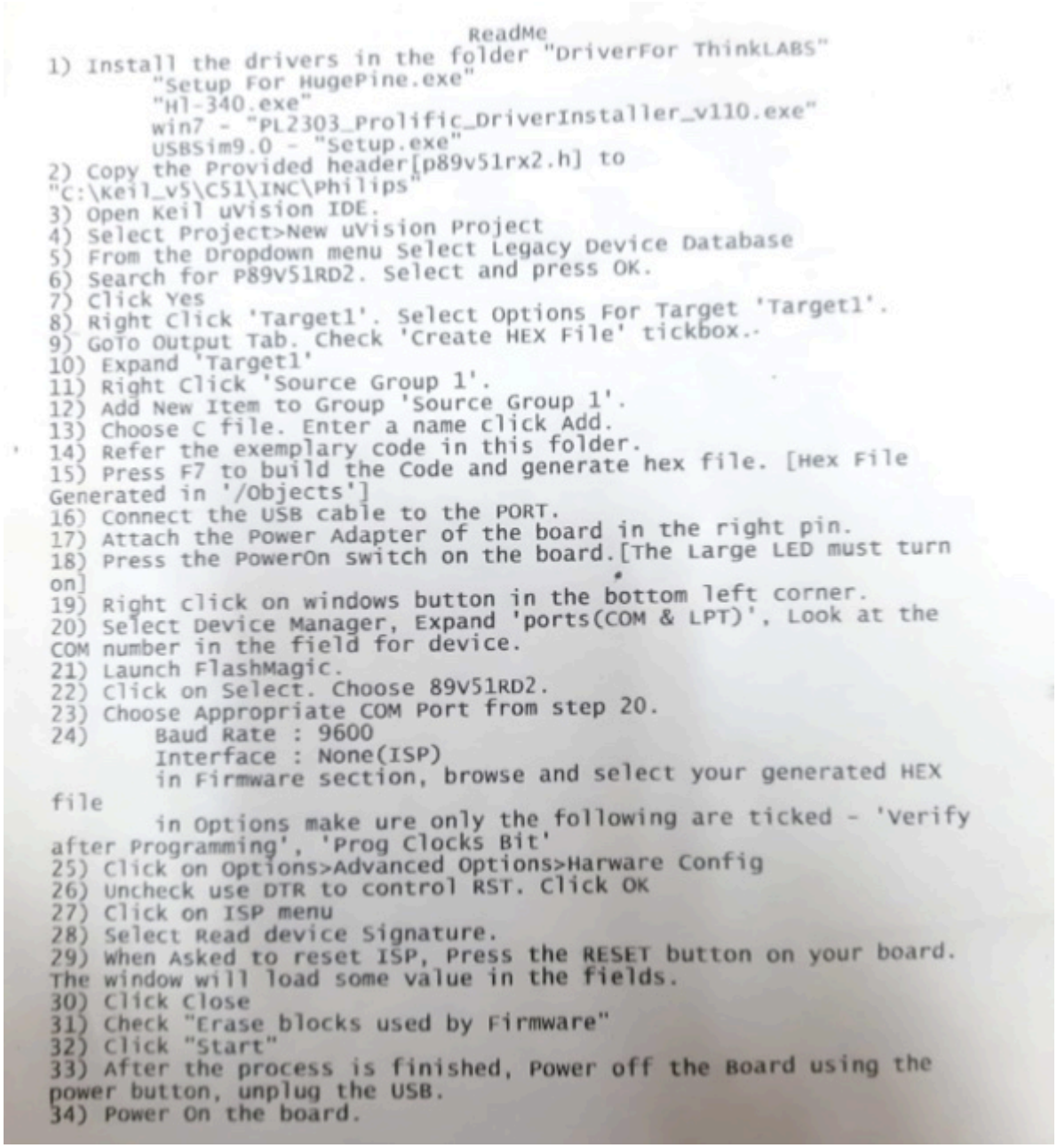
ES lab 1 : Study of Keil Micro vision IDE and Flash magic tool.

Steps

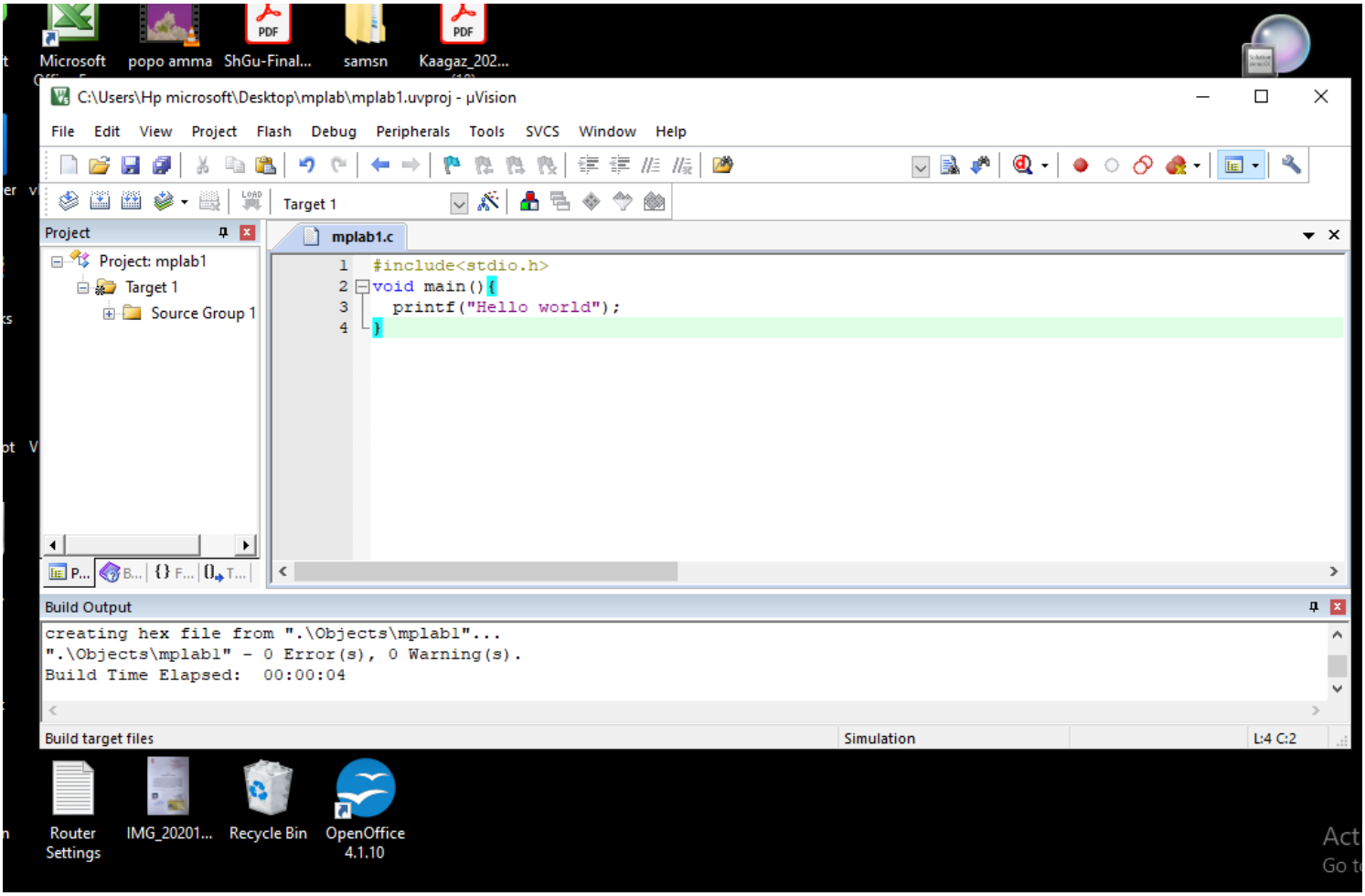


ReadMe

1) Install the drivers in the folder "DriverFor ThinkLABS"
   "Setup For HugePine.exe"
   "Hl-340.exe"
   win7 - "PL2303_Prolific_DriverInstaller_v110.exe"
   USBSim9.0 - "Setup.exe"
2) Copy the Provided header[p89v51rx2.h] to "C:\Keil_v5\C51\INC\Philips"
3) Open Keil uVision IDE.
4) Select Project>New uVision Project
5) From the Dropdown menu Select Legacy Device Database
6) Search for P89V51RD2. Select and press OK.
7) Click Yes
8) Right Click 'Target1'. Select Options For Target 'Target1'.
9) GoTo Output Tab. Check 'Create HEX File' tickbox.
10) Expand 'Target1'
11) Right Click 'Source Group 1'.
12) Add New Item to Group 'Source Group 1'.
13) Choose C file. Enter a name click Add.
14) Refer the exemplary code in this folder.
15) Press F7 to build the Code and generate hex file. [Hex File Generated in '/Objects']
16) Connect the USB cable to the PORT.
17) Attach the Power Adapter of the board in the right pin.
18) Press the PowerOn switch on the board.[The Large LED must turn on]
19) Right click on windows button in the bottom left corner.
20) Select Device Manager, Expand 'ports(COM & LPT)', Look at the COM number in the field for device.
21) Launch FlashMagic.
22) Click on Select. Choose 89V51RD2.
23) Choose Appropriate COM Port from step 20.
24) Baud Rate : 9600
    Interface : None(ISP)
    in Firmware section, browse and select your generated HEX file
    in Options make ure only the following are ticked - 'Verify after Programming', 'Prog Clocks Bit'
25) Click on Options>Advanced Options>Harware Config
26) Uncheck use DTR to control RST. Click OK
27) Click on ISP menu
28) Select Read device Signature.
29) When Asked to reset ISP, Press the RESET button on your board. The window will load some value in the fields.
30) Click Close
31) Check "Erase blocks used by Firmware"
32) Click "Start"
33) After the process is finished, Power off the Board using the power button, unplug the USB.
34) Power On the board.

17 JANUARY 2022

Keil microvision IDE for code editing and Assembling

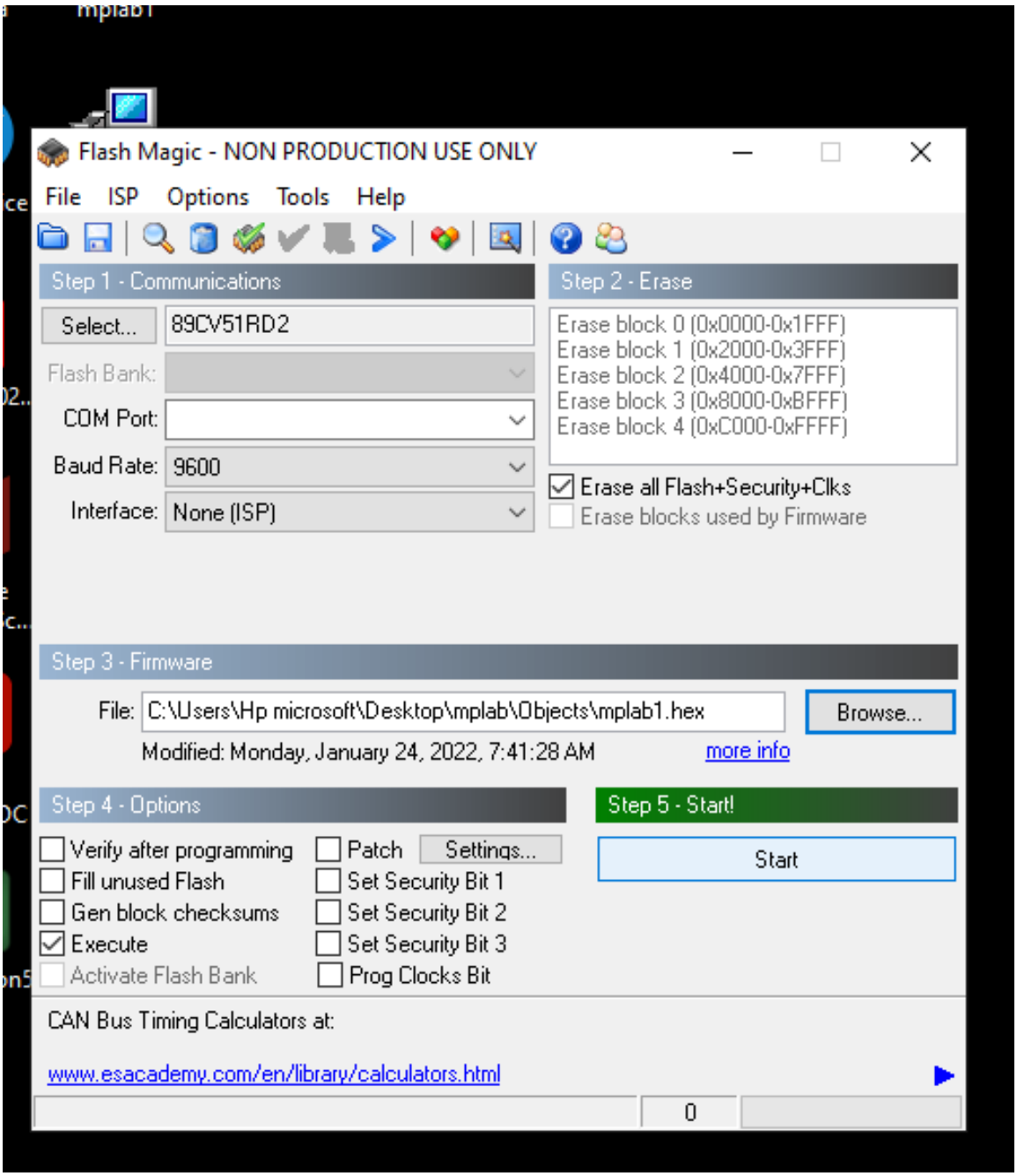


C code & hex code

```c
#include<stdio.h>
void main(){
     printf("Hello world");
}
```

```
          00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f
0000000000 3a 30 33 30 30 30 30 30 30 30 32 30 43 31 31 44    :03000000020C11D
0000000010 45 0d 0a 3a 30 43 30 43 31 31 30 30 37 38 37 46    E..:0C0C1100787F
0000000020 45 34 46 36 44 38 46 44 37 35 38 31 32 31 30 32    E4F6D8FD75812102
0000000030 30 43 32 39 45 33 0d 0a 3a 30 43 30 43 31 44 30    0C29E3..:0C0C1D0
0000000040 30 34 38 36 35 36 43 36 43 36 46 32 30 37 37 36    048656C6C6F20776
0000000050 46 37 32 36 43 36 34 30 30 38 46 0d 0a 3a 30 39    F726C64008F..:09
0000000060 30 43 32 39 30 30 37 42 46 46 37 41 30 43 37 39    0C29007BFF7A0C79
0000000070 31 44 30 32 30 38 36 32 43 30 0d 0a 3a 31 30 30    1D020862C0..:100
0000000080 38 30 30 30 30 45 35 31 37 32 34 30 42 46 38 45    80000E517240BF8E
0000000090 36 30 35 31 37 32 32 37 38 30 38 33 30 30 37 30    6051722780830070
00000000a0 32 37 38 30 42 36 35 0d 0a 3a 31 30 30 38 31 30    2780B65..:100810
00000000b0 30 30 45 34 37 35 46 30 30 31 31 32 30 42 42 34    00E475F001120BB4
00000000c0 30 32 30 42 35 43 32 30 30 30 45 42 37 46 32 45    020B5C2000EB7F2E
00000000d0 44 32 43 41 0d 0a 3a 31 30 30 38 32 30 30 30 30    D2CA..:100820000
00000000e0 30 38 30 31 38 45 46 35 34 30 46 32 34 39 30 44    08018EF540F2490D
00000000f0 34 33 34 34 30 44 34 46 46 33 30 30 34 30 42 44    43440D4FF30040BD
0000000100 30 0d 0a 3a 31 30 30 38 33 30 30 30 45 46 32 34    0..:10083000EF24
0000000110 42 46 42 34 31 41 30 30 35 30 30 33 32 34 36 31    BFB41A0050032461
0000000120 46 46 45 35 31 38 36 30 30 32 31 35 43 44 0d 0a    FFE518600215CD..
0000000130 3a 31 30 30 38 34 30 30 30 31 38 30 35 31 42 45    :1008400018051BE
0000000140 35 31 42 37 30 30 32 30 35 31 41 33 30 30 37 30    51B7002051A30070
0000000150 44 37 38 30 38 45 34 37 35 43 32 0d 0a 3a 31 30    D7808E475C2..:10
0000000160 30 38 35 30 30 30 46 30 30 31 31 32 30 42 42 34    085000F001120BB4
0000000170 45 46 30 32 30 42 41 32 30 32 30 42 45 41 37 34    EF020BA2020BEA74
```

Using flash magic to burn code into 8051 mprocessor



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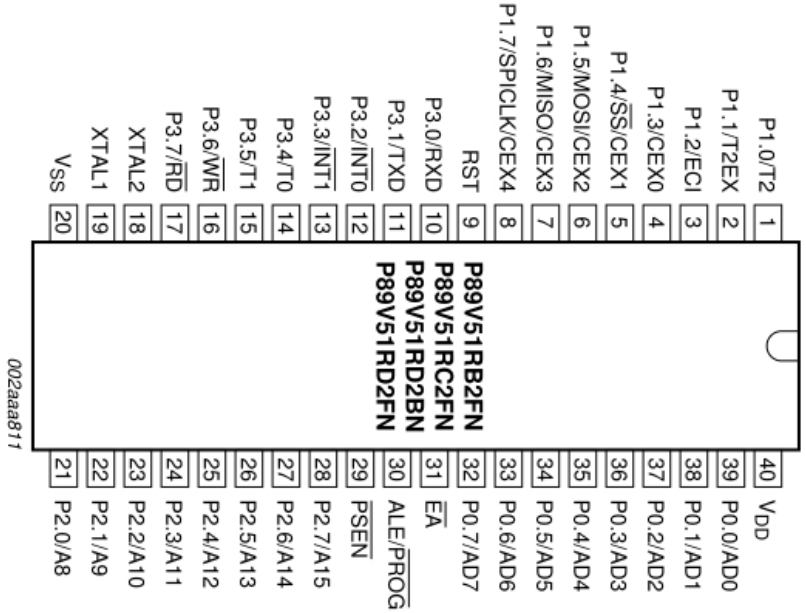
ES lab 2 : Design and implement Embedded System for blinking single LED with some delay in between, using 8051 Microcontroller and Keil.

Hardware

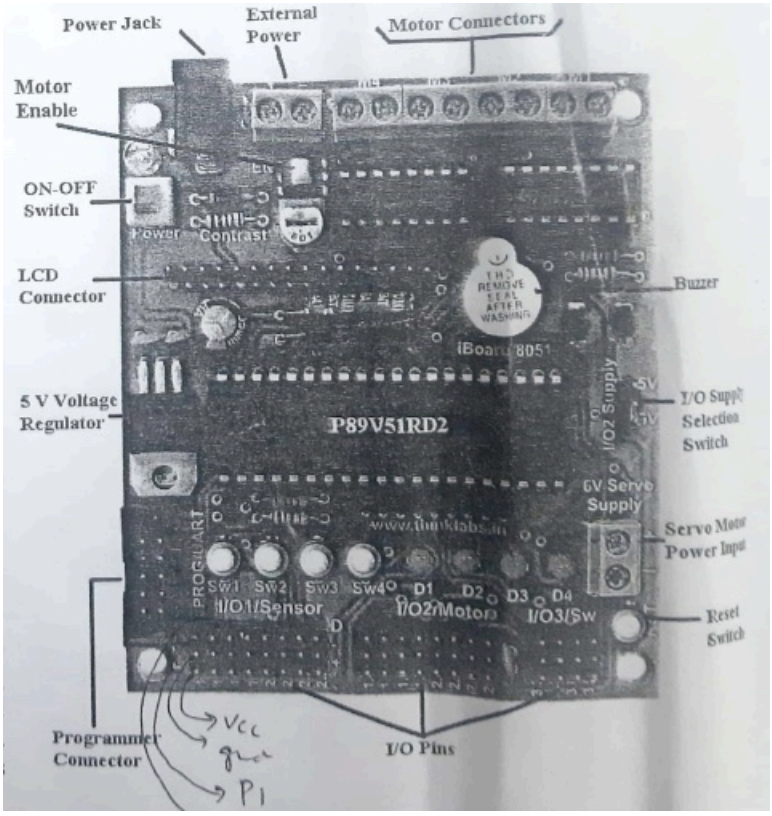
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h
IDE used : ARM keil microvision
for burning : Flash Magic

Working

LED D1 at port 3_0 (RxD) Blinks with chosen delay

C program

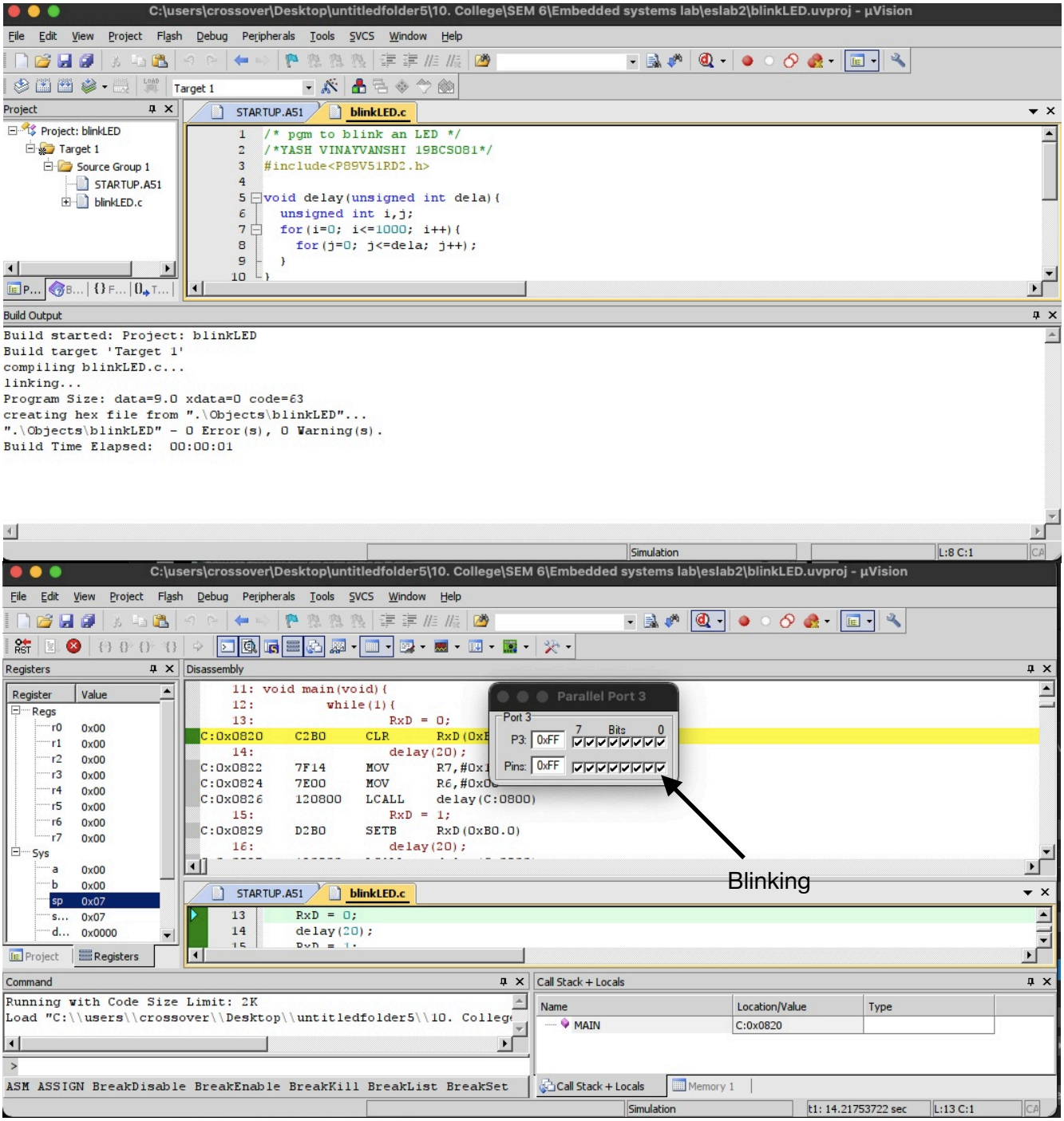
```
/* program to blink an LED */
/*YASH VINAYVANSHI 19BCS081*/
#include<P89V51RD2.h>

void delay(unsigned int dela){
      unsigned int i,j;
      for(i=0; i<=1000; i++){
            for(j=0; j<=dela; j++);
      }
}
void main(void){
      while(1){
            RxD = 0;
            delay(20);
            RxD = 1;
            delay(20);
```

```
        }
}
```

Hex code

```
:03000000020830C3
:0C083000787FE4F6D8FD758107020820EF
:10080000E4FDFCE4FBFAD3EB9FEA9E50070BBB0030
:0F081000010A80F20DBD00010CBC03E7BDE9E455
:01081F0022B6
:10082000C2B07F147E00120800D2B012080080F01F
:00000001FF
```

Run



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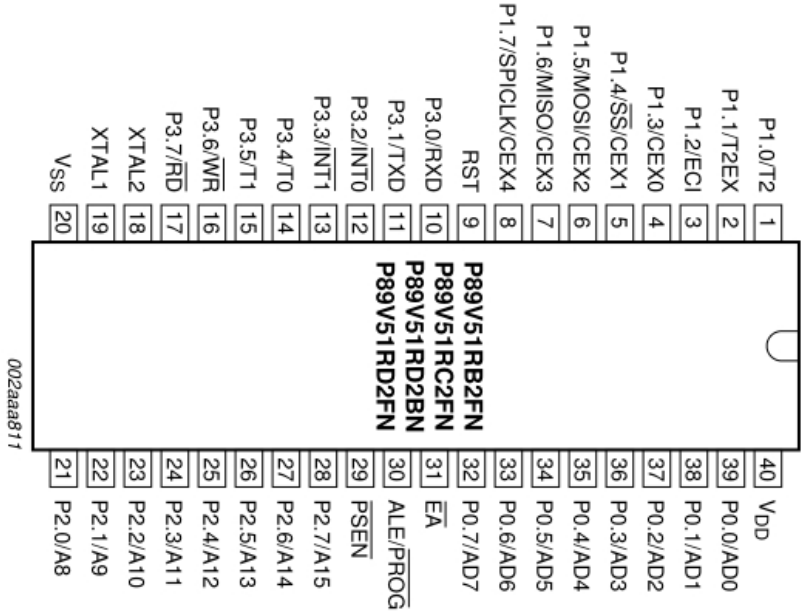
ES lab 3 : Design and implement embedded system for 3 bit led counter with some delay in between, using 8051 microcontroller and Keil.

Hardware

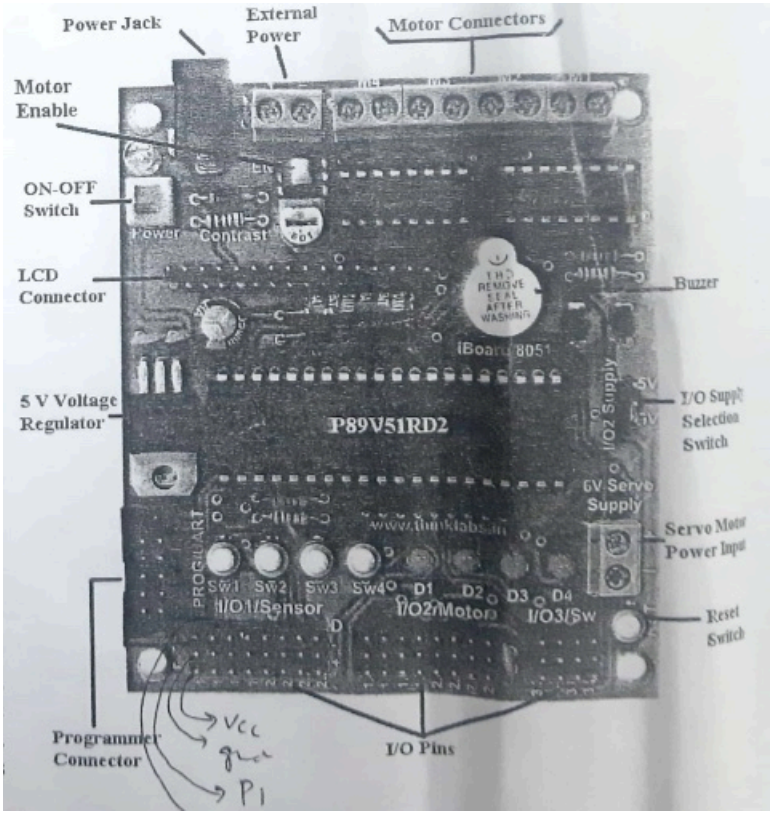
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h
IDE used : ARM keil microvision
for burning : Flash Magic

Working

LEDS D3 D2 D1 Blinks as mod 8 counter with chosen delay.

C program 1

```
/* 3 bit counter on LEDs*/
//  Created by YASH VINAYVANSHI on 07/02/22.
#include<P89V51RD2.h>

void delay(unsigned int dela){
	unsigned int i, j;
	for(i=0; i<=1000; i++){
		for(j=0; j<=dela; j++);
	}
}

void main(void)
{
	while(1) {
		unsigned int j;
		for(j=0; j<=8; j++) {
			unsigned d=j;
			RxD = d%2; //Extracting bits from 3 bit bin no.
			d =d/2;
```

```
                    TxD = d%2;
                    d=d/2;
                    WR = d%2 ;
                    delay(500);
                }

        }
}
```

C program 2

```
/* 3 bit counter on LEDs*/
//  Created by YASH VINAYVANSHI on 07/02/22.
// D1 -> p3.0 -> RxD
// D2 -> P3.1 -> TxD
// D3 -> p3.6 -> WR
//
//    |         | |
// 7 6 5 4 3 2 1 0   value    cntr
// 0 0 0 0 0 0 0 0   0        0
// 0 0 0 0 0 0 0 1   1        1
// 0 0 0 0 0 0 1 0   2        2
// 0 0 0 0 0 0 1 1   3        3
//         ...
// 0 1 0 0 0 0 0 0   64       4
// 0 1 0 0 0 0 0 1   65       5
// 0 1 0 0 0 0 1 0   66       6
// 0 1 0 0 0 0 1 1   67       7

#include<P89V51RD2.h>

void delay(unsigned int dela){
    unsigned int i, j;
    for(i=0; i<=1000; i++){
        for(j=0; j<=dela; j++);
    }
}
void main(void){
    while(1){
        P3 = 0; delay(500);
        P3 = 1; delay(500);
        P3 = 2; delay(500);
        P3 = 3; delay(500);
        P3 = 64; delay(500);
        P3 = 65; delay(500);
        P3 = 66; delay(500);
        P3 = 67; delay(500);
    }
}
```

Output :

MSB		**LSB**
D3	D2	D1
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

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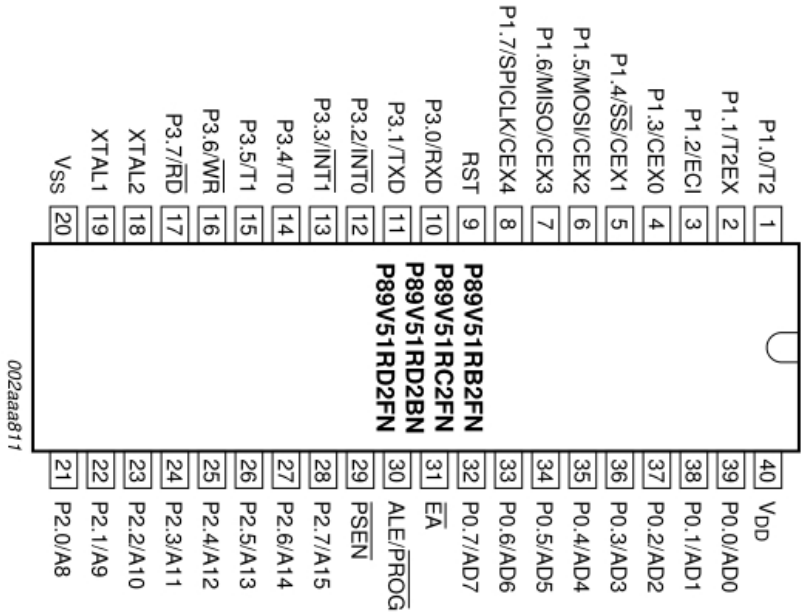
ES lab 4 : Design counter based on first two switches as input using 8051 microcontroller and Keil.

Hardware

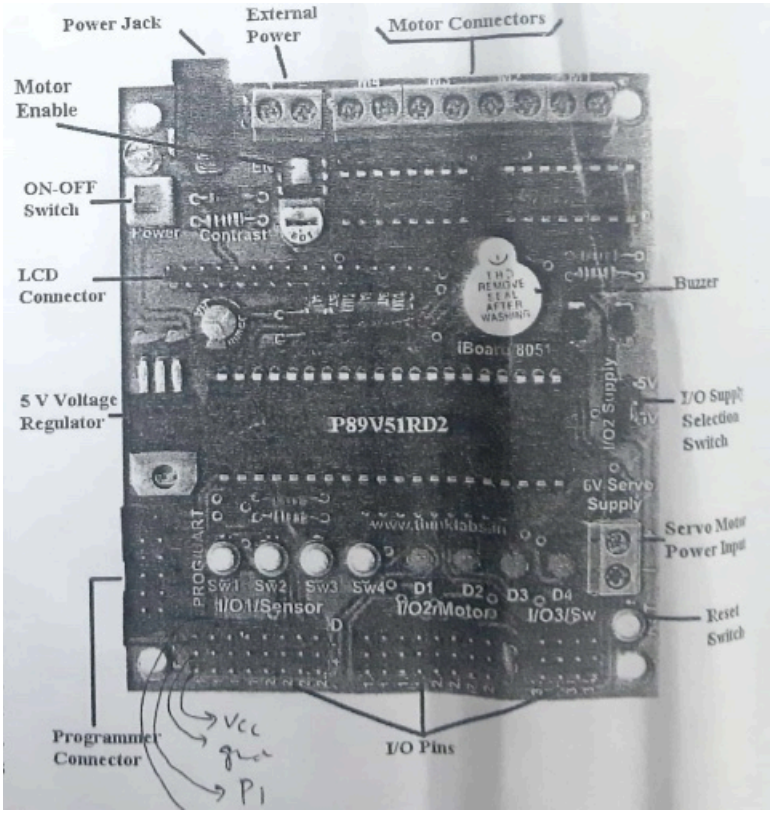
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
//To design n bit counter based on n on two switches
//created by yash vinayvanshi 19BCS081
/*
Sw1    P3.2 INT0(MSB)
Sw2    P3.3 INT1(LSB)
D1     P3.0 RxD (MSB)
D2     P3.1 TxD
D3   P3.6 RW (LSB)
*/

#include<P89V51RD2.h>
void delay(unsigned int dela){
	unsigned int i,j;
	for(i=0;i<1000;i++) {
		for(j=0; j<dela; j++);
	}
}
void main(void){
	unsigned int dela = 500;
	while(1){
		unsigned int count=1, bits=0, i=0, j=0;
		if(INT0 == 0) bits+=2;
		if(INT1 == 0) bits+=1;
		for(i=0; i<bits; i++) count*=2;
```

```
            for(; j<count; j++){
                  unsigned int d = j;
                  WR = d%2;//Extracting bits from 3 bit bin no.
                  d =d/2;
                  TxD = d%2;
                  d=d/2;
                  RxD = d%2;
                  delay(dela);
            }
      }
}
```

Output :

(user)

MSB	LSB	MSB		LSB	
S1	S2	D1	D2	D3	
0	0	X	X	X	
1 bit counter					
0	1	0	0	0	t0
		0	0	1	t1
		0	0	0	t2
		0	0	1	t3 and so on
2bit counter					
1	0	0	0	0	t0
		0	0	1	t1
		0	1	0	t2
		0	1	1	t3
		0	0	0	t4
		0	0	1	t5
		0	1	0	t6
		0	1	1	t7 and so on
3bit counter					
1	1	0	0	0	t0
		0	0	1	t1
		0	1	0	t2
		0	1	1	t3
		1	0	0	t4
		1	0	1	t5
		1	1	0	t6
		1	1	1	t7
		0	0	0	t8
		0	0	1	t9
		0	1	0	t10
		0	1	1	t11
		1	0	0	t12
		1	0	1	t13
		1	1	0	t14
		1	1	1	t15 and so on

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ES lab 5 : Design counter based on first Three switches as input using 8051 microcontroller and Keil.

Hardware

Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

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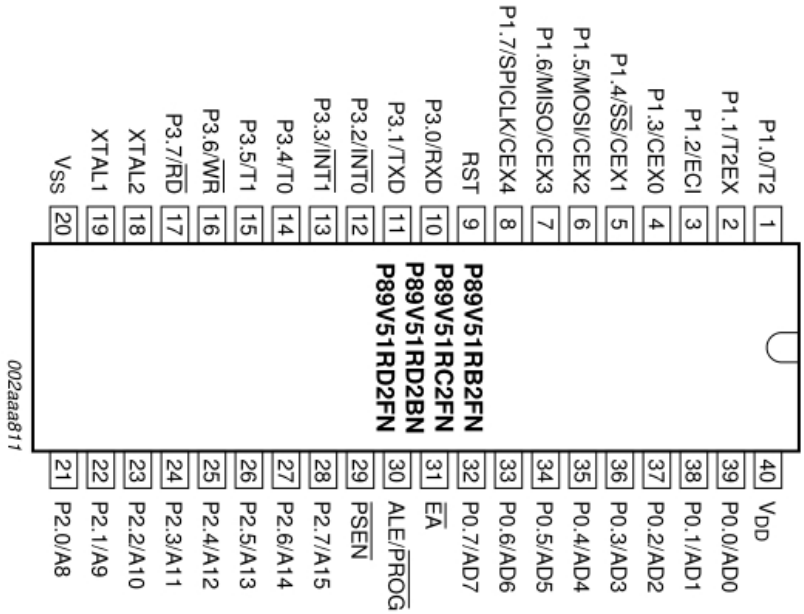
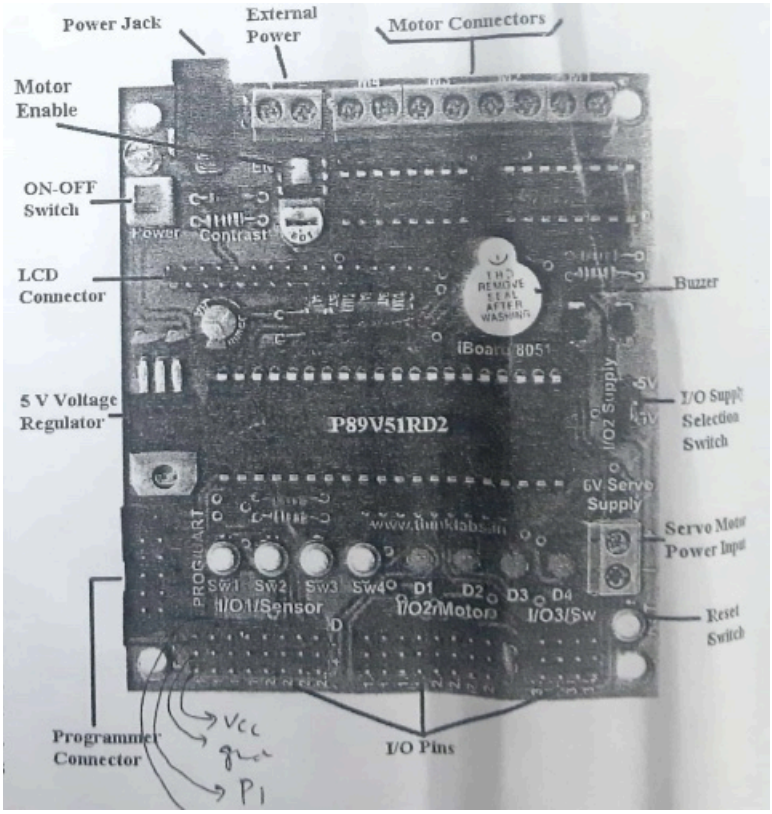
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
/*
This project is created by yash vinayvanshi 19BCS081 on
march 7, 2022

This code is designed to be tested on keil microvision debugger


 onboard
 S1   S2   S3   S4   L1   L2   L3   L4
 3.2  3.3  3.4  3.5  3.0  3.1  3.2  3.3
 MSB            LSB  MSB            LSB

 debugging tool
 7    6    5    4    3    2    1    0
 3.7  3.6  3.5  3.4  3.3  3.2  3.1  3.0
 L4   L3   S4   S3   S2   S1   L2   L1

           S4   S3   S2   S1
           LSB            MSB

 L4   L3                      L2   L1
 LSB                          MSB
```

```
          0    0    1   =  4bit (on board)        1 0 0 reversed
          1    1    0    =  4bit (on debugger)


               on board

 0     0                        0     0        0
 1     0                        0     0        1
 0     1                        0     0        2
 1     1                        0     0        3
 0     0                        1     0        4
 .                                             .
 .                                             .
 .                                             .
 1     1                        1     1        15


                on debgger
 1     1                        1     1        0
 0     1                        1     1        1
 1     0                        1     1        2
 0     0                        1     1        3
 1     1                        0     1        4
 .                                             .
 .                                             .
 .                                             .
 0     0                        0     0        15


 N bit counter : 0..2^n - 1 counter

 0 0 0 -> 0 bit counter 0..0
 0 0 1 -> 1 bit counter 0..1
 0 1 0 -> 2 bit counter 0..3
 0 1 1 -> 3 bit counter 0..7
 1 0 0 -> 4 bit counter 0..15
 ---not possible ahead with 4 LEDS---
 so if pressed value > 4, it'll reamin a 4 bit counter
 1 0 1 -> 5 bit counter 0..32
 1 1 0 -> 6 bit counter 0..63
 1 1 1 -> 7 bit counter 0..127
*/
#include<P89V51RD2.h>
void delay(unsigned int dela){
    unsigned int i,j;
    for(i=0;i<1000;i++) {
           for(j=0; j<dela; j++);
    }
}
/*
 sw1 : P3.2 INT0
 sw2 : P3.3 INT1
 sw3 : P3.4 T0
 sw4 : P3.5 T1
 D1  : P3.0 RxD
 D2  : P3.1 TxD
 D3  : P3.6 WR
 D4  : P3.7 RD
*/
void main(void){
    unsigned int dela = 500;
    while(1){
        unsigned int count=1, bits=0, i=0, j=0;
        if(INT1 == 0) bits+=4;
        if(T0 == 0) bits+=2;
        if(T1 == 0) bits+=1;
```

```
        if(bits > 4) bits=4;
        for(i=0; i<bits; i++) count*=2;
        for(; j<count; j++){
            unsigned int d = count - j - 1;
            RD = d%2;
            d = d/2;
            WR = d%2;//Extracting bits from 4 bit bin no.
            d =d/2;
            TxD = d%2;
            d=d/2;
            RxD = d%2;
            delay(dela);
        }
    }
}
```

NOTE : with three switches we can input a count upto 7, but we have only four LEDS, so any input above 4 is taken as 4

Output :

counter based on first Three switches as input is achieved.

EMBEDDED SYSTEMS LAB : CEN 691

SUBMITTED BY : **YASH VINAYVANSHI**
B.TECH COMPUTER ENGINEERING (6th SEMESTER)
ROLL NO. **19BCS081**
JAMIA MILLIA ISLAMIA FET, NEW DELHI

SUBMITTED TO : **DR. WASEEM AHMAD**
PROFESSOR
DEPARTMENT OF COMPUTER ENGINEERING
JAMIA MILLIA ISLAMIA FET, NEW DELHI

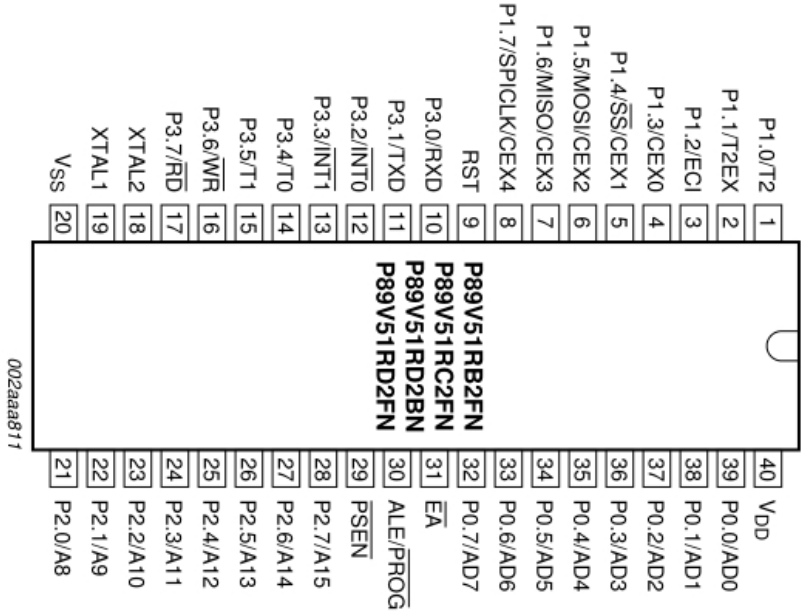
ES lab 6 : Design and implement an Embedded System that interfaces an 8051 Board by taking input from switch and then completes its cycle (in reverse order) with a buzzer.

Hardware

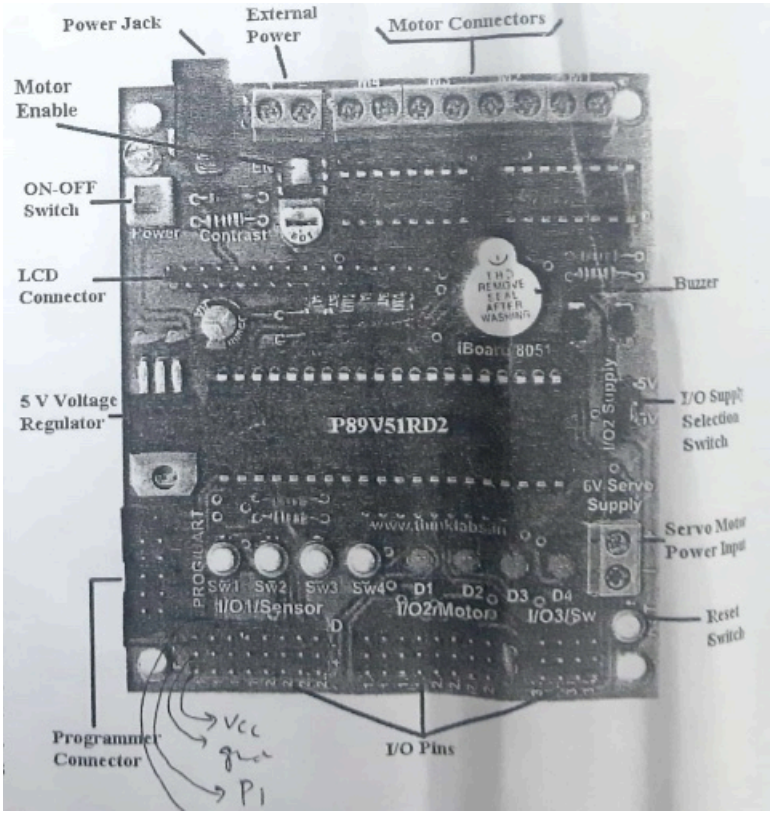
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
/*
This project is created by yash vinayvanshi 19BCS081 on
march 21, 2022

This code is designed to be tested on keil microvision debugger

 onboard
 S1   S2   S3   S4   L1   L2   L3   L4
 3.2  3.3  3.4  3.5  3.0  3.1  3.2  3.3
 MSB            LSB  MSB            LSB

 debugging tool
 7    6    5    4    3    2    1    0
 3.7  3.6  3.5  3.4  3.3  3.2  3.1  3.0
 L4   L3   S4   S3   S2   S1   L2   L1

           S4   S3   S2   S1
           LSB            MSB

 L4   L3                      L2   L1
 LSB                          MSB
```

```
pressed 4
      S1   S2   S3   S4
       X    1    0    0   =  4 (on board)
fact1 -> switches gets reversed & inverted on debugger
      S4   S3   S2   S1    (reverse)
       0    0    1    X
       1    1    0    X    (invert) = 4(on debugger)

pressed 3
      S1   S2   S3   S4       (on board)
       X    0    1    1
      p3.5 p3.4 p3.3 p3.1     (on debugger)
      S4   S3   S2   S1
       1    1    0    X (reverse)
       0    0    1    X (invert)



4bit ctr board              4 bit ctr on debugger
                          (reverse)           (invert)
D1  D2  D3  D4            D4  D3  D2  D1    D4  D3  D2  D1
0   0   0   0  (0)        0   0   0   0     1   1   1   1 (15)
0   0   0   1  (1)        1   0   0   0     0   1   1   1 (14)
0   0   1   0  (2)        0   1   0   0     1   0   1   1 (13)
0   0   1   1  (3)        1   1   0   0     0   0   1   1 (12)
0   1   0   0             0   0   1   0     1   1   0   1
0   1   0   1             1   0   1   0     0   1   0   1
0   1   1   0             0   1   1   0     1   0   0   1
0   1   1   1  (7)        1   1   1   0     0   0   0   1
.                         .                 .
.                         .                 .
.                         .                 .
1   1   1   1  (15)       1   1   1   1     0   0   0   0 (0)



 N bit counter : 0..2^n - 1 counter

 0 0 0 -> 0 bit counter 0..0
 0 0 1 -> 1 bit counter 0..1
 0 1 0 -> 2 bit counter 0..3
 0 1 1 -> 3 bit counter 0..7
 1 0 0 -> 4 bit counter 0..15
 ---not possible ahead with 4 LEDS---
 so if pressed value > 4, it'll remain to begin as a 4 bit counter
 1 0 1 -> 5 bit counter 0..32
 1 1 0 -> 6 bit counter 0..63
 1 1 1 -> 7 bit counter 0..127
*/
#include<P89V51RD2.h>
sbit buzz = P0^3;
void delay(unsigned int dela){
    unsigned int i,j;
    for(i=0;i<1000;i++) {
```

```
            for(j=0; j<dela; j++);
    }
}
/*
 sw1 : P3.2 INT0
 sw2 : P3.3 INT1
 sw3 : P3.4 T0
 sw4 : P3.5 T1
 D1  : P3.0 RxD
 D2  : P3.1 TxD
 D3  : P3.6 WR
 D4  : P3.7 RD
*/
void main(void){
    unsigned int dela = 500;
    while(1){
        unsigned int count=1, bits=0, i=0, j=0, k=0;
        //sw1(MSB) don't care as 3 switches to be used
        if(INT1 == 0) bits+=4;
        if(T0 == 0) bits+=2;
        if(T1 == 0) bits+=1;
        if(bits > 4) bits=4;
        //bit to mod conversion
        for(i=0; i<bits; i++) count*=2;
        while(count != 0){
            j = 0;
            for(; j<count; j++){
                //down count
                unsigned int d = count - j - 1;
                RD = d%2;
                d = d/2;
                WR = d%2;//Extracting bits from 4 bit bin no.
                d =d/2;
                TxD = d%2;
                d=d/2;
                RxD = d%2;
                delay(dela);
            }
            //to reduce counter
            count = count/2;
            buzz = 0;
            delay(dela);
            buzz = 1;
        }
    }
}
```

NOTE : with three switches we can input a count upto 7, but we have only four LEDS, so any input from switches above 4 is taken as 4

Output :

Embedded System to receive input from 3 switches and then complete its cycle (in reverse order) with a buzzer beep in between each counter cycle is implemented.

EMBEDDED SYSTEMS LAB : CEN 691

SUBMITTED BY : **YASH VINAYVANSHI**
B.TECH COMPUTER ENGINEERING (6th SEMESTER)
ROLL NO. **19BCS081**
JAMIA MILLIA ISLAMIA FET, NEW DELHI

SUBMITTED TO : **DR. WASEEM AHMAD**
PROFESSOR
DEPARTMENT OF COMPUTER ENGINEERING
JAMIA MILLIA ISLAMIA FET, NEW DELHI

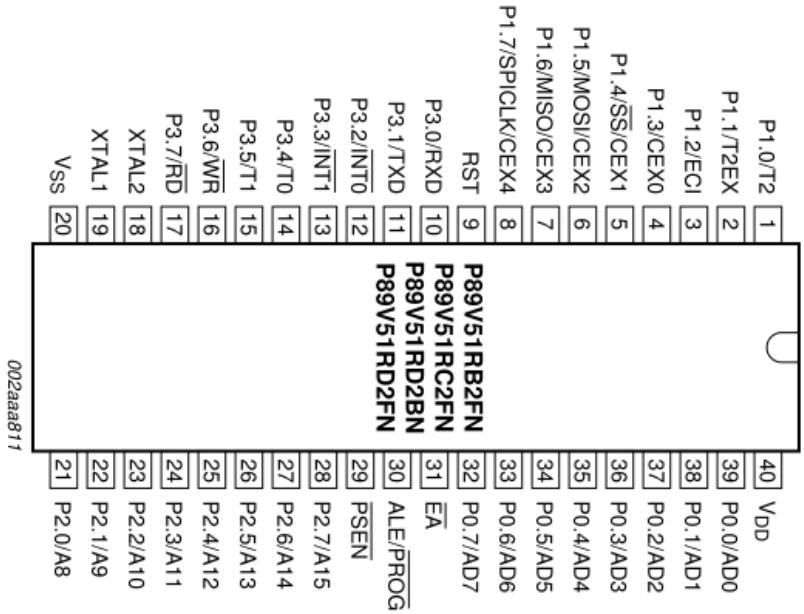
ES lab 7 : To design and implement an Embedded System that displays the roll no and name on LCD screen using 8051 microcontroller.

Hardware

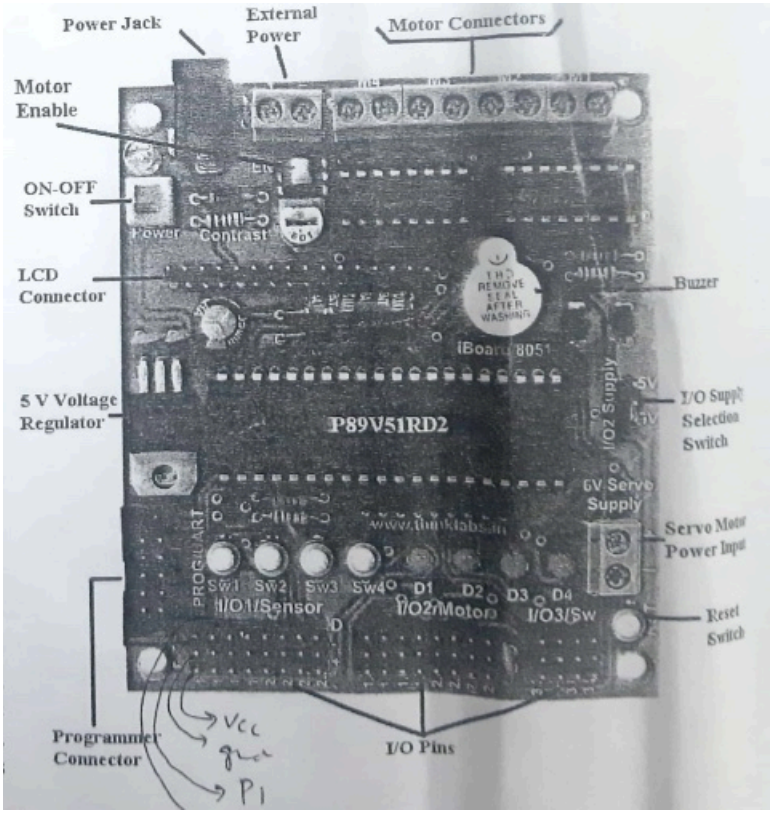
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : lcd.h for P89V51RX2
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
//
//  led.c
//  Created by YASH VINAYVANSHI on 28/03/22.
//

//#include <P89V51RX2.h>
#include <lcd.h>
void main(){
    LCD_INIT();
    LCD_WRITE("YASH VINAYV.", 0, 0);
    LCD_WRITE("19BCS081", 1, 0);
    while(1);
}
```

Output :

```
On display board
col      0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15
line  0  Y  A  S  H     V  I  N  A  Y  V  .
      1  1  9  B  C  S  0  8  1
```

EMBEDDED SYSTEMS LAB : CEN 691

SUBMITTED BY : **YASH VINAYVANSHI**
B.TECH COMPUTER ENGINEERING (6th SEMESTER)
ROLL NO. **19BCS081**
JAMIA MILLIA ISLAMIA FET, NEW DELHI

SUBMITTED TO : **DR. WASEEM AHMAD**
PROFESSOR
DEPARTMENT OF COMPUTER ENGINEERING
JAMIA MILLIA ISLAMIA FET, NEW DELHI

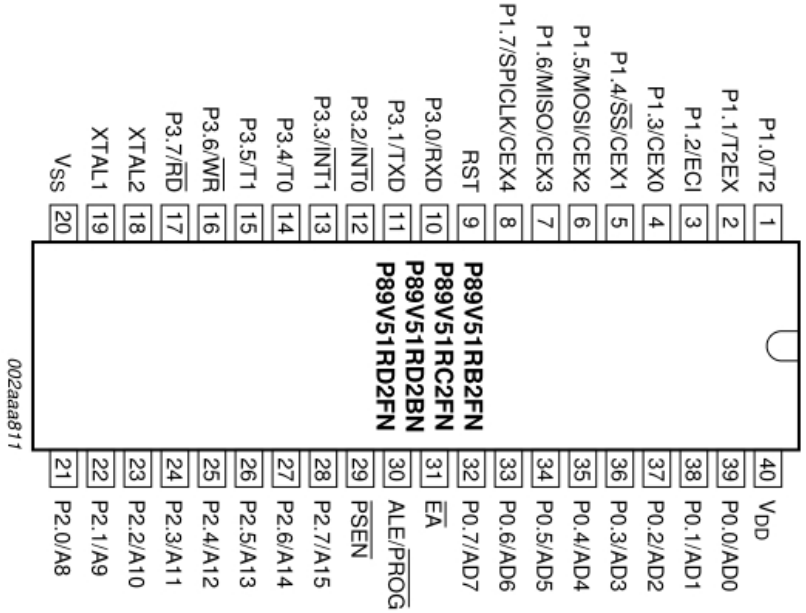
ES lab 8 : Design and implement an Embedded System that displays the factorial of a number (input through switch) on LCD screen using 8051 microcontroller.

Hardware

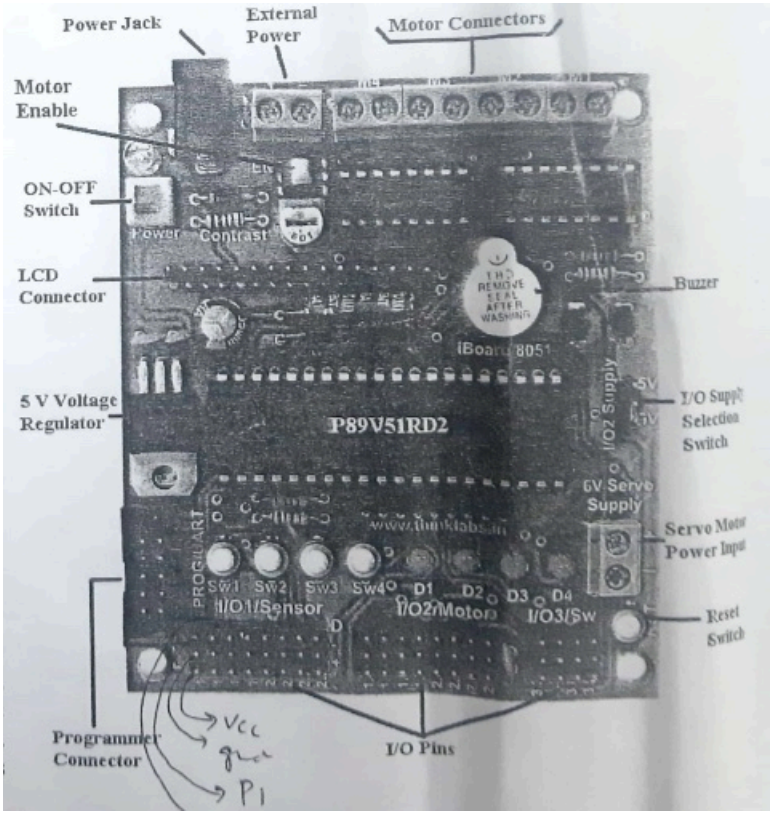
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : lcd.h for P89V51RX2
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
//
//  main.c
//  switch factorial
//
//  Created by YASH VINAYVANSHI on 11/04/22.
//
//  0! = 1
//     1! = 1
//  2! = 2
//     3! = 6
//     4! = 24
//     5! = 120
//  .
//  14! = 87178291200
//  15! = 1307674368000 (13 digits : display capacity in a line = 16 digits)
//
```

```
#include <lcd.h>
void main(){
    while(1){
        unsigned long fact=1;
        unsigned int num = 0;
                    unsigned int i = 0;
                char factorial[16];
        unsigned int index = 0;
        unsigned int length = 0;
                char number[3];
                    char temp;

        if(INT0 == 1) num+=8;
        if(INT1 == 1) num+=4;
        if(T0 == 1) num+=2;
        if(T1 == 1) num+=1;
        //if(num > 12) num=12;
        if(num > 0){
            for(i=1; i<=num; i++){
                fact*=i;
            }
        }

        //convert factorial value to string
        while(fact != 0){
            factorial[index] = (char)(fact%10+48);
            fact = fact / 10;
            length++;
            index++;
        }
        factorial[index] = '\0';
        //reverse string
        for(i=0; i<length/2; i++){
            char temp = factorial[i];
            factorial[i] = factorial[length-i-1];
            factorial[length-i-1] = temp;
        }

        index = 0;
        length = 0;
        //convert number value to string
        while(num != 0){
            number[index] = (char)(num%10+48);
            num = num / 10;
            length++;
            index++;
        }
        number[index] = '\0';
        //reverse string
        for(i=0; i<length/2; i++){
            temp = number[i];
            number[i] = number[length-i-1];
            number[length-i-1] = temp;
        }

        LCD_INIT();
```

```
        LCD_WRITE(number, 0, 0);
        LCD_WRITE(factorial, 1, 0);
        delay(100000); //abt 10sec delay if T = 1microsec
    }
}
```

Output

The system takes as input a number between 0 and 15 in binary through 4 switches and displays the factorial of input number on the LED screen.

EMBEDDED SYSTEMS LAB : CEN 691

SUBMITTED BY : **YASH VINAYVANSHI**
B.TECH COMPUTER ENGINEERING (6th SEMESTER)
ROLL NO. **19BCS081**
JAMIA MILLIA ISLAMIA FET, NEW DELHI

SUBMITTED TO : **DR. WASEEM AHMAD**
PROFESSOR
DEPARTMENT OF COMPUTER ENGINEERING
JAMIA MILLIA ISLAMIA FET, NEW DELHI

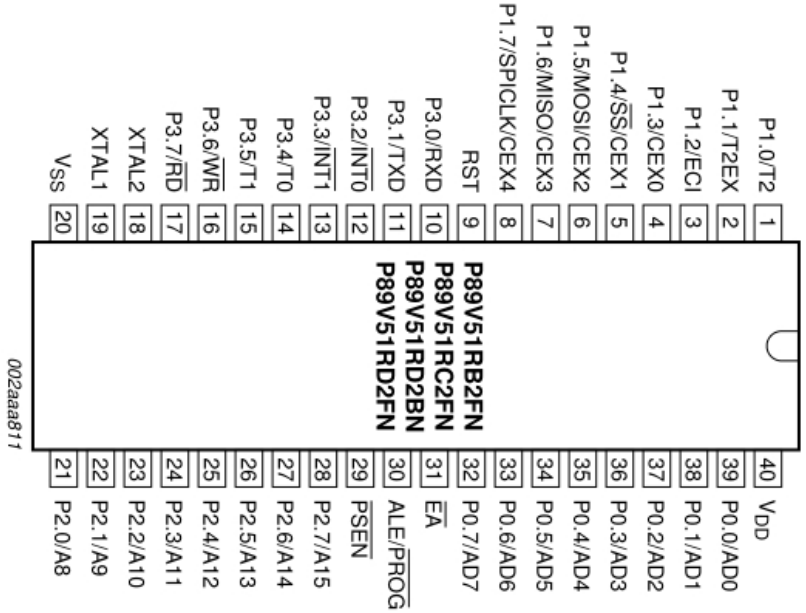
ES lab 9 : Design and implement an Embedded System that outputs factor of a number (input through switch) on LED with buzzer, in between every factor using 8051 Board.

Hardware

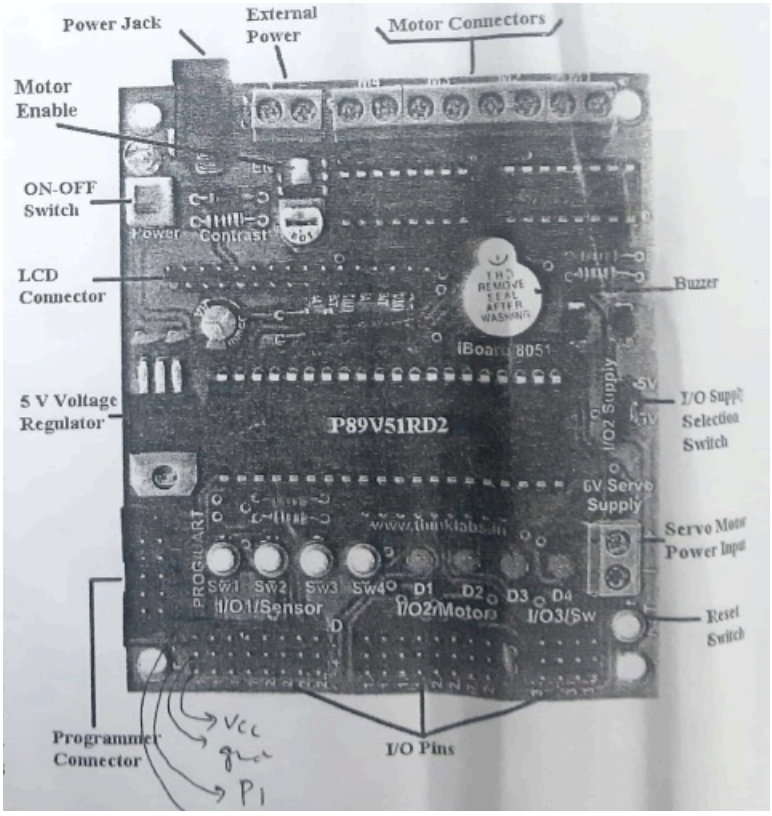
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : lcd.h for P89V51RX2
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
/*
This project is created by yash vinayvanshi 19BCS081 on 18/04/22.

This code is designed to be tested on keil microvision debugger


 onboard
 S1   S2   S3   S4   L1   L2   L3   L4
 3.2  3.3  3.4  3.5  3.0  3.1  3.2  3.3
 MSB            LSB  MSB            LSB

 debugging tool
 7    6    5    4    3    2    1    0
 3.7  3.6  3.5  3.4  3.3  3.2  3.1  3.0
 L4   L3   S4   S3   S2   S1   L2   L1

           S4   S3   S2   S1
           LSB            MSB
```

```
 D4   D3                        D2   D1
 LSB                                 MSB


pressed 4
      S1   S2   S3   S4
       X    1    0    0   =  4 (on board)
fact1 -> switches gets reversed & inverted on debugger
      S4   S3   S2   S1    (reverse)
       0    0    1    X
       1    1    0    X    (invert) = 4(on debugger)

pressed 12
      S1   S2   S3   S4       (on board)
       1    1    0    0
      p3.5 p3.4 p3.3 p3.1     (on debugger)
      S4   S3   S2   S1
       0    0    1    1 (reverse)
       1    1    0    0 (invert)



4bit ctr board              4 bit ctr on debugger
                          (reverse)           (invert)
D1  D2  D3  D4            D4  D3  D2  D1    D4  D3  D2  D1
0   0   0   0  (0)        0   0   0   0     1   1   1   1 (15)
0   0   0   1  (1)        1   0   0   0     0   1   1   1 (14)
0   0   1   0  (2)        0   1   0   0     1   0   1   1 (13)
0   0   1   1  (3)        1   1   0   0     0   0   1   1 (12)
0   1   0   0             0   0   1   0     1   1   0   1
0   1   0   1             1   0   1   0     0   1   0   1
0   1   1   0             0   1   1   0     1   0   0   1
0   1   1   1  (7)        1   1   1   0     0   0   0   1
.                         .                 .
.                         .                 .
.                         .                 .
1   1   0   0  (12)       0   0   1   1     1   1   0   0
1   1   1   1  (15)       1   1   1   1     0   0   0   0 (0)

example

input :  0 1 0 1      (12)

output : 0 1 1 1      (1)
         beep
         1 1 0 0      (12)
         beep
         beep
         1 0 1 1      (2)
         beep
         1 0 0 1      (6)
         beep
         beep
         0 0 1 1      (3)
         beep
```

```
         1 1 0 1      (4)
         beep
         beep
         0 1 0 0      (4)
         beep
         0 0 1 1      (3)
*/
/*
 sw1 : P3.2 INT0
 sw2 : P3.3 INT1
 sw3 : P3.4 T0
 sw4 : P3.5 T1
 D1  : P3.0 RxD
 D2  : P3.1 TxD
 D3  : P3.6 WR
 D4  : P3.7 RD
*/

#include<P89V51RD2.h>
sbit buzz = P0^3;
unsigned int dela = 1000;
void delay(unsigned int dela){
    unsigned int i,j;
    for(i=0;i<1000;i++) {
           for(j=0; j<dela; j++);
    }
}
void print_number(unsigned int n){
    unsigned int d = 15 - n;
    RD = d%2;
    d = d/2;
    WR = d%2;//Extracting bits from 4 bit bin no.
    d =d/2;
    TxD = d%2;
    d=d/2;
    RxD = d%2;
    delay(dela);
}
void main(void){
    while(1){
        unsigned int number=0, i=0;
        if(INT0 == 0) number+=8;
        if(INT1 == 0) number+=4;
        if(T0 == 0) number+=2;
        if(T1 == 0) number+=1;
        //find factors
        for(i=1; i<=number; i++){
            if(number%i == 0){
                //display factor 1
                print_number(i);
                //buzzer beeps
                buzz = 0; delay(dela); buzz = 1;
                //dipslay factor 1's pair
                print_number(number/i);
            }
            //one pair shown : buzzer beep beep
```

```
            buzz = 0; delay(dela); buzz = 1;
            buzz = 0; delay(dela); buzz = 1;
        }
    }
}
```

Output

The system takes as input a number between 0 and 15 through switches on board and shows its factor pairs in binary on LEDs on board with one beep between numbers and two beeps between pairs.

EMBEDDED SYSTEMS LAB : CEN 691

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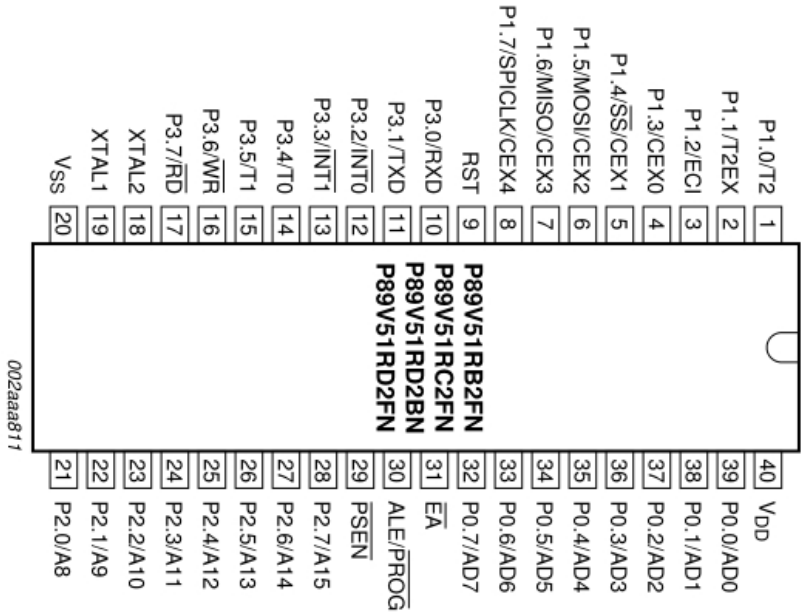
ES lab 10 : Design and implement an Embedded System that toggle only pin P 1.5 continuously every 250ms using 8051 board. Take crystal frequency=11.0592 MHz.
1. Using timer 0, mode 1
2. Using timer 1, mode 2

Hardware

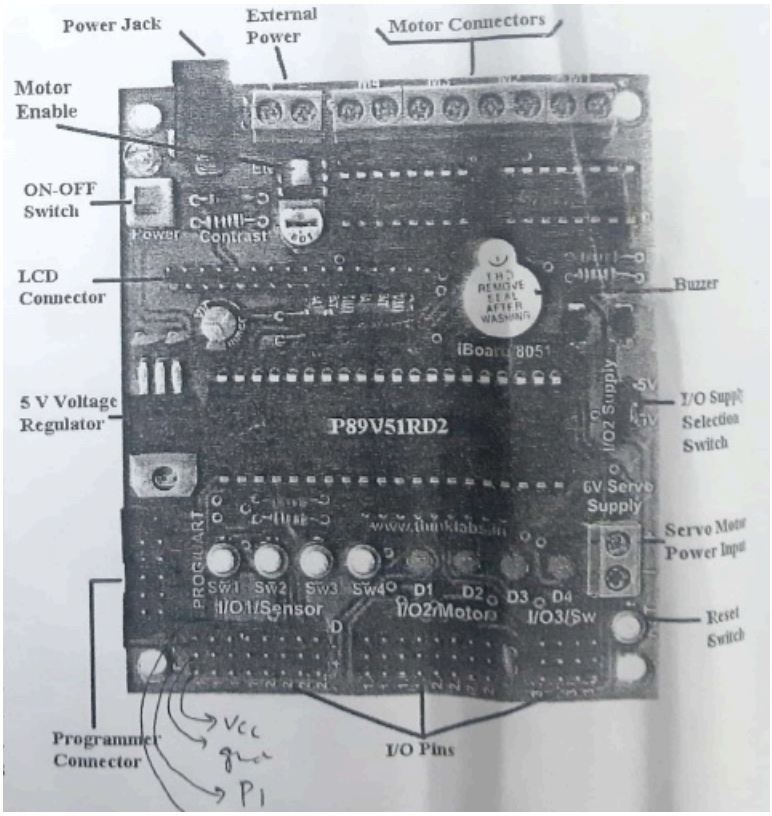
Microprocessor used : NXP (founded by Philips) P89V51RD2
Microprocessor specifications :
40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/ Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA.

Development board used : Thinklabs iboard 8051
Development board specifications :
Includes Philips 89V51RD2 Microcontroller with 64kB flash memory working at 11.0592MHz. 40 pin IC base for compatible PDIP microcontroller packages. Wide operating voltages 7V-15V. Power indicator LED. Buzzer. On board 2 Dual full H bridge motor driver with 600mA per channel for 2 Stepper or 4 DC/DC Geared motors. Separate ON/OFF switch for power and motor enable. 4 LEDs for status or debugging purposes. 4 Pushbutton switches for external inputs/interrupts. On board LCD connector. On board supply terminals for 6V Servo Motors. On board regulated power supply.

Microprocessor PIN diagram



Development board diagram



Motor Connectors	PORTS
M4	P2.6, P2.7
M3	P2.4, P2.5
M2	P1.6, P1.7
M1	P1.4, P1.5
Switches	**(active low)**
Sw1	P3.2
Sw2	P3.3
Sw3	P3.4
Sw4	P3.5
LEDs	**(active low)**
D1	P3.0
D2	P3.1
D3	P3.6
D4	P3.7
LCD	
Data	P0.4 to P0.7
Control pins	P0.0 to P0.2
ISP	
RXD	P3.0
TXD	P3.1
Sensor Connectors	
P1.0 to P1.7	
P2.0 to P2.7	
P3.2 to P3.5	
Misc	
Buzzer	P0.3
Crystal (11.0592Mhz)	Pin 18 and 19
Reset Switch	Pin 9

Active low

Header file : P89V51RD2.h for P89V51RD2
IDE used : ARM keil microvision
for burning : Flash Magic

C program

```
/*
This project is created by yash vinayvanshi 19BCS081 on 18/04/22.
 */

/*
 TMOD
                          GATE C/T M0  M1 GATE C/T M1  M0
 T0M1(16 bit)              0    0   0   0   0   0   0   1
 T1M2(8bit auto reload)    0    0   1   0   0   0   0   0
 */

#include<P89V51RD2.h>
sbit Tpin = P1^5;
void T0M1Delay(void);
void T1M2Delay(void);
void main(void){
    unsigned char i, j, k;

    //run this loop for 5 sec : 20*250ms = 5 sec
    for(k=0; k<20; k++){
        Tpin = !Tpin;
```

```
        for(i=0; i<5; i++){
            T0M1Delay();
         }
    }

    CEX3 = !CEX3;

    //run this loop for 5 sec : 20*250ms = 5 sec
              for(k=0; k<20; k++){
        Tpin = !Tpin;
        for(i=0; i<10; i++){
            for(j=0; j<100; j++){
                T1M2Delay();
            }
        }
    }

              while(1);
}
void T0M1Delay(void){
    /*
     Max Delay generated = 65536 * 1.085us = 71106.56us
     To generate 250ms, loop = 250ms/71.1065us ~3.5
     round off non negligible
     Generate delay in chunks 50us
     for 50ms : 50ms/1.085us-1 = 46082 = 4BFDH
     FFFFH - 4BFDH = B402H
     */
    TMOD = 0x01;
    TL0 = 0x02;
    TH0 = 0xB4;
    TR0 = 1; //start timer
    while(TF0==0);
    TR0 = 0;
    TF0 = 0;

}
void T1M2Delay(void){
    /*
                Generate delay in chunks of 250us
     Delay generated = 250/1.085us = 230;
     to generate 250 ms, loop = 250ms/250us ~ 1000times
     Assuming 8 bit registers, they can hold value upto 256
       `  DELAY for instructions and for loop not taken into
consideration
     */
    TMOD = 0x20; //00100000B = 32D = 20H
    TH1 = 0x1A; //256 - 230 = 26D = 1AH
    TR1 = 1; //start timer
    while(TF1==0); //run timer until overflow
    TR1 = 0; //reinit timer
    TF1 = 0;
}
```

Output

Pin P1.5 toggles at every 250ms for 5 seconds using timer 0 mode 1 and then again toggles at every 250 ms for 5 seconds using timer 1 mode 2. Pin1.6 is high when timer 0 is employed for toggling and low when timer 1 is employed for toggling.