PESIT Bangalore South Campus
Hosur road, 1km before Electronic City, Bengaluru -100
Department of Computer Science and Engineering

MICROPROCESSOR AND MICROCONTROLLER LABORATORY

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2016 -2017)

LAB MANUAL

SEMESTER – IV

Subject Code 15CSL48 — IA Marks 20
Number of Lecture Hours/Week 01 I + 02 P — Exam Marks 80
Total Number of Lecture Hours 40 — Exam Hours 03

CREDITS – 02

Course objectives: This course will enable students to

- To provide practical exposure to the students on microprocessors, design and coding knowledge on 80x86 family/ARM. To give the knowledge and practical exposure on connectivity and execute of interfacing devices with 8086/ARM kit like LED displays, Keyboards, DAC/ADC, and various other devices.

Description

Demonstration and Explanation hardware components and Faculty in-charge should explain 8086architecture, pin diagram in one slot. The second slot, the Faculty in-charge should explain instructionset types/category etc. **Students have to prepare a write-up on the same and include it in the Labrecord and to be evaluated.**

Laboratory Session-1: Write-up on Microprocessors, 8086 Functional block diagram, Pin diagram anddescription. The same information is also taught in theory class; this helps the students to understandbetter.

Laboratory Session-2: Write-up on Instruction group, Timing diagrams, etc. The same information isalso taught in theory class; this helps the students to understand better.

Note: These TWO Laboratory sessions are used to fill the gap between theory classes and practical
sessions. **Both sessions are evaluated as lab experiments for 20 marks.**

Experiments

- Develop and execute the following programs using 8086 Assembly Language. Any suitable assembler like MASM/TASM/8086 kit or any equivalent software may be used.
- Program should have suitable comments.
- The board layout and the circuit diagram of the interface are to be provided to the student during the examination.
- Software Required: Open source ARM Development platform, KEIL IDE and Proteus for Simulation

SOFTWARE PROGRAMS: PART A

1. Design and develop an assembly language program to search a key element "X" in a list of 'n'16-bit numbers. Adopt Binary search algorithm in your program for searching.

2. Design and develop an assembly program to sort a given set of 'n' 16-bit numbers in ascending order. Adopt Bubble Sort algorithm to sort given elements.

3. Develop an assembly language program to reverse a given string and verify whether it is a palindrome or not. Display the appropriate message.

4. Develop an assembly language program to compute nCr using recursive procedure. Assumethat 'n' and 'r' are non-negative integers.

5. Design and develop an assembly language program to read the current time and Date from thesystem and display it in the standard format on the screen.

6. To write and simulate ARM assembly language programs for data transfer, arithmetic and logical operations (Demonstrate with the help of a suitable program).

7. To write and simulate C Programs for ARM microprocessor using KEIL (Demonstrate withthe help of a suitable program)

Note : To use KEIL one may refer the book: Insider's Guide to the ARM7 based microcontrollers, Hitex Ltd.,1st edition, 2005

HARDWARE PROGRAMS: PART B

8. a. Design and develop an assembly program to demonstrate BCD Up-Down Counter (00-99)on the Logic Controller Interface.
b. Design and develop an assembly program to read the status of two 8-bit inputs (X & Y) from the Logic Controller Interface and display X*Y.

9. Design and develop an assembly program to display messages "FIRE" and "HELP" alternately with flickering effects on a 7-segment display interface for a suitable period of time. Ensure a flashing rate that makes it easy to read both the messages (Examiner does not specify these delay values nor is it necessary for the student to compute these values).

10. Design and develop an assembly program to drive a Stepper Motor interface and rotate themotor in specified direction (clockwise or counter-clockwise) by N steps (Direction and N are specified by the examiner). Introduce suitable delay between successive steps. (Any arbitrary value for the delay may be assumed by the student).

11. Design and develop an assembly language program to
a. Generate the Sine Wave using DAC interface (The output of the DAC is to be displayed on the CRO).
b. Generate a Half Rectified Sine waveform using the DAC interface. (The output of the DAC is to be displayed on the CRO).

12. To interface LCD with ARM processor-- ARM7TDMI/LPC2148. Write and execute programs in C language for displaying text messages and numbers on LCD

13. To interface Stepper motor with ARM processor-- ARM7TDMI/LPC2148. Write a programto rotate stepper motor

Study Experiments:

1. Interfacing of temperature sensor with ARM freedom board (or any other ARM microprocessor board) and display temperature on LCD
2. To design ARM cortex based automatic number plate recognition system
3. To design ARM based power saving system

Course Outcomes: After studying this course, students will be able to

- Learn 80x86 instruction sets and gins the knowledge of how assembly language works.
- Design and implement programs written in 80x86 assembly language
- Know functioning of hardware devices and interfacing them to x86 family
- Choose processors for various kinds of applications.

Graduate Attributes

- Engineering Knowledge
- Problem Analysis
- Modern Tool Usage
- Conduct Investigations of Complex Problems
- Design/Development of Solutions

Conduction of Practical Examination:

- All laboratory experiments (all 7 + 6 nos) are to be included for practical examination.
- Students are allowed to pick one experiment from each of the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks
- PART –A: Procedure + Conduction + Viva: 10 + 25 +05 (40)
- PART –B: Procedure + Conduction + Viva: 10 + 25 +05 (40)
- Change of experiment is allowed only once and marks allotted to the procedure part to be made zero.

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SOFTWARE PROGRAMS

HARDWARE PROGRAMS

EXPERIMENT NO.:- 1. BINARY SEARCH

AIM: Search a key element in a list of 'N' 16-bit numbers using the Binary search algorithm.

Procedure:

```
INPUT: Sorted LIST of size N, Target Value key

OUTPUT: Position of T in the LIST = I

BEGIN

1. MAX = N

MIN = 1

FOUND = false



2. WHILE (FOUND is false) and (MAX > = MIN)

2.1 MID = (MAX + MIN)DIV 2

2.2   If key = LIST [MID]

I=MID

FOUND = true

Else If key< LIST[MID]

MAX = MID-1

Else

MIN = MD+1

END
```

```
.model small

.data

.code

        a db 3h,5h,7h,10h,20h
        n dw $-a

        key db 5h

        m1 db 10,13,"KEY FOUND$"

        m2 db 10,13,"KEY NOT FOUND$"

.code

start:mov ax,@data

        mov ds,ax

        mov cx,key

        mov dx,n

        dec dx

        mov al,key

again:cmp cx,dx

        ja over1

        mov bx,cx

        add bx,dx

        shr bx,01h

        mov si,bx

        cmp al,a[si]

       je over2

       cmp al,a[si]

       jae big

      dec si

      mov dx,si

      jmp again

big: inc si
```

```
      mov cx,si
      jmp again
over1:lea dx,m2
          mov ah,09
          int 21h
          jmp exit
over2: lea dx,m1
         mov ah,09h
          int 21h
exit: mov ah,4ch
        int 21h
end start
```

EXPERIMENT NO.:- 2 BUBBLE SORT

AIM: Sort a given set of 'n' numbers in ascending and descending orders using the Bubble Sort algorithm

Procedure:

```
beginBubbleSort(list)

for all elements of list
if list[i]> list[i+1]
        swap(list[i], list[i+1])
endif
endfor
return list
endBubbleSort
```

```
.model Small
.data
a    dw      20h,70h,40h,10h,50h
cnt equ    ($-a)
.code
start: mov ax,@data
       mov ds, ax
       mov dx, cnt-1
again0:mov cx, dx
         lea si  ,a
again1:mov ax, [si]
         cmp ax ,[si+2]
         jl pr1
         xchg [si+2], ax
         xchg [si], ax
```

```
pr1: add si,02
     loop again1
     dec dx
      jnz again0
      mov ah,4ch
      int 21h
     end start
```

EXPERIMENT NO.:- 3 PALINDROME

AIM: Reverse a given string and check whether it is a palindrome or not.

Procedure: The program illustrates the use of string instructions.

- Initialize a pointer to end of the string.
- Store the string in reverse order in some memory location.
- Initialize one pointer to string and one more to the reversed string.
- Compare both the strings character by character.
- If all the characters match, display the message 'Palindrome'
- Else display the message 'Not Palindrome'.

```
.model small
.data
        str db "MADAM$"
        len equ 5
        rstr db 10 dup(?)
        msg1 db 10,13,"PALINDROME$"
        msg2 db 10,13,"NOT A PALINDROME$"
.code
        mov ax,@data
         mov ds,ax
         mov es,ax
         lea si,str
        lea di,rstr
        add di,len
        dec di
        mov cl,len
again: mov al,[si]
mov [di],al
dec di
        inc si
         dec cl
```

```
        jnz again
        cld
        mov ch,0h
        mov cl,len
         lea si,str
         lea di,rstr
         repe
        cmpsb
         je palin
        lea dx,msg2
        mov ah,09h
        int 21h
exit: mov ah,4ch
 int 21h
palin: lea dx,msg1
mov ah,09h
 int 21h
        jmp exit
        end
```

EXPERIMENT NO.:- 4 COMPUTING NCR

AIM: Compute ^{n}Cr (nCr) using recursive procedure. Assume that 'n' and 'r' are non-negative integers.

Procedure:

- Input n and r.
- If n = 0 and r = 0 , then res = 0

  Else
  Case i: If r = 0 or r = n then $^{n}c_{r} = 1$

  Case ii: If r = 1 or r = n-1 then $^{n}c_{r} = n$

  Case iii: $^{n}c_{r} = {}^{(n-1)}c_{r} + {}^{(n-1)}c_{(r-1)}$

```
.model small

.data

      n dw 3h

       r dw2h

      ncr dw   01h dup(0)

.code

      mov ax,@data

       mov ds,ax

       mov ax,n

       mov bx,r

       call ncrproc

       mov dx,ncr

       add dx,30h

       mov ah,02h

        int 21h

       mov ah,4ch

       int 21h
```

```
ncrproc proc
        cmp ax,bx
        je res1
        cmp bx,0
        je res1
       cmp bx,1
         je resn
         dec ax
         cmp ax,bx
         je resn
        push ax
        push bx
        call ncrproc
        pop bx
pop ax
        dec bx
        push ax
        push bx
       call ncrproc
       pop bx
       pop ax
       ret
res1: inc ncr
        ret
resn: addncr,ax
        ret
ncrproc endp
end
```

EXPERIMENT NO.:- 5 . DISPLAY SYSTEM TIME

AIM: Read the current time from the system and display it in the standard format on the screen.

Procedure: The program depicts the use of DOS routines.

- DOS function 2Ch is used to read the system time.
- To start with 2Ch is loaded in AH register and the respective function is called by interrupt INT21h.
- When this function is invoked
  - Register CH is loaded with hours
  - Register CL is loaded with minutes
  - Register DH is loaded with seconds
  - Register DL is loaded with hundredths of seconds.
- In this program we read the time in hh:mm:ss format and display it.

- To read Date, 2Ah is loaded in AH register and the respective function is called by interrupt INT21h.
- When this function is invoked
  - Register CX is loaded with year
  - Register DH is loaded with month
  - Register DL is loaded with the day.
- In this program we read the date in dd:mm:yyyy format and display it.

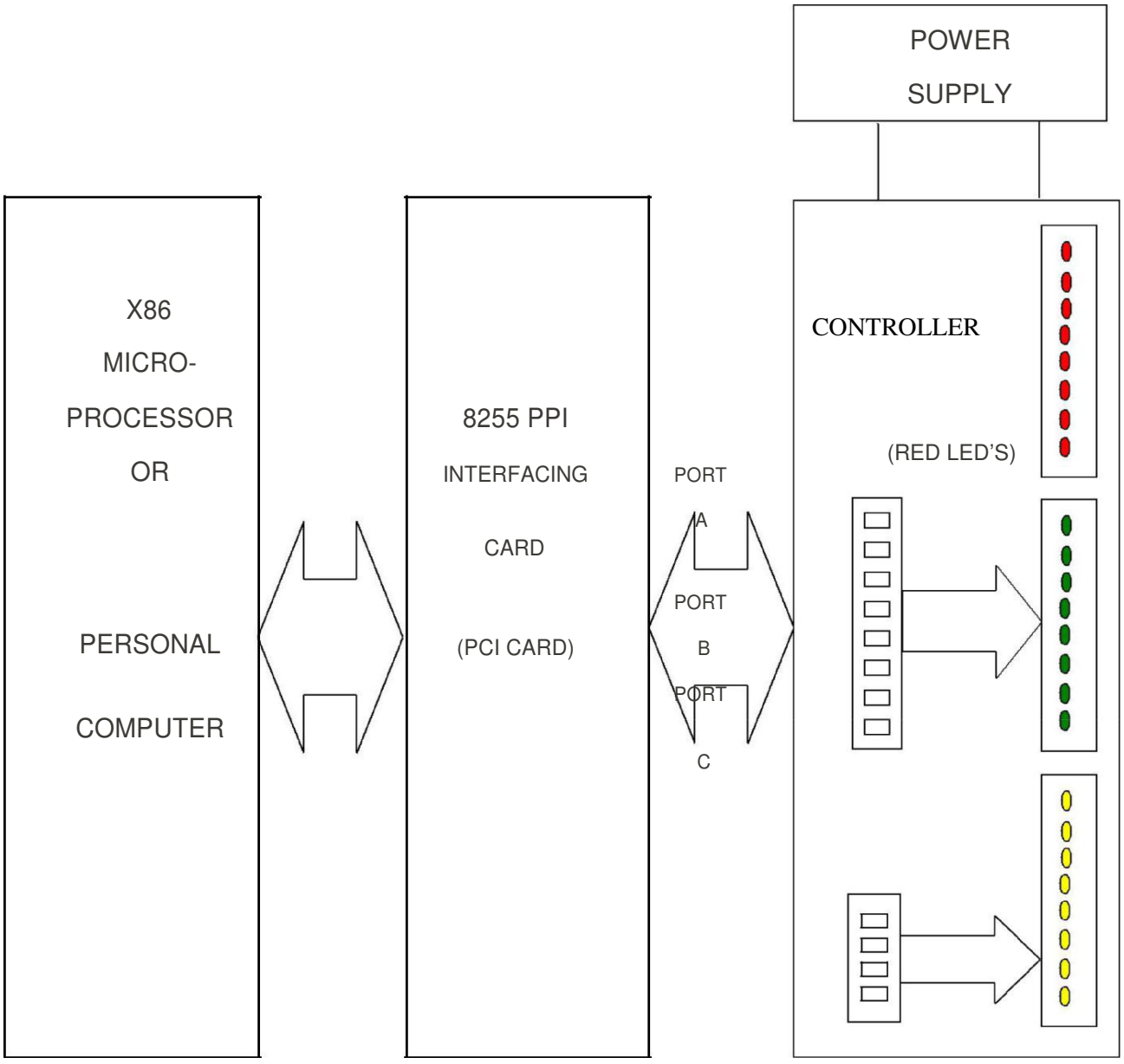
```
.model small

.code

    mov ah,2ch

    int 21h

    mov al,ch

     aam

    mov bx,ax

    call disp

    mov dl,':'

    mov ah,02h

    int 21h

    mov al,cl

    aam

    mov bx,ax
```

```
        call disp
        mov al,dh
        aam
        mov bx,ax
        call disp
        mov dl,':'
        mov ah,02h
        int 21h
        mov ah,4ch
        int 21h

disp proc
        mov dl,bh
        add dl,30h
        mov ah,02h
         int 21h
        mov dl,bl
        add dl,30h
        mov ah,02h
         int 21h
        ret
disp endp
end
```

Hardware interfacing programs.

EXPERIMENT NO. 1.BCD UP-DOWN USING LOGIC CONTROLLER

INTERFACE DIAGRAM:



```
.model small

.data

      msg db 'press any key for returning to dos',13,10,'$'
      porta dw 9800h

      portb dw 9801h

      portc dw 9802h

      ctlw dw 9803h

.code

      mov ax,@data

      mov ds,ax

      mov dx,offset

      msg mov ah,09h

      int 21h

      mov al,82h

      mov dx,ctlw

      out dx,al

      mov dx,portb

      in al,dx

      cmp al,0ffh

      je up4

up : mov al,00

up3 : push ax

      mov ax,00h

      mov ah,06h

      mov dl,0ffh

      int 21h

      jnz quit

      mov dx,porta

      pop ax

      out dx,al

      call delayp
```

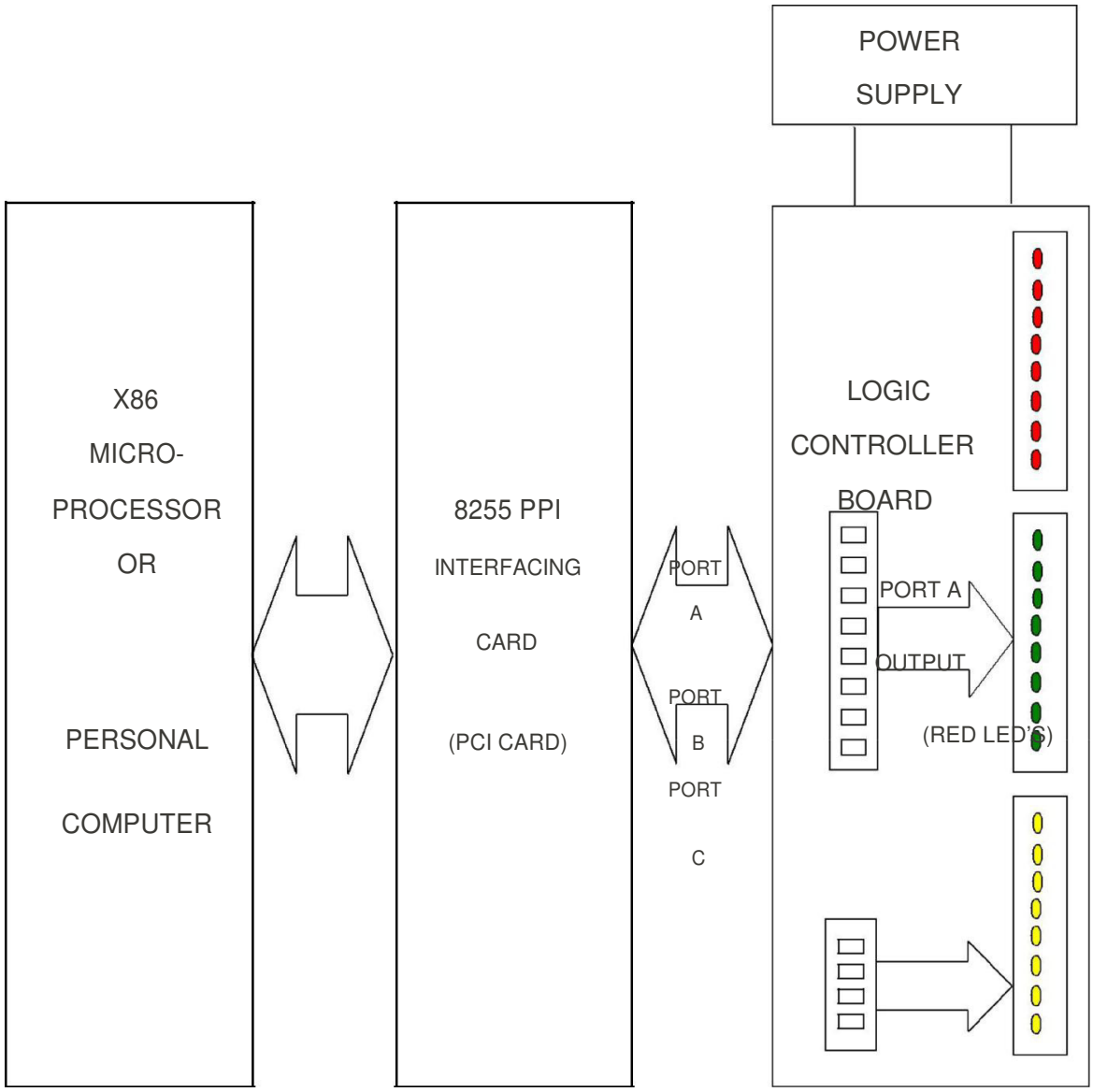
```
        inc al
        cmp al,0ah
        je up
        jmp up3
up4 : moval,09h
up5 : push ax
        mov ax,00h
        mov ah,06h
        mov dl,0ffh
        int 21h
        jnz quit
        mov dx,porta
        pop ax
        out dx,al
        call delayp
        dec al
        cmp al,0ffh
        je up4
        jmp up5
quit : mov ah,4ch
        int 21h

        delay proc
        push cx
        push bx
        mov cx,05fffh
up2 : mov bx,0ffffh
up1 : dec bx
        jnz up1
        loop up2
        pop bx
```

```
    pop cx
    ret
delay endp
end
```

EXPERIMENT NO. 2.DISPLAY X*Y

AIM: Read the status of two 8-bit inputs (X & Y) from the Logic Controller Interface and display X*Y.

INTERFACE DIAGRAM:

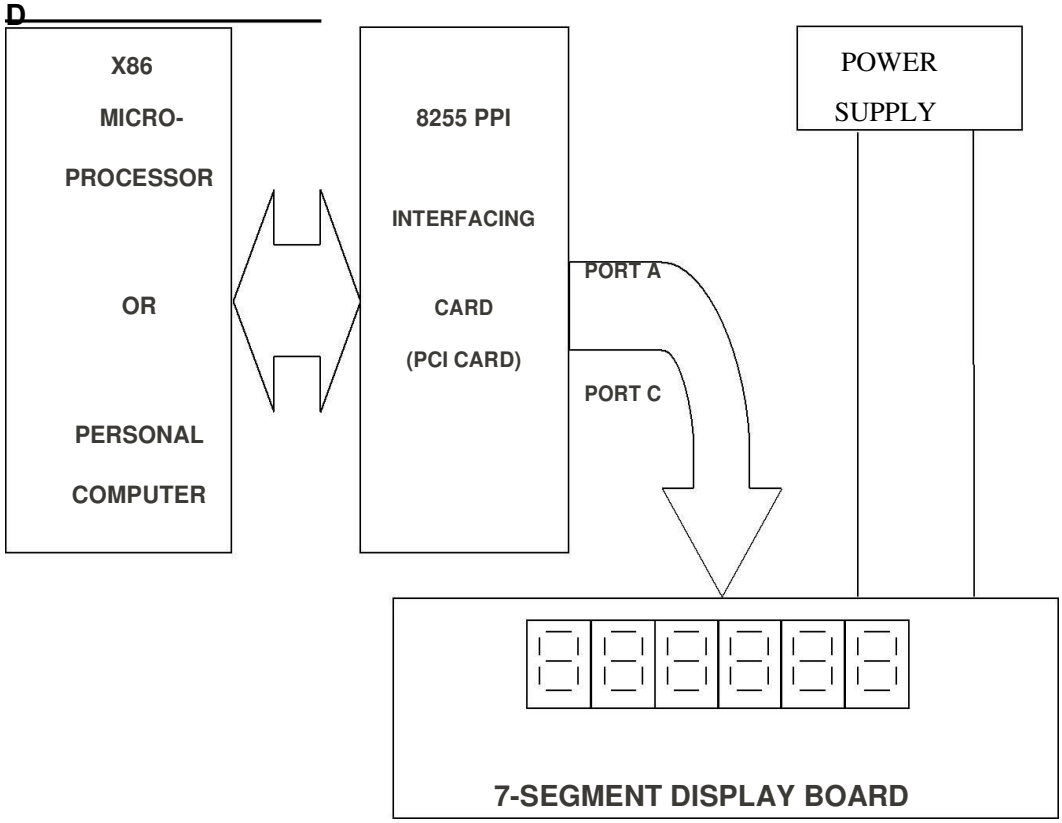


```
.model small
.code
      mov dx,9803h

      mov al,82h

out dx,al
      mov dx,9801h
      in al,dx
 movbl,al
in al,dx
      mul bl
      mov dx,9800h
      out dx,al
      mov al,ah
      out dx,al
      mov ah,4ch
      int 21h
end
```

EXPERIMENT NO.:- 3. DISPLAY MESSAGES ALTERNATIVELY

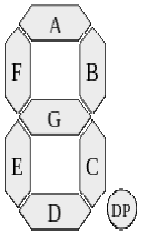
AIM: Display messages FIRE and HELP alternately with flickering effects on a 7-segment display interface for a suitable period of time. Ensure a flashing rate that makes it easy to read both the messages (Examiner does not specify these delay values nor it is necessary for the student to compute these values).

INTERFACE DIAGRAM:



Character	h	g	f	e	d	c	b	a	In Hex

7 SEGMENT CODES



F	0	1	1	1	0	0	0	1	71H
I	0	0	0	0	0	1	1	0	06H
R	0	1	1	1	0	1	1	1	77H
E	0	1	1	1	1	0	0	1	79H
H	0	1	1	1	0	1	1	0	76H
E	0	1	1	1	1	0	0	1	79H
L	0	0	1	1	1	0	0	0	38H
P	0	1	1	1	0	0	1	1	73H

All ports are configured as I/O ports in Mode-0.

Port A & Port C are output ports.

CONTROL WORD:

D7	D6	D5	D4	D3	D2	D1	D0	
1	GA	GA	PA	PCU	GB	PB	PCL	
1	0	0	0	0	0	0	0	= 80H

```
.model small
.data
    firstcode db 86h,88h,0f9h,8eh
    seccode db 8ch,0c7h,86h,89h

.code
    start : mov ax,@data
    mov ds,ax
    mov dx,9803h
    mov al,80h
    out dx,al
    mov bh,0ah
again : mov si,offest
    firstcode call display1
    call delay
    mov si,offset seccode
    call display1
    call delay
    dec bh
    cmp bh,00h
    je terminate
    jmp again
```

```
display1 proc
    mov cx,04h
    loop2 : mov
    bl,08h mov al,[si]
next : ror al,01h
    mov dx,9801h
    out dx,al
    push ax
    mov al,0ffh

    inc dx
    out dx,al
    mov al,00h
    out dx,al
    dec bl
    pop ax
    jz next1
    jmp next
next1 : inc si
    loop
    loop2 ret
    display1 endp
delay proc
    push ax
   push cx
    mov cx,0ffffh
loop1 : mov ax,0fffh
loop3 : dec ax
    jnz loop3
    loop loop1
```

```
    pop cx
    pop ax
    ret
delay endp
terminate : mov ah,4ch
int 21h
end start
```

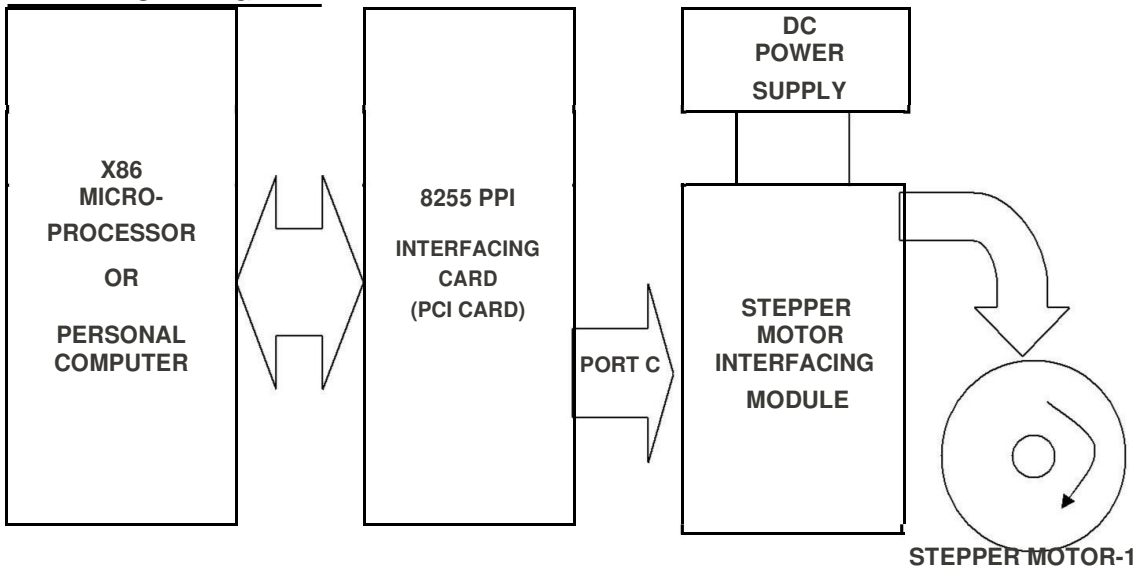
EXPERIMENT NO.:- 4.STEPPER MOTOR IN BOTH DIRECTION

AIM: Drive a stepper motor interface to rotate the motor by N steps left direction and N steps right direction (N is specified by the examiner). Introduce suitable delay between successive steps. (Any arbitrary value for the delay may be assumed by the student).

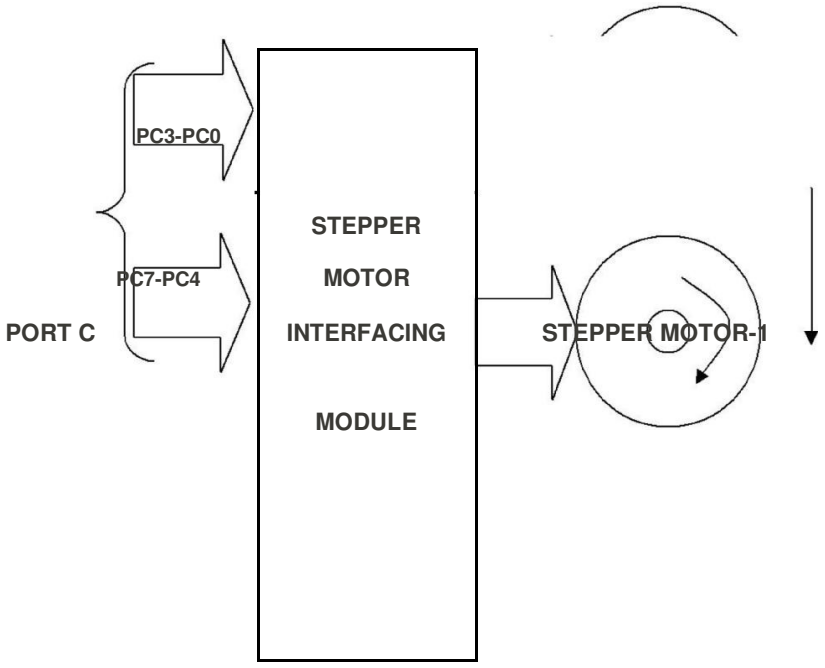
CLOCKWISE PROGRAM:

INTERFACE DIAGRAM:

INTERFACE DIAGRAM:



STEPPER MOTOR INTERFACING MODULE INTERNAL CONNECTIONS:



To rotate a Stepper Motors in clock-wise or anticlockwise direction, the sequence should be output in the nibble of Port C as shown above. Sequence is output on PC3-PC0 for Stepper Motor –1 and on PC7-PC4 for Stepper Motor–2.

CONTROL WORD:

D7	D6	D5	D4	D3	D2	D1	D0	
1	GA	GA	PA	PCU	GB	PB	PCL	
1	0	0	0	0	0	0	0	= 80H

All ports are configured as I/O ports in Mode-0.

```
.model small
.data
      n dw 200
.code
       mov ax, @data
       mov ds,ax
      mov dx,09803h
      mov al,80h
     out dx,al
    mov dx,09800h
    mov al,88h
    mov cx,n
again : out dx,al
             call delay
             ror al,01
             loop again
             mov ah,4ch
             int 21h
delay proc
       push  bx
       push cx
       mov cx,0fffh
repeat : mov bx,0ffffh
here1 : dec bx
          jnz here1
         loop repeat
```

```
        pop cx
        pop bx
    ret
    delay
endp end
```

ANTICLOCKWISE PROGRAM:

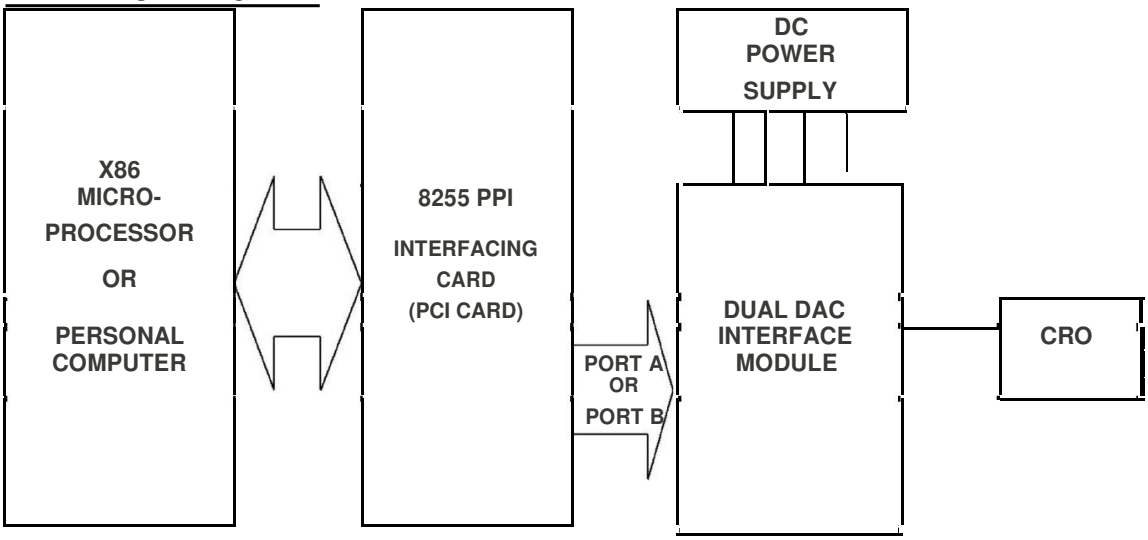
```
.model small
.data
    n dw 200
.code
     mov ax,@data
     mov ds,ax
     mov dx,09803h
     mov al,80h
     out dx,al
     mov dx,09800h
    mov al,88h
    mov cx,n
again : out dx,al
          call delay
          rol al,01
    loop again
    mov ah,4ch
    int 21h
```

```
delay proc
      push  bx
      push cx
      mov cx,0fffh
repeat : mov bx,0ffffh
here1 : dec bx
      jnz here1
      loop repeat
      pop cx
      pop bx
      ret
delay
endp
end
```

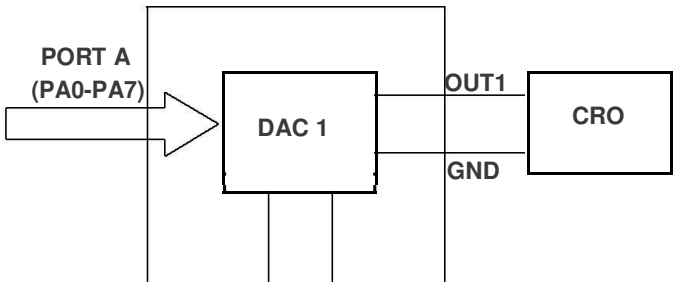
EXPERIMENT NO.:- 5(a) GENERATE SINE-WAVE

AIM: Generate the Sine Wave using DAC interface (The output of the DAC is to be displayed on the CRO).

INTERFACE DIAGRAM:



DAC INTERFACE INTERNAL CONNECTIONS:



Analog output corresponding to Digital data input in Port A is available in OUT-1, while the one corresponding to data input in Port B is available in OUT-2.

CONTROL WORD:

D7	D6	D5	D4	D3	D2	D1	D0	
1	GA	GA	PA	PCU	GB	PB	PCL	
1	0	0	0	0	0	0	0	= 80H

All ports are configured as I/O ports in Mode-0.

```
.model small

.data

arr db

7fh,8ch,99h,0a6h,0b2h,0bfh,0cah,0d4h,0ddh,0e6h,0edh,0f3h,0f8h,0fdh,0fch

h,ofbh,0f8h,0f3h,0edh

db 0e6h,0ddh,0d4h,0cah,0bfh,0b2h,0a6h,99h,08ch,7fh,72h,65h,58h,4ch,3fh,34h db
2ah,21h,18h,11h,0bh,06h,03h,01h,00h,01h,03h,06h,0bh,11h,18h,21h,2ah,34h,3f
h,4ch,58h,65h,72h,7fh

.code

    mov ax,@data

    mov ds,ax

    mov dx,9803h

    mov al,80h
```

```
      out dx,al
up1:lea si,arr
       mov cx,60
  up:mov al,[si]
      mov dx,9800h
      out dx,al
      mov dx,9801h
      out dx,al
      call delay
      inc si
      loop up
      jmp up1
      mov ah,4ch
      int 21h
delay proc
      push bx
      push cx
      mov cx,0fh
repeat : mov bx,0ffh

here1 : dec bx
      jnz here1
      loop repeat
      pop cx
      pop bx
      ret
      delay endp end
```

EXPERIMENT NO.:- 5(b) HALF RECTIFIED SINE WAVE

AIM: Generate a Half Rectified Sine wave form using the DAC interface. (The output of the DAC is to be displayed on the CRO).

```
.model small

.data

arr db

7fh,8ch,99h,0a6h,0b2h,0bfh,0cah,0d4h,0ddh,0e6h,0edh,0f3h,0f8h,0fdh,0fc

h,ofbh,0f8h,0f3h,0edh

db 0e6h,0ddh,0d4h,0cah,0bfh,0b2h,0a6h,99h,08ch,7fh,72h,65h,58h,4ch,3fh,34h db
00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,00h,
00h,00h,00h,00h,00h


.code

      mov ax,@data

      mov ds,ax

      mov dx,9803h

      mov al,80h

      out dx,al

up1:lea si,arr

  mov cx,60

   up:mov al,[si]

      mov dx,9800h

      out dx,al

      mov dx,9801h

      out dx,al

      call delay

      inc si

      loop up

      jmp up1

      mov ah,4ch

      int 21h

delay proc
```

```
        push bx
        push cx
        mov cx,0fh
repeat : mov bx,0ffh
here1 : dec bx
        jnz here1
        loop repeat
        pop cx
        pop bx

        ret
delayendp
end
```