QMP 7.1 D/F

Channabasaveshwara Institute of Technology

(An ISO 9001:2008 Certified Institution)

NH 206 (B.H. Road), Gubbi, Tumkur – 572 216. Karnataka.

Department of Information Science and Engineering

BE – IV Semester

MICROPROCESSOR AND MICROCONTROLLER LABORATORY

[As per Choice Based Credit System (CBCS) scheme]

15CSL48

Academic Year : 2016-17

Prepared By:

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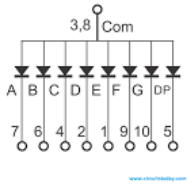
Stepper motor

ARM Processor

Seven Segment Display



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USN: _____

BATCH: _____ Section: _____

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SYLLABUS

Laboratory Code: 15CSL48	**IA Marks 20**
Number of Lecture Hours/Week 01I + 02P	**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 8086 architecture, pin diagram in one slot. The second slot, the Faculty in-charge should explain instruction set types/category etc. Students have to prepare a write-up on the same and include it in the Lab record and to be evaluated.

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

Laboratory Session-2: Write-up on Instruction group, Timing diagrams, etc. The same information is also 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. Assume that 'n' and 'r' are non-negative integers.
5. Design and develop an assembly language program to read the current time and Date from the system 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 with the 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 the motor 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 program to 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.

INDEX PAGE:

Sl.No	Name of the Experiment	Date			Manual Marks (Max . 25)	Record Marks (Max. 10)	Signature (Student)	Signature (Faculty)
		Conduction	Repetition	Submission of Record				
1.	Laboratory Session 1							
2.	Laboratory Session 2							
3.	Binary Search							
4.	Bubble Sort							
5.	Palindrome							
6.	nCr							
7.	Date and Time							
8.	ARM ALP							
9.	ARM using KEIL							
10.	BCD UP-DOWN counter							
11.	7 – Segment Display							
12	Stepper Motor							
13.	DAC							
14	LCD with ARM							
15.	Stepper Motor with ARM							
16.	Study Experiments							
AVERAGE								

Note: If the student fails to attend the regular lab, the experiment has to be completed in the same week. Then the manual/observation and record will be evaluated for 50% of maximum marks.

General Instructions to Students:

1. Understand the theoretical concept for the respective experiment.
2. Draw the circuit diagram in the given space in the observation book.
3. Tabulate the readings in the observation book and plot the graphs if necessary.
4. Every Student must at least construct one circuit.
5. After the completion of the experiment, get signature in the observation book.
6. Before coming to next lab, Make sure that records will be updated and signed from the concerned faculty.

Guide Lines for Writing Manual:

Blank Page (USE PENCIL)	Ruled Page (USE PEN)
Practical No:	Practical No:
Aim:	Aim:
Circuit Diagram	Apparatus Required
Characteristics/Wave form/ Observation Table	Theory:
Result	Procedure:
Calculation:	
Result:	

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CONTENT SHEET

1. Search a key element in a list of n numbers using the *Binary Search Algorithm.*

Algorithm:

Step1: Initialize
low=1,high=n; Step2
:while(low<=high)
*/*compare low>high if true the element is not found ,exit*
*/*else find mid*
mid=(low+high)/2;
(For the sample input given elements are allocated as given .From the above formula fmid mid =(low+high)/2
=(1+5)/2 =3
Means the midpoints to 2003 memory location (78), but that is not the exact mid, it should have been 2004 (62). Hence we *mid=mid-1*
3-1=2
mid=mid+mid=2+2=4.Now the midpoints to the exact mid position.)
Step 3:if (key==a[mid])
found&exit;
else
if(key>a[mid])
low=mid+1;
else
high=mid-1;
}
Step 4:Not
found Step
5:Stop;

Registers Used:

AX=key CX=low
DX=high
BX=SI=mid

Memory Allocation

Word	Address	Elements
0	2000	12
	2001	34
1	2002	56
	2003	78
2	2004	62
	2005	56
3	2006	73
	2007	21
4	2008	84
	2009	54

```
.model small
.data
a dw 1234h,5678h,6252h,7617h,8213h          ;numbers in ascending order
n       equ 5
key     dw 1234h                                ;keytobesearched
msg1    db 10,13,"Key is found$"
 msg2   db 10,13,"Key is not found$"
.code
Mov     ax,@data
Mov     ds,ax                                   ;Initialize thedatasegment

Mov     ax,key
mov  cx,0
mov dx,n-1
loop1:cmp       cx,dx ja
        notfound
mov     bx,cx
add     bx,dx
shr bx,1
mov     si,bx

add     si,si                                   ;to point to the actual mid
cmp     ax,a[si] je
found
ja above
mov dx,bx                                       ;high=mid-1
dec dx
jmp loop1
above:mov cx,bx                                 ;low=mid+1
inc cx
jmp loop1
found:lea dx,msg1
jmp print notfound:lea
dx,msg2 print: mov ah,09h
int 21h

mov ah,4ch int
21h
end
```

Output Sample Input:

8213h

F:\MASM> filename.exe

KEYFOUND

Program terminated normally

Sample Input: 5623h

F:\MASM> filename.exe

KEYNOTFOUND

Program terminated normally

2. Sort a given set of 'n' numbers in ascending using Bubble-Sort algorithm.

```
.model small

.data

        Arr     db 5,1,8,7,4,3          ;array to be sorted
        Len     equ $-arr               ;to find the length of array

.code

        Mov     ax,@data
        Mov     ds,ax                   ; initializing the data segment
        mov ch,len-1                    ;ch holds number of passes
again:mov       cl,ch                   ;cl holds number of comparisons
        mov     si,offset arr           ;point si to the first element of array
repeat:mov al,[si] inc  si
        cmp al,[si]
        jbe next
        xchg al,[si]                    ;Exchange the content of two locations
        mov [si-1],al

        next: dec cl
        jnz repeat
        dec     ch
        jnz again
        int 3
        end
```

Output

F:\MASM>afdebug filename.exe

In the debugging window keep pressing **F1** until the given numbers are arranged in the ascending order.

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

```
.model small
.data
Str     db "LIRIL"
Len     equ $-str                       ;calculates length of a string
Rstr    db 20 dup(0)                    ;reserve few locations to store the reversed string
msg1    db 10,13,"It is a Palindrome $" msg2   db
10,13,"It is not a Palindrome $"

.code
Mov ax,@data
Mov     ds,ax
Mov     es,ax                           ;uses extra segment for string comparisons
Mov     si,offset str                   ;si points to first element of str
Mov     di,offset rstr                  ;di points to first element of rstr
add di,len-1                            ;making di point to last element of rstr
mov     cx,len

back: mov al,[si]
        mov[di],al
        inc     si
        dec  di
        loop back
        mov     si,offset str
        mov     di,offset rstr
        mov     cx,len
        cld                                     ;clear direction flag
        repe cmpsb                      ;compare strings with the increasing addresses
        jne down
        lea dx,msg1
        jmp down1

down: lea dx,msg2
down1: mov ah,09h
        int 21h
        mov ah,4ch
        int 21h
end
```

Output

F:\MASM> filename.exe
STRING IS A PALINDROME
Program terminated normally

4. Compute nCr using recursive procedure. Assume that 'n' and 'r' are non-negative integers

To find nCr:

Step 1: if r=0 or n=r then nCr=1
Step 2: if r =1 or r = n-1 then
nCr=n Step 3: Recursive
definition of nCr is

nCr = (n-1) C r + (n-1)C(r-1)

```
.model small
.data

N dw 8
R dw 2
Res dw 0

.code

Mov ax,@data
Mov ds,ax
Mov  ax,n
Mov bx,r

Call ncr

mov ah,4ch
int 21h

ncr proc
cmp bx,0
je res1
cmp bx,ax
je res1
cmp
bx,01h je
res2 dec
ax cmp
ax,bx je
incrn
push ax
push bx

callncr
 pop bx
pop ax
 dec bx
 push ax
 push bx
```

```
        call ncr

        pop bx
        pop ax
        ret

res1:inc res ret
incrn:inc ax
res2:add res,ax
ret
ncr endp
```

Output

F:\MASM>afdebug filename.exe

In the debugging window keep pressing **F1** until you get the result, i.e., the value of ncr

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

H is used for getting the current system time

CX and DX registers return values

CH – current hours 0 -23 CL – current minutes 0 – 59 (24 hours format, values stored in hexadecimal)

DH – current seconds 0-59 DL – hundredth of seconds

```
.model small
.data
Msg db 10,13,'The current time is:'
hour db 2 dup(0),':'
min db 2 dup(0),':'
sec db 2 dup(0),'$'
.code
Mov ax,@data
 Mov ds,ax

mov ah,2ch                ;service number to read system time
int 21h

mov al,ch
aam
add ax,3030h              ;hours
mov hour,ah mov hour+1,al

mov al,cl aam
add ax,3030h
mov min,ah                ;minutes
      mov min+1,al

mov al,dh
aam
add ax,3030h              ;seconds
mov sec,ah
mov sec+1,al

mov ah,09h
lea dx,msg
int 21h
mov ah,4ch
int 21h
end
```

Output:

```
F:\MASM>filename.exe
        00:05:21
F:\MASM>filename.exe
00:05:32
```

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

6.a. ASM-DATA TRANSFER

```
area pgm1,code,readonly
entry

start

ldr r1,=value
ldr r2,[r1]
ldr r4,=res
str r2,[r4]

loop b loop

value
dcd 0x22222222;
area data1,data,readwrite
res
dcd 0x00;
end
```

6.b. ASM-LOGICAL OPERATIONS

```
area pgm,code,readonly
entry
start
        mov r0,0
        mov r1,1
        and r1,r0
        orr r1,r0
        eor r1,r0
        loop b loop
 end
```

6.c. ASM-ARITHMETIC OPERATIONS

```
area pgm3,code,readonly
entry

        ldr r0,=0x00000002
        ldr r1,=0x00000004
        muls r2,r1,r0
```

```
loop b loop
end
```

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

7.a. C-ARITHMETIC OPERATIONS

```
#include<lpc21xx.h>
main()
{
        int a=6,b=2,sum,mul,sub,div;
        sum=a+b;
        mul=a*b;
        sub=a-b;
        div=a/b;
}
```

7.b. C-LOGICAL OPERATIONS

```
#include<lpc21xx.h>
main()
{
    int a=0,b=1,and,or,exor,not;
    and=a&b;
    or=a|b;
    exor=a^b;
    not=~a;
}
```

8.a Implement a BCD Up-Down Counter on the Logic Controller Interface.

```
model small
.data
.code

pa equ 0c800h
pb equ 0c801h
pc equ 0c802h
ctrl equ 0c803h

mov ax,@data
mov ds,ax

mov al,82h   ; PA = o/p, PB = i/p and PC = o/p
mov dx,ctrl
out dx,al

mov cx,10
mov dx,pa
mov al,00


back: out dx,al        ; Display 0 to 9 in binary through port A
call delay
inc al                 ; increment al from 0 to 9
loop back

mov cx,10
mov dx,pa
mov al,09
b1:out dx,al           ; Display 9 to 0 in binary through port A call delay
dec al                ; decrement al from 9 to 0 loop b1

mov ah,4ch
int 21h

delay proc
      push cx
      push dx
     mov cx,0ffffh
outloop:mov dx,0ffffh
                inloop:dec dx
                jnz inloop
               loop outloop
                pop dx
              pop cx
              ret
              delay endp
END
```

8.b Read the status of two 8-bits inputs (X & Y) from the Logical Counter Interface and display X*Y.

```
.model small
.data
    pa equ 0c800h
    pb equ 0c801h
    pc equ 0c802h
    ctrl equ 0c803h
    x db ?
    y db ?

    msg1 db 10,13,"Enter x:$"
    msg2 db 10,13,"Enter y:$"
.code
    disp macro x
    lea dx,x
    mov ah,09h
    int 21h

    endm

    mov ax,@data
    mov ds,ax

    mov al,82h
    mov dx,ctrl
    out dx,al

    disp msg1
    mov ah,08h
    int 21h

    mov dx,pb
    in al,dx   ; Take the value into al
    mov x,al ; move the contents from al to variable x disp msg2
    mov ah,08h
    int 21h

    mov dx,pb
    in al,dx   ; Take the value into al

    mov y,al ; move the contents from al to variable y
    mul x          ; The multiplied contents stored in AX mov cx,ax
    mov al,ch
    mov dx,pa
    out dx,al      ; Display higher byte of data
    call delay
    mov al,cl
```

```
        mov dx,pa
        out dx,al          ; Display lower byte of data

        mov ah,4ch
        int 21h
```

8.b Read the status of two 8-bits inputs (X & Y) from the Logical Counter Interface and display X*Y.

```
    .model small
    .data
    .code
pa equ 0c800h pb equ 0c801h
pc equ 0c802h ctrl equ
0c803h x db ?
y db ?
msg1 db 10,13,"Enter x:$" msg2 db
10,13,"Enter y:$"

disp macro x
        lea dx,x
        mov ah,09h
        int 21h
        endm

      mov ax,@data
      mov ds,ax

        mov al,82h
        mov dx,ctrl
        out dx,al

      disp msg1
      mov ah,08h
      int 21h

      mov dx,pb
      in al,dx                ;Take the value into al

 mov x,al                     ; move the contents from al to variable     x disp

    msg2
    mov ah,08h
    int 21h

    mov dx,pb
in al,dx                     ; Take the value into al

mov y,al                     ; move the contents from al to variable y
mul x                        ; The multiplied contents stored in AX mov cx,ax
mov al,ch
```

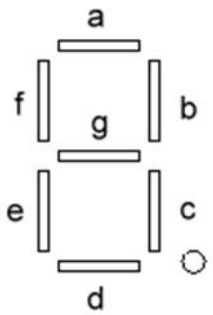
```
        mov dx,pa
    out dx,al                       ; Display higher byte of data
    call delay

        mov al,cl
        mov dx,pa
    out dx,al                   ; Display lower byte of data

        mov ah,4ch
        int 21h

 delay proc
            push cx
            push dx
            mov cx,0ffffh
outloop:mov dx,0ffffh
 inloop:dec dx
            jnz inloop
            loop outloop
            pop dx
            pop cx
            ret
 delay endp
        end
```

9. 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 students to compute these values).



Ports
Port A – is used to send the data whole 8 bits at a time
Port C – is used to select or enable the digits before sending the data through Port A
For 6 digits: Digits selected

```
.model small
.data
fire db 00H,00h,79h,50H,30H,71H          ; seven segment equivalent code for FIRE help db
73h,38h,79h,76h,00h,00h                  ; seven segment equivalent code for HELP

pa equ 0C800h
pb equ 0C801h
pc equ 0C802h
ctr equ 0C803h

.code

mov ax,@data
mov ds,ax

mov dx,ctr
mov al,80H          ; all ports in output ports out dx,al


disp:   mov DI,10
fire1:  lea SI,fire      ;call display dec DI
jnz fire1

mov DI,10
help1:  lea SI,help      ;call display dec DI
jnz help1

mov ah,06H
mov dl,0FFH
int 21h
jz disp

mov ah,4CH
int 21H

display proc
mov dx,pc
mov al,07H          ;To enable all the digits out dx,al
```

```
mov cx,06H

mov bl,00
back:   mov al,bl       ;To select one digit from digit 1 to 6 (0-5) mov dx,pc
out dx,al

mov dx,pa
lodsb                   ;Send the data to the selected digit out dx,al

call delay
inc bl                  ; increment bl to select next higher digit loop back

ret display
endp


delay proc


push CX
push dx
mov cx,0FFFH

outloop: mov dx,0FFFH
inloop:  dec dx
jnz inloop
loop outloop

pop dx
pop cx
ret
delay endp
end
```

10. Drive a Stepper Motor interface to rotate the motor 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).

```
.model small
.data

.code

pa equ 0c800h
pb equ 0c801h
pc equ 0c802h
cr equ 0c803h
count db 10

mov ax,@data
mov ds,ax
mov dx,cr
mov al,80h
out dx,al
mov bh,count
mov al,88h      ; at a time one coil is selected

up:mov dx,pc
out dx,al
call delay
ror al,1 ; rotate anticlockwise dec bh
jnz up
mov bh,count
mov dx,pc
mov al,88h
back:   out dx,al
call delay
rol al,1 ;          rotate clockwise
dec  bh
jnz back
mov ah,4ch
int 21h

delay proc
push cx
push dx
mov cx,8000h
outloop:mov dx,4000h
inloop: dec dx
jnz inloop
loop outloop
pop dx
pop cx
ret
```

```
delay endp

end
```

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

Calculate table values using the formula table[i]=127+127 Sin (Equation to generate sine wave)
Where ranges from 0 to 180 in steps of 6 degree

I	Θ	table[i]=127+127 SinΘ
1	0	127
2	6	140
3	12	133
4	18	166
5	24	170
6	30	190
7	36	201
8	42	211
9	48	221
10	54	229
11	60	236
12	66	243
13	72	247
14	78	251
15	84	253
16	90	254
17	96	253
18	102	251
19	108	247
20	114	243
21	120	236
22	126	229
23	132	221
24	138	211
25	144	201
26	150	190
27	156	170
28	162	166
29	168	133
30	174	140
31	180	127

```
.MODEL SMALL
.DATA

pa equ 0c800h
pb equ 0c801h
pc equ 0c802h
ctrl equ 0c803h

TABLE DB
    127,140,153,166,178,190,201,211,221,229,236,243,247,251,253,254,253,251,24
7,243,236,229,221,211,201,190,178,166,153,140,127
```

```
.CODE

MOV AX,@DATA        ; initialize the data segment MOV DS,AX

MOV AL,80H          ; 80h is the control word MOV DX,ctrl ; ctrl reg addr
OUT DX,AL           ; ctrl word is moved to ctrl reg

BEGIN : MOV DX,pa   ; Port A address
    LEA SI,TABLE    ; SI points to beginning of table MOV CX,31
                    ; CX is moved with 31
BACK  : MOV AL,[SI] ; [SI] is moved to AL OUT DX,AL
    INC SI          ; increment SI
    LOOP BACK       ; loop to print all values in table MOV AL,127
                    ; move 127(reference line) to AL
    MOV CX,31       ; move 31 to CX
BACK1 : OUT DX,AL   ; display AL
    LOOP BACK1      ; loop back1 print all value
    MOV AH,06H
    MOV DL,0FFH
    INT 21H
    JZ BEGIN        ; if no key is pressed goes to begin
    MOV AH,4CH      ; terminate the program
    INT 21H
    END             ; end of program
```

11.b 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

pa equ 0c800h
pb equ 0c801h
pc equ 0c802h
ctrl equ 0c803h

TABLE DB 127,140,153,166,170,190,201,211,221,229,236,243,247,251,253
DB 254,253,251,247,243,236,229,221,211,201,190,178,166,153,140,127

.CODE

MOV AX,@DATA        ; initialize data segment
MOV DS,AX
```

```
MOV AL,80H          ; 80h is control word
MOV DX,ctrl         ; ctrl reg addr
OUT DX,AL           ; ctrl word is moved to ctrl reg

BEGIN : MOV DX,pa   ; Port A address
LEA SI,TABLE        ; SI points to 1st position of table
MOV CX,31           ; 31 (total no of values) is mov to CX

BACK    : MOV AL,[SI]
    OUT DX,AL
    INC SI          ; increment SI
    LOOP BACK       ; loop decrements the CX register value

    MOV AH,06H
    MOV DL,0FFH
    INT 21H
    JZ BEGIN        ; if no key is pressed goes to begin

    MOV AH,4CH      ; terminate the program INT 21H
    END             ; end of program
```

12.LCD

```
    // LCD INTERFACING
//-----------------------------------------------------------------
// CONTROLLER                : LPC-2148
// DATE                      : December - 2015
// Developed By         : Advanced Electronic Systems Bangalore, India
//-----------------------------------------------------------------
//-----------------------------------------------------------------
// Predefined data will be displayed on LCD
//-----------------------------------------------------------------

#include<lpc214x.h>
#include<stdio.h>                                   //Function prototypes
void lcd_init(void);
void wr_cn(void);
void clr_disp(void);
void delay(unsigned int);
void lcd_com(void);
void wr_dn(void);
void lcd_data(void);
unsigned char temp1;
unsigned long int temp,r=0;
unsigned char *ptr,disp[] = "SVIT BENGALURU",disp1[] = "LCD INTERFACING";

int main()
{
        PINSEL0 = 0X00000000;                   // configure P0.0 TO P0.15 as GPIO
    IO0DIR = 0x000000FC;              //configure o/p lines for lcd [P0.2-P0.7]
    lcd_init();             //lcd intialisation
    delay(3200);                                    // delay  1.06ms
    clr_disp();                                     //clear display
    delay(3200);                    // delay  1.06ms
    temp1 = 0x81;                   //Display starting address       of first line 2nd pos
        lcd_com();                                          //function to send command to lcd
        ptr = disp;                                         // pointing data
    while(*ptr!='\0')
    {
                temp1 = *ptr;
            lcd_data();                         //function to send data to lcd
                ptr ++;
    }
        temp1 = 0xC0;           // Display starting address of second line 1st pos
        lcd_com();                                          //function to send command to lcd
        ptr = disp1;                            // pointing second data
        while(*ptr!='\0')
   {
        temp1 = *ptr;
        lcd_data();                             //send data to lcd
        ptr ++;
   }
```

```
  while(1);
 }                    //end of main()

// lcd initialisation routine.

void lcd_init(void)
{
        temp = 0x30;                    //command to test LCD voltage level
        wr_cn();
        delay(3200);
        temp = 0x30;                     //command to test LCD voltage level
        wr_cn();
        delay(3200);
        temp = 0x30;                    //command to test LCD voltage level
        wr_cn();
        delay(3200);
        temp = 0x20;            // change to 4 bit mode from default 8 bit mode
        wr_cn();
        delay(3200);
        temp1 = 0x28;        // load command for lcd function setting with lcd in 4 bit mode,
        lcd_com();           // 2 line and 5x7 matrix display
        delay(3200);
        temp1 = 0x0C;          // load a command for display on, cursor on and blinking off
        lcd_com();
        delay(800);
        temp1 = 0x06;       // command for cursor increment after data dump
        lcd_com();
        delay(800);
        temp1 = 0x80;               // set the cursor to beginning of line 1
        lcd_com();
        delay(800);
}
 void lcd_com(void)
{
        temp = temp1 & 0xf0;                //masking higher nibble first
        wr_cn();
        temp = temp1 & 0x0f;                //masking lower nibble
        temp = temp << 4;
        wr_cn();
        delay(500);                                         // some delay
}
// command nibble o/p routine

void wr_cn(void)            //write command reg
{
        IO0CLR  = 0x000000FC;                    // clear the port lines.
        IO0SET= temp;                           // Assign the value to the PORT lines

        IO0CLR  = 0x00000004;               // clear bit  RS = 0
        IO0SET= 0x00000008;                 // E=1
```

```
        delay(10);
        IO0CLR  = 0x00000008;                   //E=0
}
 // data nibble o/p routine

void wr_dn(void)                        ////write data reg
{
        IO0CLR = 0x000000FC;        // clear the port lines.
        IO0SET = temp;                          // Assign the value to the PORT lines
        IO0SET = 0x00000004;        // set bit  RS = 1
        IO0SET = 0x00000008;        // E=1
        delay(10);
        IO0CLR = 0x00000008;        //E=0
}
 // data o/p routine which also outputs high nibble first
// and lower nibble next

void lcd_data(void)
{
         temp = temp1 & 0xf0;           //masking higher nibble first
         temp = temp ;
        wr_dn();
        temp= temp1 & 0x0f;             //masking lower nibble
        temp= temp << 4;                //shift 4bit to left
       wr_dn();
       delay(100);
}
     void clr_disp(void)                        // function to clear the LCD screen
{
   temp1 = 0x01;
   lcd_com();
   delay(500);
}
       void delay(unsigned int r1)              // delay function using for loop
{
         for(r=0;r<r1;r++);
}
```

13.STEPPER

```
// STEPPER MOTOR INTERFACING
//-------------------------------------------------------------
// CONTROLLER                    : LPC-2148
// DATE                          : JULY - 2016
// Developed By : Advanced Electronic Systems Bangalore,India
//-------------------------------------------------------------
//-------------------------------------------------------------------
// A stepper motor direction is controlled by shifting the voltage across
// the coils. Port lines : P1.20 to P1.23
//-------------------------------------------------------------------

#include <LPC21xx.h>

void clock_wise(void) ;
void anti_clock_wise(void) ;

unsigned  int var1 ;
unsigned long int i = 0 , j = 0 , k = 0 ;

int main(void)
{
        PINSEL2 = 0x00000000;           //P1.20 to P1.23 GPIO
        IO1DIR |= 0x00F00000 ;          //P1.20 to P1.23 made as output


                while(1)
                {

                        for( j = 0 ; j < 50 ; j++ )                 // 50 times in Clock wise Rotation
                        clock_wise() ;                              // rotate one round clockwise

                        for( k = 0 ; k < 65000 ; k++ ) ;            // Delay to show  anti_clock Rotation

                        for( j=0 ; j < 50 ; j++ )                   // 50 times in  Anti Clock wise Rotation
                        anti_clock_wise() ;                          // rotate one round anticlockwise
                        for( k = 0 ; k < 65000 ; k++ ) ;            // Delay to show ANTI_clock Rotation
                }

}                                                                   // End of main

void clock_wise(void)
{
        var1 = 0x00080000;                                          //For Clockwise

        for( i = 0 ; i <= 3 ; i++ )                                 // for A B C D Stepping
        {
                var1 <<= 1 ;
                IO1CLR =0x00F00000 ;                                //clearing all 4 bits
                IO1SET = var1 ;                                      // setting particular bit
                for( k = 0 ; k < 3000 ; k++ );                      //for step speed variation
        }
}

void anti_clock_wise(void)
```

```
{
        var1 = 0x00800000 ;                     //For Anticlockwise
        IO1CLR =0x00F00000 ;                    //clearing all 4 bits
        IO1SET = var1 ;
        for( k = 0 ; k < 3000 ; k++ ) ;
        for( i = 0 ; i < 3 ; i++ )              // for A B C D Stepping
        {
                        var1 >>=1;                      //rotating bits
                         IO1CLR =0x00F00000 ;           // clear all bits before setting
                        IO1SET = var1 ;                 // setting particular bit

                         for( k = 0 ; k < 3000 ; k++ ) ;        //for step speed variation

        }
}
```

VIVA QUESTION AND ANSWERS

1. Define Microprocessor

The Processor is an integrated circuit in a small size and hence the name microprocessor.

2. How many bit is 8086 Microprocessor

8086 is a 16-bit microprocessor.

3. How many bits are 8086 data and address bus

Data bus – 16 bit and address bus – 20 bit.

4. How many 16-bit register are available in 8086. Name them

There are 14, 16-bit register. They are AX, BX, CX, DX- general purpose registers, CS, SS, ES, DS- Segment registers, SI, DI, SP, BP, IP – Index and pointer registers and Flag register,

5. **Name 2 modes in which 8086 can work?**

   8086 can work in

   i) Minimum mode- when only one 8086 CPU is used.

   ii) Maximum mode – when more than one processor (multiprocessor) is used.

6. **What is the function of AX register?**

   AX is used as 16-bit Accumulator.

7. **What does segment register hold?**

   Segment registers are used to hold the upper 16-bits of the starting addresses of the 4 memory segments.

8. **What is the size of the memory in 8086?**

   Maximum Size of memory in 8086 is 1Mega byte.

9. **What is the maximum size of each segment in 8086 Microprocessor**

   Maximum Size of each segment in 8086 is 64K byte.

10. **What does pointer registers hold?**

    The pointer register IP, BP and SP holds the offset within the code, data, and stack segments.

11. **What does index register hold?**

    SI –Source Index register hold the offset of a data word in the data segment. 20-bit physical data address is calculated from SI and DS.

    DI- Destination Index register hold the offset of a data word in the extra segment. 20-bit physical data address is calculated from DI and ES.

12. **How many active flags are there in 8086? Name them.**

    There are 9 active flags. They are Carry Flag, Parity Flag, Auxillary Flag, Zero Flag, Sign Flag, and Overflow Flag.

13. **Explain the working of PUSH operation**

    PUSH operation decrements the stack pointer by 2 and copies a word from some source to the location in the stack where the stack pointer points.

14. **Explain the working of POP operation**

    POP operation copies a word from the stack location pointed by the stack pointer to the destination and then stack pointer is automatically incremented by 2,

15. Explain the different types of instructions in 8086

Data transfer instruction, Arithmetic and Logical instruction, Shift and Rotate instructions, String instructions, Jump instructions, Machine Control and Miscellaneous instructions and Interrupt instructions.

16. What is the use of DUP directive?

Dup directive can be used to initialize several locations and to assign value to these locations.

17. List the directives used to define different types of variables

DB- Define Byte

DW- Define Word

DD- Define Doubleword
DQ- Define Quadword
DT- Define Terabytes.

18. List some Data Transfer instructions

MOV instruction to transfer byte, PUSH/POP instructions, Load Effective address instructions(LEA), String Data transfer instructions(MOVSB), XCHG,LAHF, SAHF, XLAT, IN and OUT

19. List some Arithmetic and logical instructions

ADD, SUB, MUL, DIV, AND OR, NOT, TEST, CMP, AAM, AAD etc…

20. Explain how AAM instruction is executed

Syntax: AAM ; No operands

- Is used to convert the binary result to 2 digit unpacked BCD
- Working of AAM instruction depends on the contents of AL register.
- The data entered from a keyboard will be in the ASCII format(e.g. if entered '9' then inside the computer it will be stored as 39H)
- Suppose AL contains 3FH i.e 63 in BCD.It can be represented in unpacked BCD as 06 03 BCD.
- Example: MOV AL,15 AL Contains 15 i.e. 0Fh
  AAM AH=01 and AL=05H

21. Differentiate between TEST and AND instruction

TEST instruction performs AND operation. Difference is that the AND instruction changes the destination operand while TEST instruction does not. TEST instruction only affects the condition of the flag register, which indicates the result of the test.

22. SHR AL, 1. Give the equivalent meaning of this instruction

SHR-shifts each bit in the specified destination to the right. It is equivalent to divide by 2.

23. What are 2 types of JUMP instruction

Two types are Conditional and Unconditional JUMP instructions.

24. Distinguish between the instructions JA Label and JG Label

JA(Jump if Above) is used when we are comparing unsigned numbers.

JG(Jump if Greater) is used when we are comparing the signed numbers.

25. Differentiate between NEAR and FAR JUMP.

NEAR JUMP- Is 3 byte instruction, which allows a branch or jump within + 32kbytes from the instruction in the current code segment. Only IP is changes, the content of CS remains same.

FAR JUMP- Is 5 byte instruction, which allows a jump to any memory location within the real memory system. A FAR jump is a jump where the destination location is from a different segment. In this case both IP and CS are changed as specified in the destination.

26. What is the other name for NEAR jump and FAR jump.

NEAR jump is also called as intersegment jump and FAR jump is also called as intrasegment jump.

27. Which instruction is used to SET and RESET direction flag?

STD- is used set the direction flag. SI and DI are automatically decremented. CLD-

is used to reset the direction flag. SI and DI are automatically incremented.

28. Differentiate between Macro and Procedure

Sl. No.	**Procedure**	**Macro**
1.	Accessed by CALL and RET instruction	Accessed during assembly with the name given to macro when defined
2.	Machine code for instructions is put only once in the memory	Machine code is generated for instructions each time when macro is called
3.	Less memory is required	More memory is required
4.	Parameters can be passed in registers, memory locations or stack	Parameters passed as part of statement which calls nacro.

29. What is the default size of Stack?

Default size of stack is 64KB

30. Explain the working of XLAT instruction

XLAT instruction: Translate the value in

AL Syntax: XLAT ; No operands

- Instruction replaces a byte in AL register with a byte from a lookup table in memory.
- BX register stores the offset of the starting address of the lookup table and AL register stores the byte number from the lookup table.
- The instruction copies byte from address pointed by [BX+AL] back into AL
- Equivalent MOVE instruction is MOV AL,[AL][BX]
- Use of XLAT instruction in Program 6b.

i) Store in the data segment; say for example starting from offset location 4000H, the table of 7-segment equivalent code in hexadecimal. For example, the character '6' has the ASCII code of 36H and 7 segment equivalent code of 7DH (refer 7 segment equivalent code table). Thus 7DH is stored in location 4036H.

ii) To convert the ASCII code of 36H to 7 segment equivalent code of 7Dh, we must execute XLAT instruction with AL contents 36H and BX contents as 4000H. This results in AL contents changing to 7DH.

	Before	After
(AL)	36	7DH
(BX)	4000	4000
(DS:36[BX]	7D	7D

31. What are assembler directives. Name few of them.

.model, dw,dd,db etc

32. List the memory model available in 8086.

Small, medium, compact

33. Differentiate between arithmetic and logical shift instructions

Logical shifts move a 0 into the rightmost bit position for a logical left shift(SHL) and 0 to the leftmost bit position for a logical right shift(SHR). Arithmetic left shift(SAL) and SHL are identical

but arithmetic right shift (SAR) copies the sign bit through the number, while logical right shift copies a 0 through the number.

34. Define interrupt

When a microprocessor is interrupted it stops executing its current program and calls a special routine which services the interrupt. The event that causes the interruption is called interrupt. Special routine executed to the service is called Interrupt Service Routine (ISR).

35. Which are the 3 ways by which a normal program can be interrupted

3 ways are:

1. By External Signal – applied to NMI or INTR input pin
2. Special Instruction in the program – Eg INT
3. By the occurrence of some condition – Divide by zero, overflow etc.

36. Differentiate between hardware and software interrupts

Interrupt caused by an external signal is referred to as hardware interrupt. Conditional interrupts or interrupts caused by special instructions are called software interrupts.

37. What is interrupt vector table

In 8086 system the first 1Kbyte of memory is reserved for storing the starting addresses of interrupt service routines. This block of memory is called as Interrupt Vector table or interrupt pointer table.

38. How many interrupts service routines can be stored in the interrupt vector table

Table can hold the starting addresses for 256 interrupt service routines.

39. Name the dedicated interrupt types.

a) Divide By Zero Interrupt(Type 0)
b) Single Step Interrupt(Type 1)
c) Non-Maskable Interrupt(Type 2)
d) Breakpoint Interrupt(Type 3)
e) Overflow Interrupt(Type 4)

40. What is 8255?

8255 is a general purpose programmable I/O device used for parallel data transfer.

1. What are the operation modes of 8255?

Two basic modes are Bit Set/Reset(BSR) mode and I/O mode.

2. How 20 bit address generated using 16 bit register?

8086 generates 20-bit address using the contents of segment register and offset register associate d with it. For Eg: the contents of CS register are multiplied by 16 (10 H) i.e shifted by 4 position to the left by inserting zero bits and then the offset i.e the contents of IP register are added to the shifted contents of CS to generate 20 bit physical address.

CS register- 348A H after appending zero to the left it becomes 348A0 H. IP

register – 4214.

20 bit physical address – 348A0+4214=38AB4.

3. Difference between DIV and IDIV

DIV instruction is used to divide unsigned word by a byte or to divide an unsigned double word by a word.

IDIV instruction is used to divide signed word by a signed byte or to divide a signed double word by a signed word.

4. Difference between MUL and IMUL

MUL instruction is used multiplies an unsigned byte from source and unsigned byte in AL.

IMUL instruction multiplies a signed byte from some source and a signed byte in AL.

5. Why is NOP instruction required?

NOP instruction does nothing but takes 3 clock cycles of processor time to execute.

6. What is the default registers used in string instructions?

Source index register (SI) and Destination index register (DI) are the default registers used in string instructions.

7. What is the difference between JE and JZ?

JE (Jump if Zero) and JZ (Jump if Zero Flag) is same but the difference is JE is used after CMP instruction whereas JZ is used after the arithmetic operation.

41. Differentiate between SUB and CMP

SUB instruction - subtracts the number in the source from the number in the destination and put the result in the destination.

CMP instruction – Compares a byte/word from the specified source with a byte/word from the specified destination. The comparison is done by subtracting the source byte or word from the destination byte/word. But the result is not stored in the destination. Source and destination remain unchanged, only flags are updated.

42. Generate single instruction

MOV DX, AX

MOV AX, BX

MOV BX, DX just like any other

Single instruction is XCHG AX, BX

43. Which register is affected when LOOP instruction is used?

CX register is affected when LOOP instruction is used.

44. What is the DOS function call invoked to create a file?

3CH is the Service number to create a file.

45. What is the DOS function call invoked to delete a file?

41H is the service number to delete a file.

46. Which are the 2 interrupt pin available in 8086?

INTR – Interrupt pin

NMI- Non maskable Interrupt input pin.

47. What is the DOS function to read a character from the keyboard

01H is the service number to read a character from the keyboard and read character will be stored in AL register.

48. What is the DOS function to display string on the output screen

09H is the service number to display string on the output screen and the effective address of the string to be displayed should be stored in DX register