

# **DESIGN ASSIGNMENT**

## **STERILIZATION UNIT USING 8086 MICROPROCESSOR (P4)**

An assignment submitted in partial fulfillment of the  
course requirements for

### **MICROPROCESSOR PROGRAMMING AND INTERFACING**

**MADE BY**

**GROUP NO. 43**

SPARSH WAIRYA

2017A3PS0115P

VINAY U PAI

2017A3PS0131P

PARVATHY UNNIKRISHNAN

2017A3PS0149P

PRADHIT ONGOLE

2017A3PS0188P



**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI  
PILANI CAMPUS  
(APRIL 2019)**

## PROBLEM STATEMENT

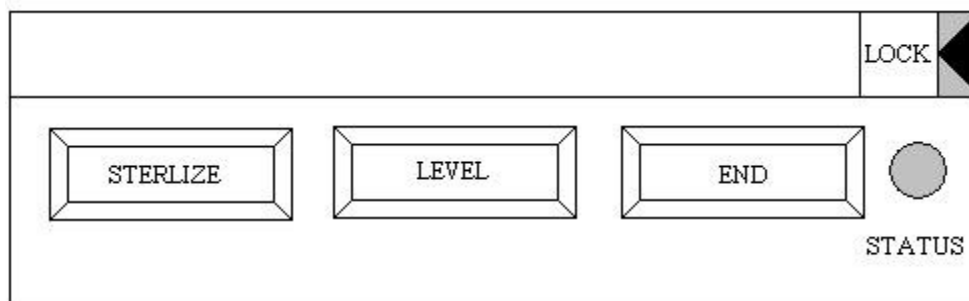
### P4 System to be designed: STERILIZATION UNIT

Description: This unit performs sterilization by increasing temperature to maximum value ( $x^{\circ}\text{C}$ ). The temperature has to be maintained at the maximum value for 2 minutes before it is brought gradually to a nominal temperature value ( $y^{\circ}\text{C}$ ). The time taken for bringing down the temperature can be varied between four different values as decided by the user. A slider is used to decide this value

Level 1: 2 minutes  
Level 2: 4 minutes  
Level 3: 6 minutes  
Level 4: 8 minutes

While the sterilization process is taking place the door to the unit must remain locked. The Door can be opened only when user presses End.

User Interface: Status LED glows as long as the sterilization process is being done. Once  $30^{\circ}\text{C}$  has been reached then LED goes off and the door mechanism unlocks. Once the door is closed again the temperature has to be brought back to  $30^{\circ}\text{C}$ .



## **ASSUMPTIONS**

The maximum value of temperature is  $80^{\circ}\text{C}$  and minimum temperature required is  $30^{\circ}\text{C}$ .

The opening of the door is controlled by a door motor. The door opens when the user presses the END button. But the closing of the door has to be done manually by the user.

IR (toggle switch) is 0 implies door is closed and 1 implies door is open. The toggling is done manually.

LEV1: Fan motor cools the sterilization unit from  $80^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  in 2 mins at 50% duty cycle

LEV2: Fan motor cools the sterilization unit from  $80^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  in 4 mins at 33% duty cycle

LEV3: Fan motor cools the sterilization unit from  $80^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  in 6 mins at 20% duty cycle

LEV4: Fan motor cools the sterilization unit from  $80^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  in 8 mins at 10% duty cycle

The turning on of FAN motor leads to decrease in temperature. After this the temperature reduces on its own until it reaches to  $30^{\circ}\text{C}$ .

(For eg: If the user chooses LEV1, the motor will run for 2 mins at 50% duty cycle. After that self-cooling occurs until heater reads the temperature  $30^{\circ}\text{C}$ .)

## **COMPONENETS USED**

1. 8086(1) - Microprocessor
2. 8255(1) - Programmable Peripheral Interface
3. 8253(1) - Programmable Interval Timer
4. 2732(2) - 4K ROM
5. 6116(2) - 2K SRAM
6. ADC0808 (1) - Analog to Digital Converter
7. 74LS373 (3) – Latch
8. 74LS245 (2) - Bidirectional Buffer
9. 74LS138 (1) - Decoder (3 : 8)
10. 2- Simple DC motors
11. L293D (1) – Motor Driver
12. 1 - Heater
13. 1 – Tri-state buffer
14. 1 – Toggle Switch
15. 6 – Button Switches
16. 3 - LEDs
17. 6 – OR Gates
18. 4 – NOT Gates

## **LED STATUS VALUES AND MEANINGS**

1. 'TIMER' LED – Used to count the time when the temperature reaches 80 deg. C. Along with this, the user chosen time is also displayed here.
  - a. 1 = Counting
  - b. 0 = Not Counting
2. 'STATUS' LED –
  - a. 1 = Sterilization process going on
  - b. 0 = Sterilization process stopped
3. 'DOOR' LED –
  - a. 1 = Door is locked
  - b. 0 = Door is unlocked

## **INPUT/OUTPUT PORT MATCHING**

1. Port A: 00h
2. Port B: 02h
3. Port C: 04h
4. Control Register: 06h
5. Counter 0: 08h
6. Counter 1: 0Ah
7. Counter 2: 0Ch
8. Counter Control Register: 0Eh

## **MEMORY MATCHING**

1. ROM 1E => 00000H -01FFEh (4K)
2. ROM 1O => 00001H-01FFFh (4K)
3. RAM 1E => 02000H – 02FFEh (2K)
4. RAM 2O => 02001H – 02FFFh (2K)

## **DESIGN**

### **SPECIFICATIONS**

#### ***Simple DC Motor:***

Nominal Voltage: 12 V

Coil

Resistance: 12

Coil Inductance: 100Mh

Zero load RPM: 2200

Max Torque%: 1

Effective mass: 0.0000001

#### ***Heater:***

Ambient temperature: 25

Thermal Resistance to Ambient: 0.05

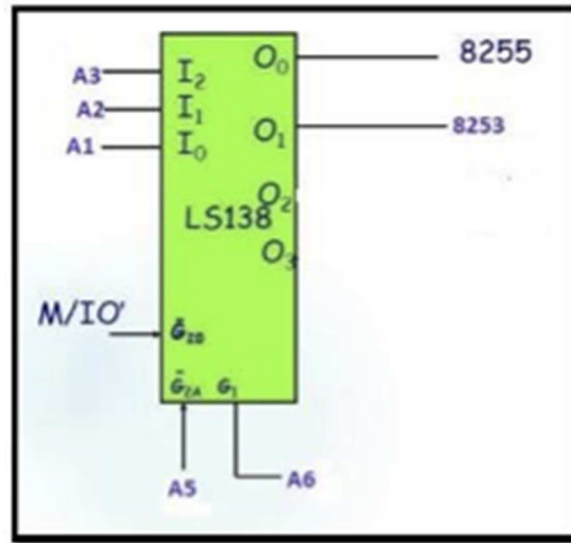
Oven Time Constant: 6

Heater Time Constant: 0.0001

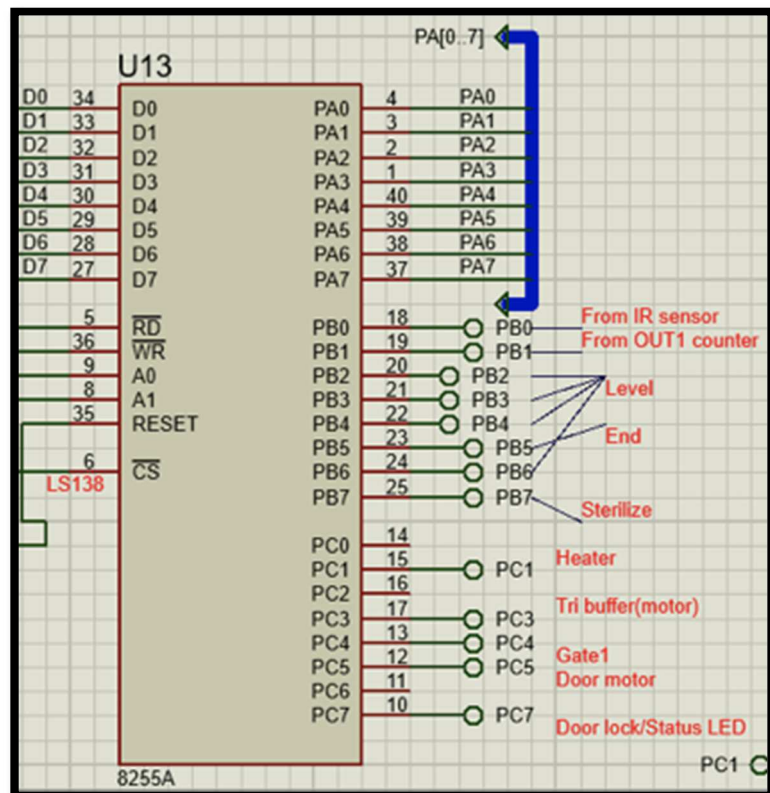
Temperature coefficient: 1

Heating power: 2.3 Kw

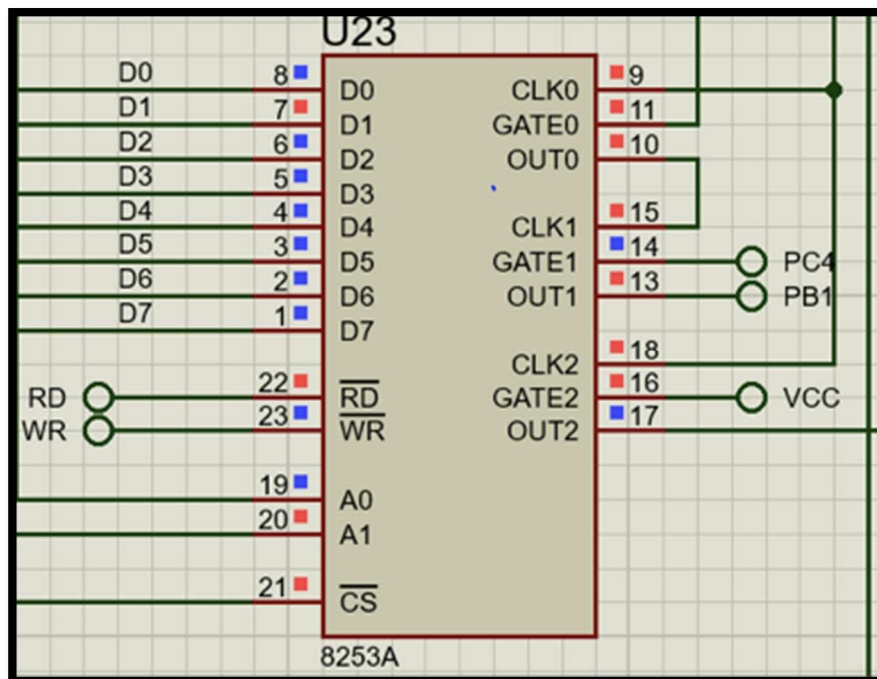
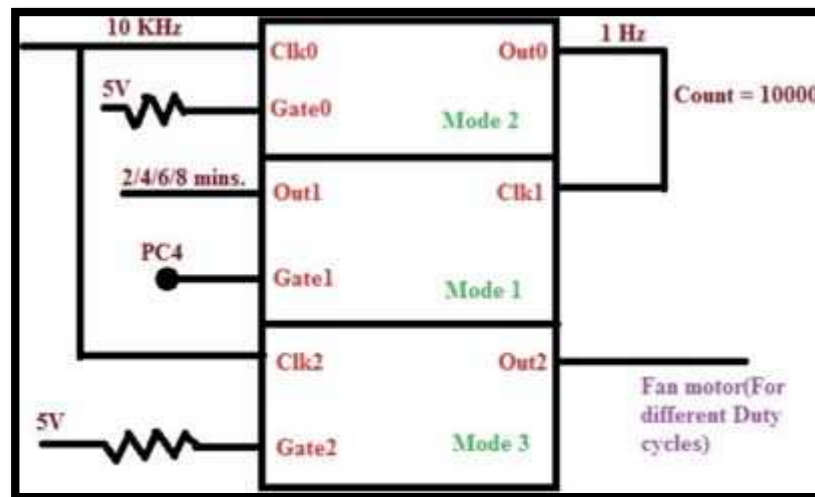
## 74LS138(Decoder):



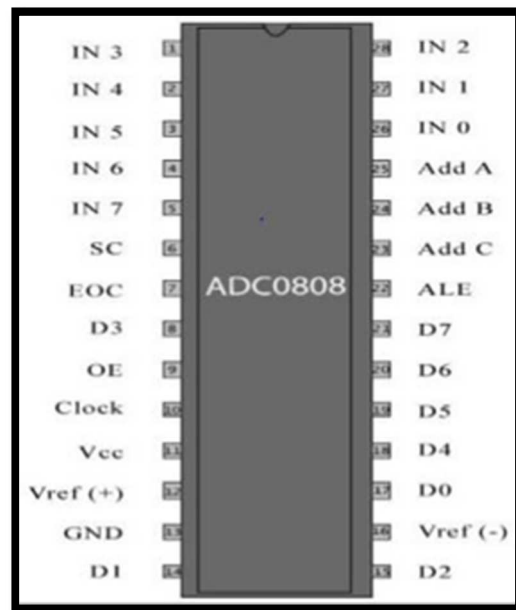
## 8255:



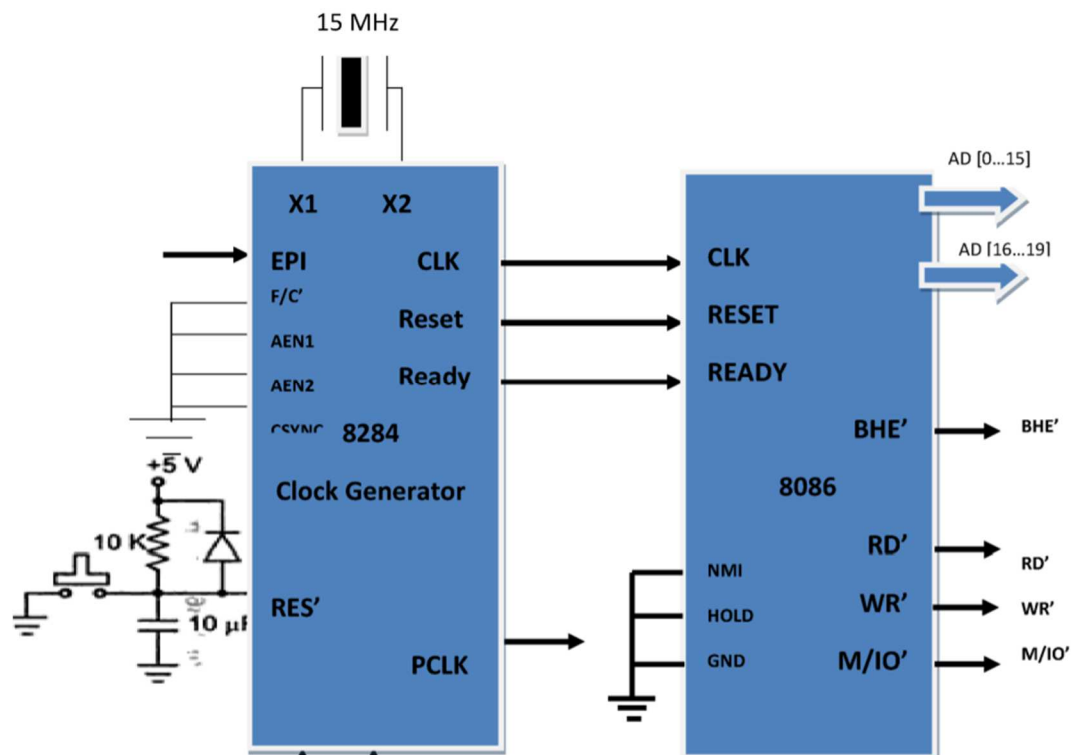
## 8253(Counter):



### *ADC 0808(AC to DC Converter):*

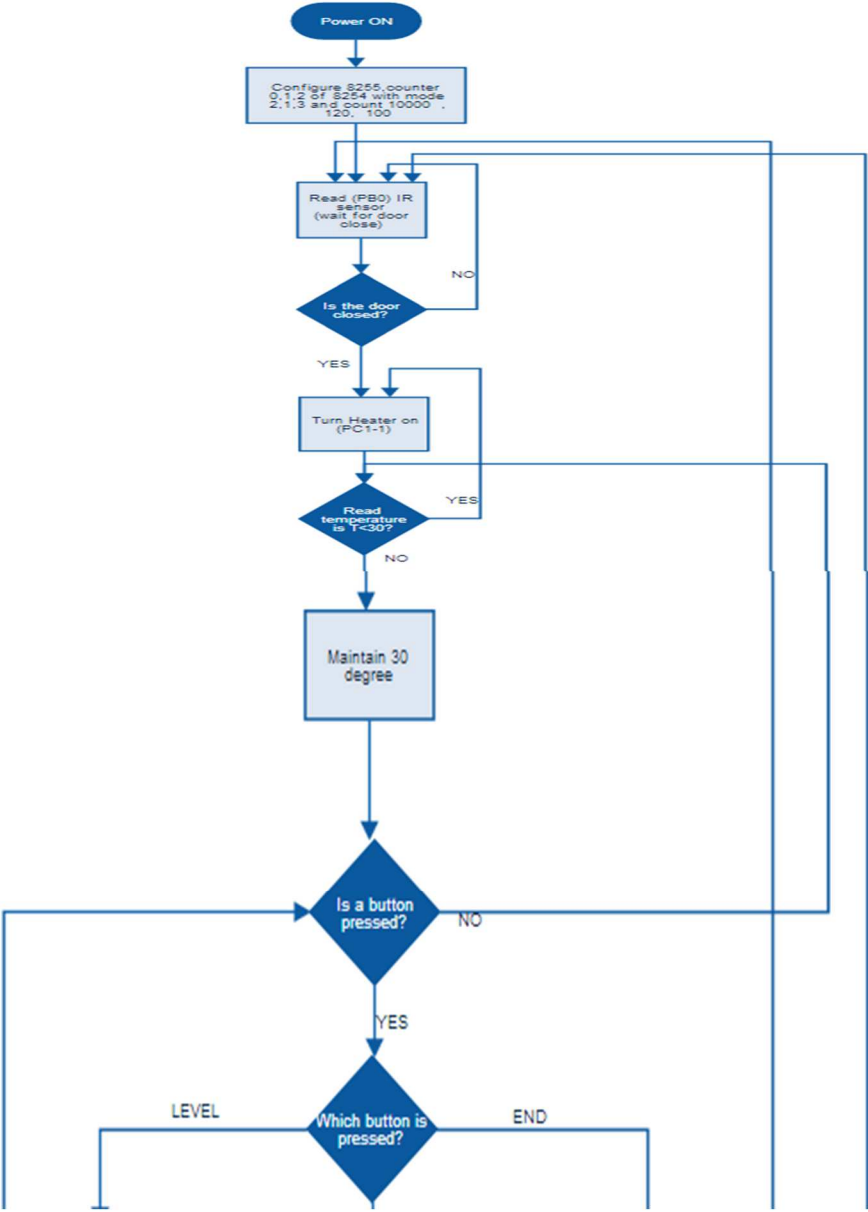


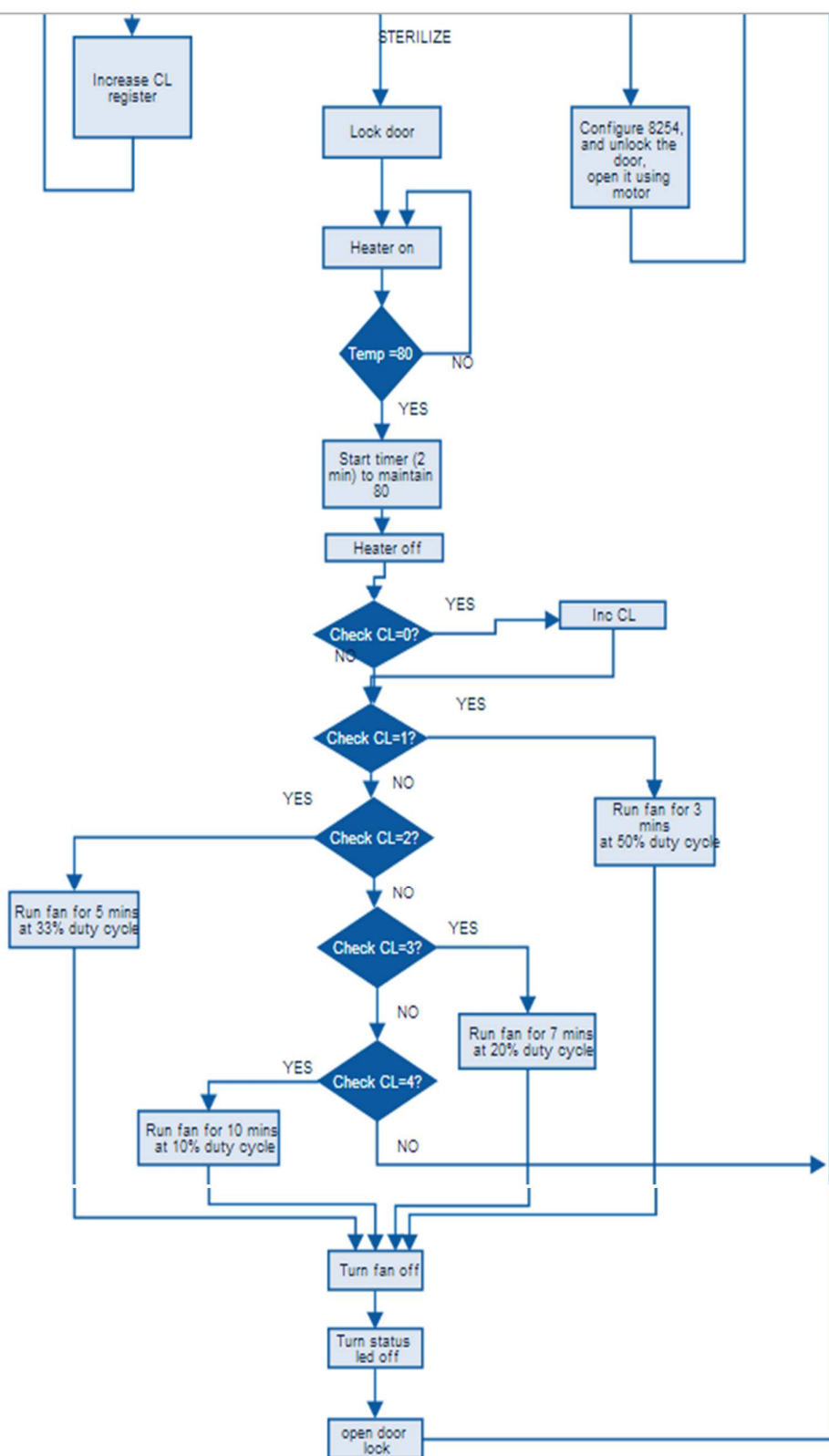
### *CLOCK GENERATOR*





# FLOW CHART





## ASM CODE

#make\_bin#

#LOAD\_SEGMENT=FFFFh#

#LOAD\_OFFSET=0000h#

#CS=0100h#

#IP=03feh#

#DS=0100h#

#ES=0100h#

#SS=0100h#

#SP=9FFFh#

#AX=0000h#

#BX=0000h#

#CX=0000h#

#DX=0000h#

#SI=0000h#

#DI=0000h#

#BP=0000h#

```
    jmp  st1
    db   509 dup(0)
```

;IVT entry for 80H

```
    dw   0000
    db   508 dup(0)
;main program
; initialize ds, es,ss to start of RAM
st1: cli
```

```
mov ax,0200h
mov ds,ax
mov es,ax
mov ss,ax
mov sp,0FFFEH
```

```
MOV AL,92H
OUT 06H,AL          ;config 8255
MOV AL,00110100B    ;config 8254 (Counter 0, Mode 2)
OUT 0Eh,AL
MOV AL,64H          ;08H – 2710h(10,000)
OUT 08H,AL
MOV AL,00H          ;08H – 2710h(10,000)
OUT 08H,AL

MOV AL,01110010B    ;config 8254 (Counter 1, Mode 1)
OUT 0Eh,AL
MOV AL,0Ch          ;0Ah – 78h(120)
OUT 0Ah,AL
MOV AL,00H          ;0Ah – 78h(120)
OUT 0Ah,AL
MOV AL,10110110B    ;config 8254 (Counter 2, Mode 3)
OUT 0Eh,AL
MOV AL,64H          ;0Ch( To be given to SOC) – 064h(100)
OUT 0Ch,AL
MOV AL,00H
OUT 0Ch,AL
```

```
IR1:
IN AL,02h           ; (PB 0 – IR Sensor)
AND AL,01H
JNZ IR1
```

```
MOV CL,0
```

```
MOV AL,00000000B ;( PC4- GATE1 =0)
OUT 04H,AL
MOV AL,00000000B ;( PC1- heater =0)
OUT 04H,AL
```

```
START:
IN AL, 00h
CMP AL,38 ; Maintaining Temperature= 30 degrees
JGE X1
MOV AL,00000010b ;Heater(PC 1) on
OUT 04H,AL
JMP START
```

```
X1:
MOV AL,00000000b ;Heater(PC 1) off
OUT 04H,AL
```

```
GETLEVEL:
IN AL,02H
MOV AH,AL
AND AH,01000000B
JNZ LVL3
MOV CL,04H
JMP END10
LVL3:
MOV AH,AL
AND AH,00010000B
JNZ LVL2
MOV CL,03H
JMP END10
LVL2:
MOV AH,AL
AND AH,00001000B
```

```
JNZ LVL1
MOV CL,02H
JMP END10
LVL1:
MOV AH,AL
AND AH,00001000B
MOV CL,01H
END10:
```

```
IN AL,02h
MOV AH,AL
AND AH,80H
;CMP AH,80H           ;80h = sterlize
JZ STER
MOV AH,AL
AND AH,20H
;CMP AH,20H           ;20H=END
JZ END1
JMP START
```

```
END1:           ;end pressed
```

```
CALL DELAY_20MS ;de-bounce
```

```
IN AL,02h
AND AL,20H
;CMP AL,20H
JNZ START
```

```
MOV AL,10110110B ;config 8254 (Counter 2, Mode 3) "reinitialize for adc "
OUT 0Eh,AL
MOV AL,64H        ;0Ch( To be given to SOC) – 064h(100)
OUT 0Ch,AL
MOV AL,00H
```

```

OUT 0Ch,AL
MOV AL,01110010B ;COUNTER 1 MODE 1
OUT 0Eh,AL
MOV AL,03H ; COUNT =3 (3 sec)
OUT 0Ah,AL
MOV AL,00H
OUT 0Ah,AL

MOV AL,00010000B ; PULSE TO GATE 1 (PC4)
OUT 04H,AL
NOP;??
NOP
MOV AL,00000000B ;PULSE
OUT 04H,AL

DOOR:
MOV AL,00100000B
OUT 04H,AL ;Switching motor on( PC 5)
IN AL,02h ;OUT 1 (PB1)
AND AL,02H
JZ DOOR

MOV AL,00000000B ;Switching motor off( PC 5)
OUT 04H,AL

JMP IR1

STER: ;sterilize pressed

CALL DELAY_20MS ;de-bounce
IN AL,02h
AND AL,80H
;CMP AL,80H
JNZ START
MOV AL,10000000b ;lock door( PC 7)/ STATUS ON

```

OUT 04H,AL

X5:

MOV AL,10000010b ; HEATER (PC 1)-ON

OUT 04H,AL

WAIT1: IN AL, 00h

CMP AL,102 ; Waiting for 80 degree Celsius ???

JLE WAIT1

MOV AL,10010010B ; PULSE TO GATE 1 (PC4)

OUT 04H,AL

NOP

NOP

MOV AL,10000010B ;PULSE

OUT 04H,AL

TEMP100:

IN AL, 00h

CMP AL,102 ; Mantaining Temperature=80 degrees

JLE HTRON

MOV AL,10000000b ;Heater(PC 1) oFF

OUT 04H,AL

NOP ;NOP given to calibrate heater's rate of cooling with heating

NOP

NOP

NOP

NOP

NOP

NOP





```
CMP AL,0
JZ TEMP100
```

```
MOV AL,01110010B ;COUNTER 1 MODE 1
OUT 0Eh,AL
CMP CL,1 ;Count of level button
JZ S1
CMP CL,2
JZ S2
CMP CL,3
JZ S3
CMP CL,4
JZ S4
```

```
S1:
MOV AL,120 ;COUNT =120 (2 MIN)
OUT 0Ah,AL
MOV AL,00H
OUT 0Ah,AL
MOV AL,10010000B ;PULSE TO GATE 1 (PC4)
OUT 04H,AL
NOP
NOP
MOV AL,10000000B ;PULSE
OUT 04H,AL
FAN1:
MOV AL,10001000B ;Switching motor on (PC 3)
OUT 04H,AL
IN AL,02h ;OUT 1 (PB1)
AND AL,02H
JZ FAN1
JMP OUT1
S2:
MOV AL,10110100B ;COUNTER 2, MODE 2
```

```

OUT 0Eh,AL
MOV AL,02H           ;GIVEN COUNT 2 (Duty cycle:50%)??
OUT 0Ch,AL
MOV AL,00H
OUT 0Ch,AL
MOV AL,0f0H         ; COUNT =240 (4 MIN)
OUT 0Ah,AL
MOV AL,00H
OUT 0Ah,AL
MOV AL,10010000B    ; PULSE TO GATE 1 (PC4)
OUT 04H,AL
NOP
NOP
MOV AL,10000000B    ;PULSE
OUT 04H,AL
FAN2:
MOV AL,10001000B    ;Switching motor on (PC 3)
OUT 04H,AL
IN AL,02h           ;OUT 1 (PB1)
AND AL,02H
CMP AL,0
JZ FAN2
JMP OUT1
S3:
MOV AL,10110100B    ;COUNTER 2, MODE 2
OUT 0Eh,AL
MOV AL,03H           ;GIVEN COUNT 3 (Duty cycle:33%)
OUT 0Ch,AL
MOV AL,00H
OUT 0Ch,AL
MOV AL,68H           ; COUNT =360 (6 MIN)
OUT 0Ah,AL
MOV AL,01H
OUT 0Ah,AL
MOV AL,10010000B    ; PULSE TO GATE 1 (PC4)

```

```

OUT 04H,AL
NOP
NOP
MOV AL,10000000B ;PULSE
OUT 04H,AL
FAN3:
MOV AL,10001000B ;Switching motor on (PC 3)
OUT 04H,AL
IN AL,02h ;OUT 1 (PB1)
AND AL,02H
CMP AL,0
JZ FAN3
JMP OUT1
S4:
MOV AL,10110100B ;COUNTER 2, MODE 2
OUT 0Eh,AL
MOV AL,04H ;GIVEN COUNT 4 (Duty cycle:25%)
OUT 0Ch,AL
MOV AL,00H
OUT 0Ch,AL
MOV AL,0e0H ; COUNT =480 (8 MIN)
OUT 0Ah,AL
MOV AL,01H
OUT 0Ah,AL
MOV AL,10010000B ; PULSE TO GATE 1 (PC4)
OUT 04H,AL
NOP
NOP
MOV AL,10000000B ;PULSE
OUT 04H,AL
FAN4:
MOV AL,10001000B ;Switching motor on (PC 3)
OUT 04H,AL
IN AL,02h ;OUT 1 (PB1)
AND AL,02H

```

```
CMP AL,0
JZ FAN4
JMP OUT1
```

```
OUT1:
MOV AL,10000000B ;Switching motor off (PC 3)
OUT 04H,AL
MOV AL,00000000b ;Unlock door( PC 7)/ STATUS OFF
OUT 04H,AL
MOV AL,10110110B ;config 8254 (Counter 2, Mode 3)
OUT 0Eh,AL
MOV AL,0E8H ;0Ch( To be given to SOC) – 03E8h(1000)
OUT 0Ch,AL
MOV AL,03H ;0Ch( To be given to SOC) –03E8h(1000)
OUT 0Ch,AL
JMP START
```

```
DELAY_20MS PROC NEAR ;subroutine
MOV DX,CX
MOV CX,10
X2: NOP
NOP
LOOP X2
MOV CX,DX
RET
DELAY_20MS ENDP
```

## CIRCUIT DIAGRAM

