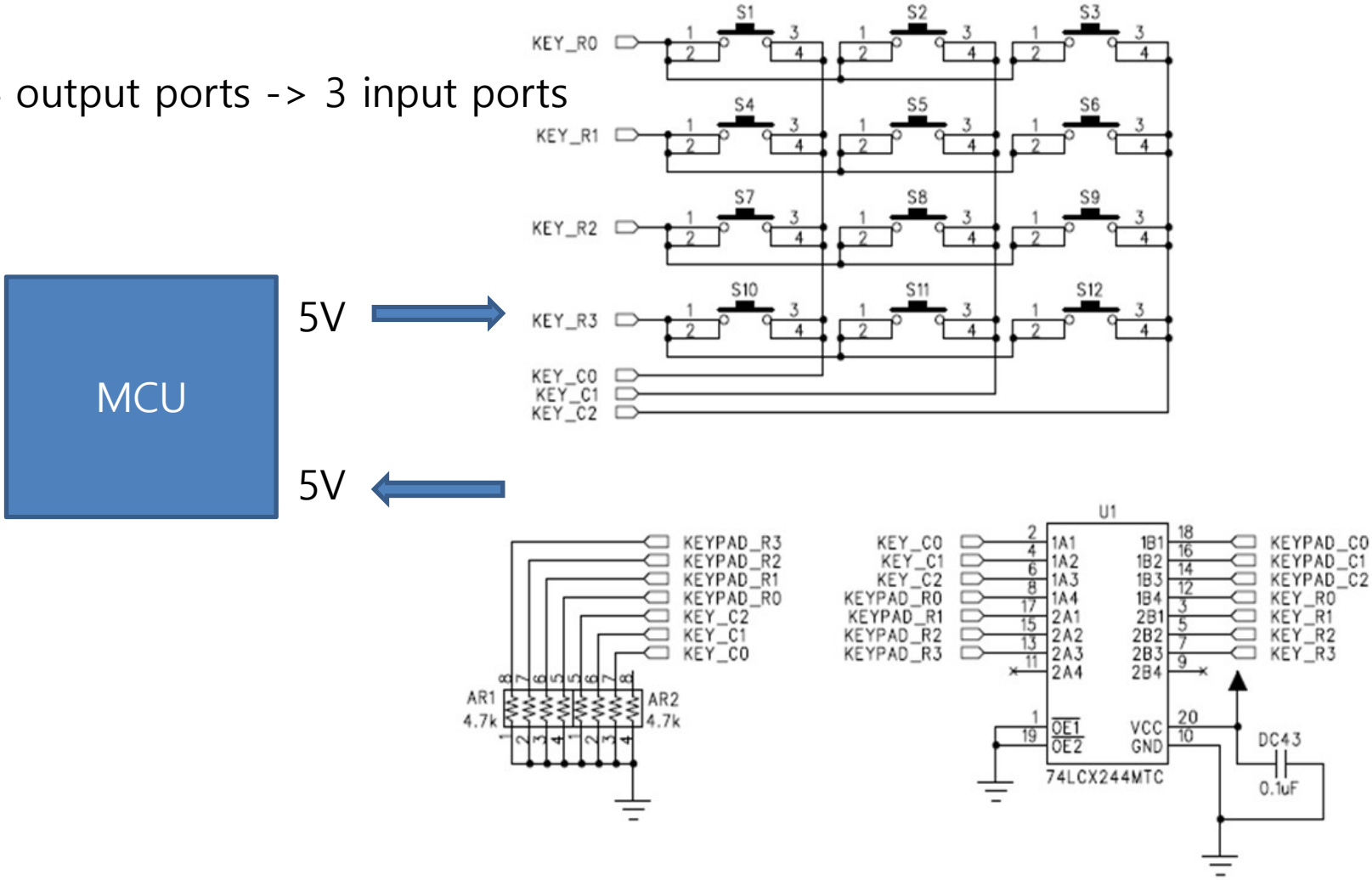
Microprocessor

6th Week: Port Input Part 2

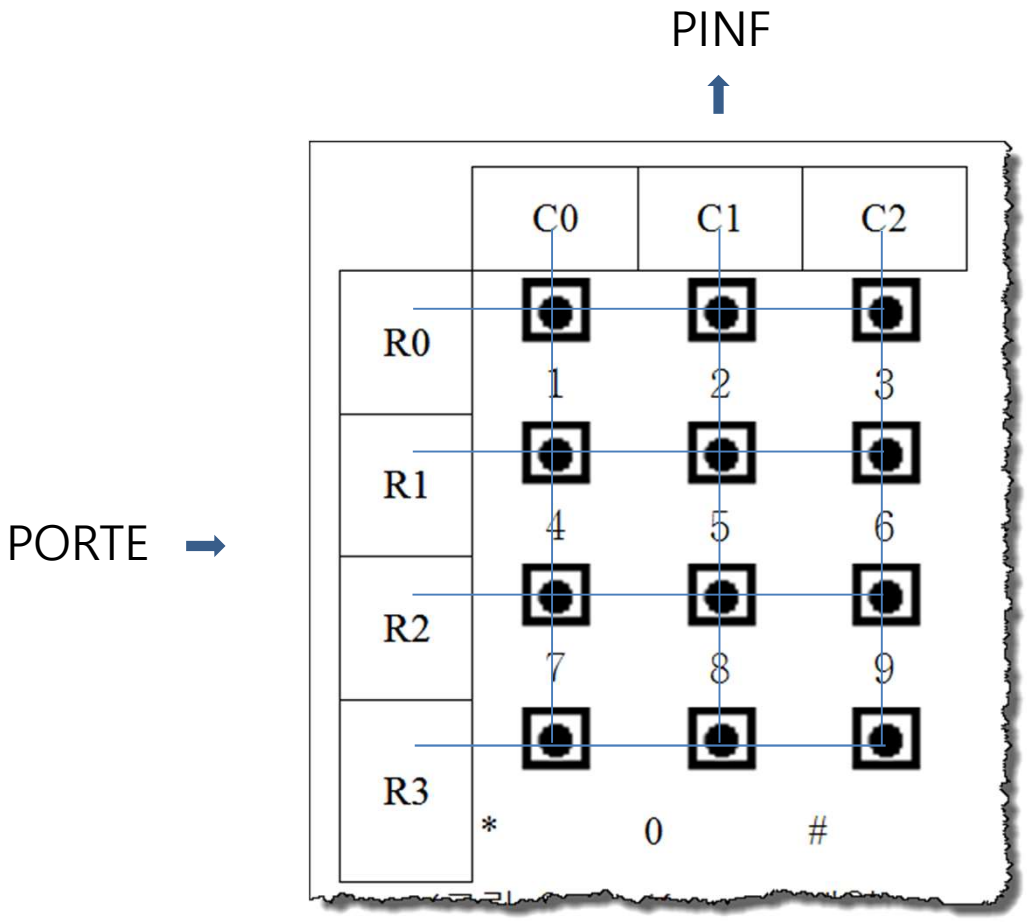
Computer Architecture and System SW Lab.
HANYANG UNIVERSITY

3x4KeyPad

◆ 4 output ports -> 3 input ports



3x4KeyPad.diagram



3x4KeyPad.wire

PORTE → KeyPad R3:R0								
MCU	PE7	PE6	PE5	PE4	X	x	x	x
KEY	R3	R2	R1	R0	X	x	x	x

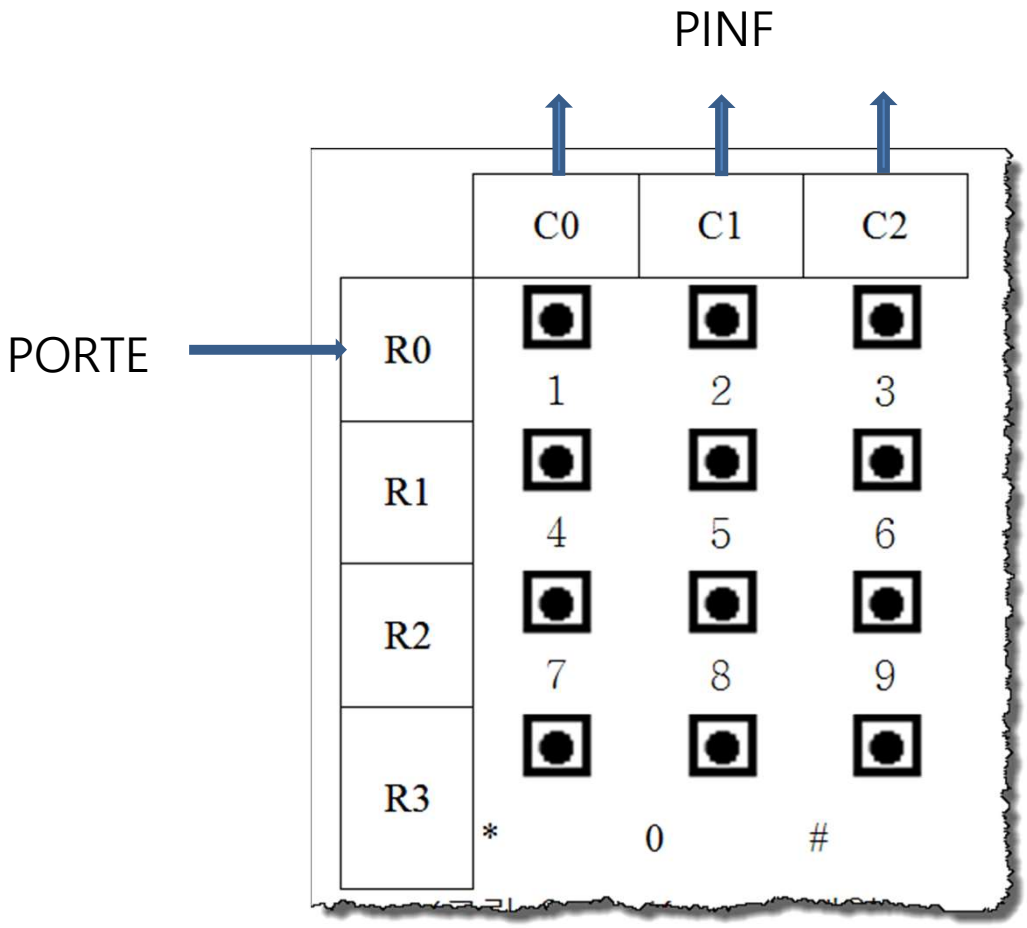
PINF ← KeyPad C2:C0								
MCU	x	x	x	x	x	PF2	PF1	PF0
KEY	x	x	x	x	x	C2	C1	C0

PORTA → LED								
MCU	PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0
LED	LED7	LED6	LED5	LED4	LED3	LED2	LED1	LED0

3x4KeyPad.1.1

```
#include <avr/io.h>

int main()
{
    DDRF = 0x00;
    DDRE = 0xFF;
    DDRA = 0xFF;

    PORTE = 0x10;

    while(1)
    {
        PORTA=PINF & 0x07;
    }
}
```

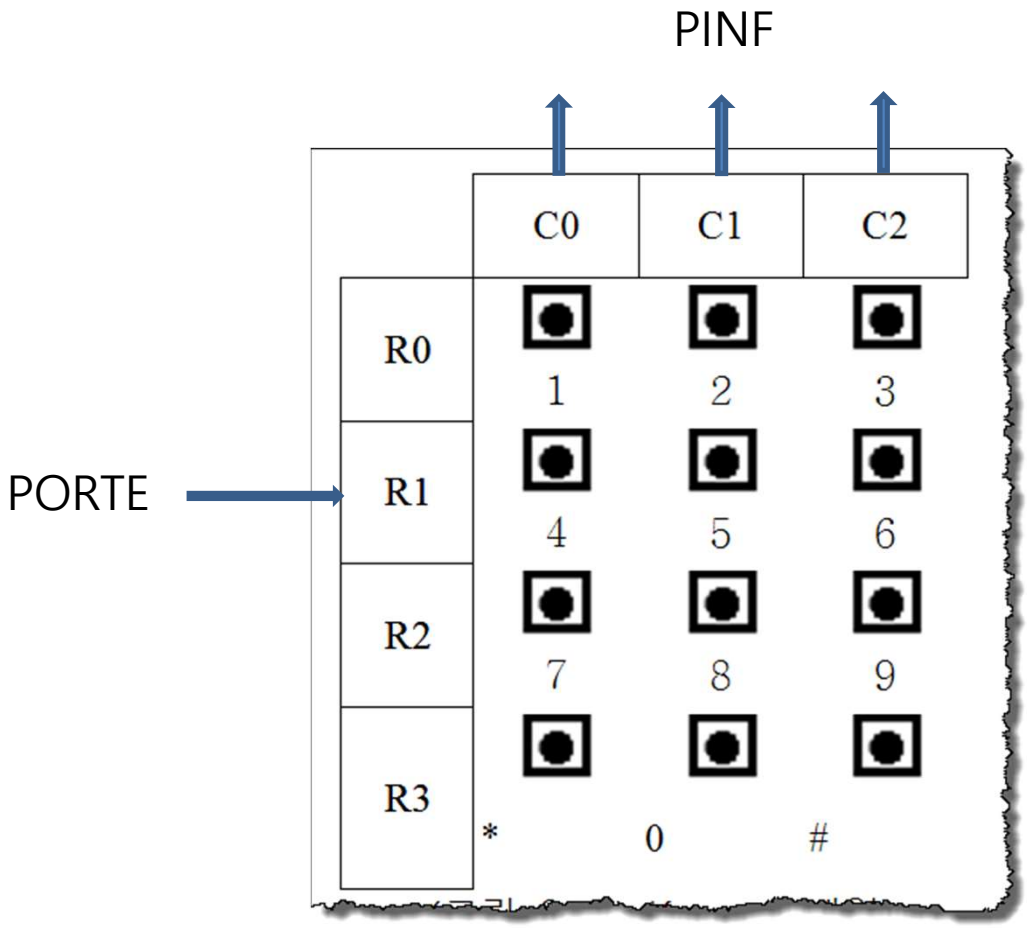
3x4KeyPad.1.2



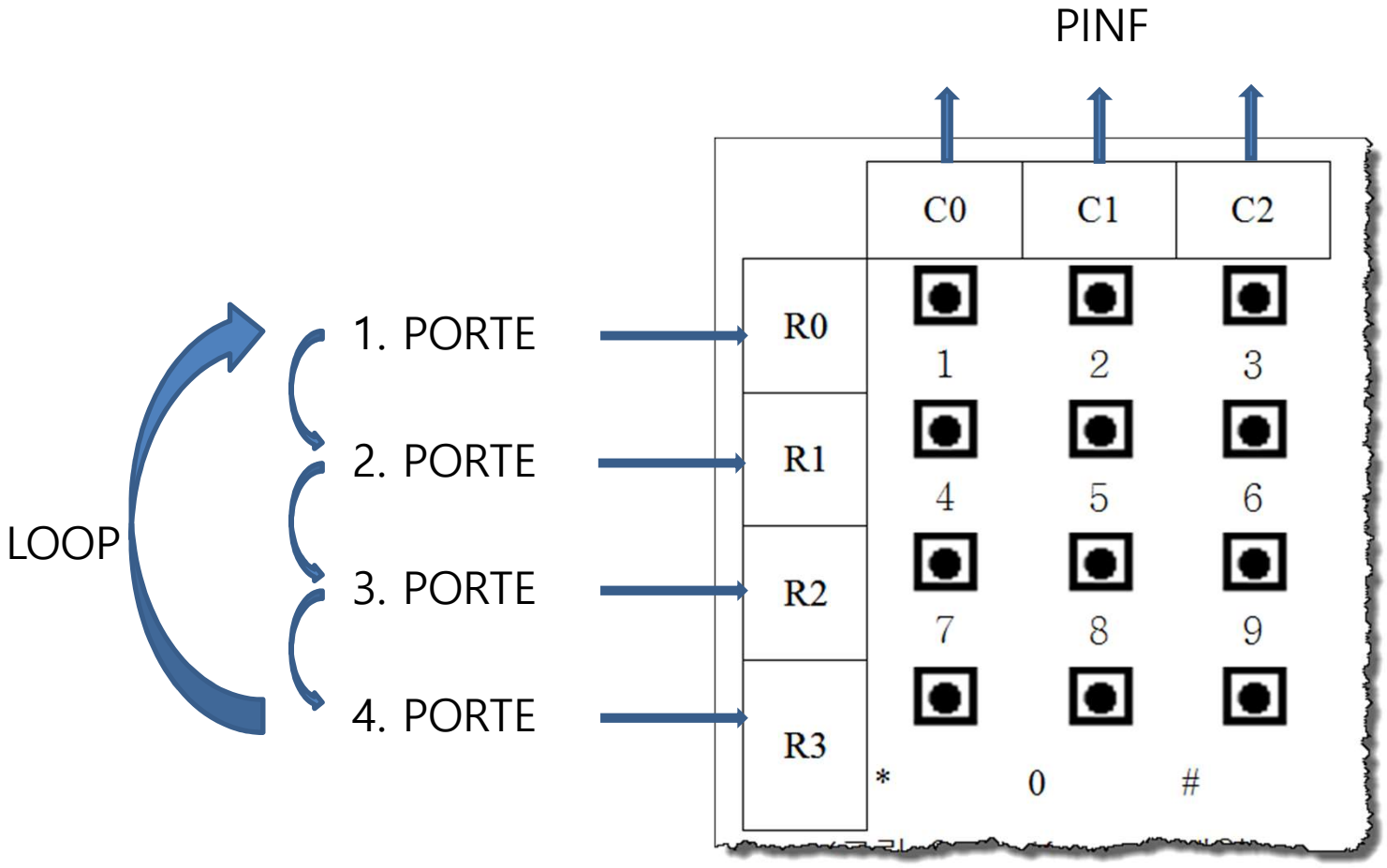
3x4KeyPad.2.1

```
#include <avr/io.h>

int main()
{
    DDRF = 0x00;
    DDRE = 0xFF;
    DDRA = 0xFF;

    PORTE = 0x20;

    while(1)
    {
        PORTA = PINF & 0x07;
    }
}
```

3x4KeyPad.2.2



3x4KeyPad.3.1



3x4KeyPad.3.2

```
#include <avr/io.h>

void delay(unsigned long x)
{
    while(x--);
}

int main(void)
{
    unsigned char led = 0;
    unsigned char input_data = 0;
    unsigned char key = 0;

    DDRF = 0x00;
    DDRE = 0xFF;
    DDRA = 0xFF;
```

3x4KeyPad.3.3

```
while(1)
{
    key = 0;

    PORTE = 0x10;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+1;

    PORTE = 0x20;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+4;

    PORTE = 0x40;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+7;

    PORTE = 0x80;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+10;

    led = 0x01;

    if(key == 0)
        led = 0x00;

    else if(key < 9)
        led = led << (key-1);

    else if(key == 9)
        led = 0x81;

    else if(key == 10)
        led = 0x0F;

    else if(key == 11)
        led = 0xFF;

    else if(key == 12)
        led = 0xF0;

    PORTA = led;
  }
}
```

3x4KeyPad.3.3

```
while(1)
{
    key = 0;

    PORTE = 0x10;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+1;

    PORTE = 0x20;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+4;

    PORTE = 0x40;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+7;

    PORTE = 0x80;
    delay(1);
    input_data = PINF & 0x07;

    if(input_data != 0)
        key = (input_data/2)+10;

    led = 0x01;

    if(key == 0)
        led = 0x00;

    else if(key < 9)
        led = led << (key-1);

    else if(key == 9)
        led = 0x81;

    else if(key == 10)
        led = 0x0F;

    else if(key == 11)
        led = 0xFF;

    else if(key == 12)
        led = 0xF0;

    PORTA = led;
  }
}
```

3x4KeyPad.4.1

Optimized

```
#include <avr/io.h>
#define KEY_CTRL PORTE
#define R0 0x10

void delay(unsigned long x)
{
    while(x--);
}

unsigned char key_scan(void)
{
    unsigned char scan = 0;
    unsigned char key_control = 0;
    unsigned char input_data = 0;
    unsigned char key = 0;

    key_control = R0;

    for(scan=0;scan<4;scan++)
    {
        KEY_CTRL &= 0x0F;
        KEY_CTRL |= key_control;
        delay(1);
        input_data = PINF & 0x07;

        if(input_data != 0)
            key = (input_data>>1) + 1 + scan * 3;

        key_control <<= 1;
    }

    return key;
}
```

3x4KeyPad.4.1

Optimized

```
#include <avr/io.h>
#define KEY_CTRL PORTE
#define R0 0x10

void delay(unsigned long x)
{
    while(x--);
}

unsigned char key_scan(void)
{
    unsigned char scan = 0;
    unsigned char key_control = 0;
    unsigned char input_data = 0;
    unsigned char key = 0;

    key_control = R0;

    for(scan=0;scan<4;scan++)
    {
        KEY_CTRL &= 0x0F;
        KEY_CTRL |= key_control;
        delay(1);
        input_data = PINF & 0x07;

        if(input_data != 0)
            key = (input_data>>1) + 1 + scan * 3;

        key_control <<= 1;
    }

    return key;
}
```

3x4KeyPad.4.2

```c
int main(void)
{
    unsigned char led = 0;
    unsigned char key = 0;
    DDRF = 0x00;
    DDRE = 0xFF;
    DDRA = 0xFF;

    while(1)
    {
        key = key_scan();

        led = 0x01;

        if(key == 0)
            led = 0x00;

        else if(key < 9)
            led = led << (key-1);

        else if(key == 9)
            led = 0x81;

        else if(key == 10)
            led = 0x0F;

        else if(key == 11)
            led = 0xFF;

        else if(key == 12)
            led = 0xF0;

        PORTA = led;
    }
}
```

Homework 5

- Write any program that utilizes LED, one or more types of FND, one or more types of input(keypad should be included), to do a certain function.
- Due date : 2020.10.17 23:59
- Upload on your GitLab project, only the C file (only the code)
- File name : mp_week6_studentNumber.c

Homework 5 (Sample)

```
#include <avr/io.h>
#define KEY_CTRL PORTE
#define R0 0x10

void delay(unsigned long x)
{
    while(x--);
}

unsigned char key_scan(void)
{
    unsigned char scan = 0;
    unsigned char key_control = 0;
    unsigned char input_data = 0;
    unsigned char key = 0;

    key_control = R0;

    for(scan=0;scan<4;scan++)
    {
        KEY_CTRL &= 0x0F;
        KEY_CTRL |= key_control;
        delay(1);
        input_data = PINF & 0x07;

        if(                )


    }

    return key;
}
```

```
int main(void)
{
    unsigned char led = 0;
    unsigned char key = 0;
    DDRF = 0x00;
    DDRE = 0xFF;
    DDRA = 0xFF;

    while(1)
    {
        key = key_scan();

        led = 0x01;

        if(key == 0)
            led = 0x00;

        else if(key < 9)
            led = led << (key-1);

        else if(key == 9)
            led = 0x81;

        else if(key == 10)
            led = 0x0F;

        else if(key == 11)
            led = 0xFF;

        else if(key == 12)
            led = 0xF0;

        PORTA = led;
    }
}
```