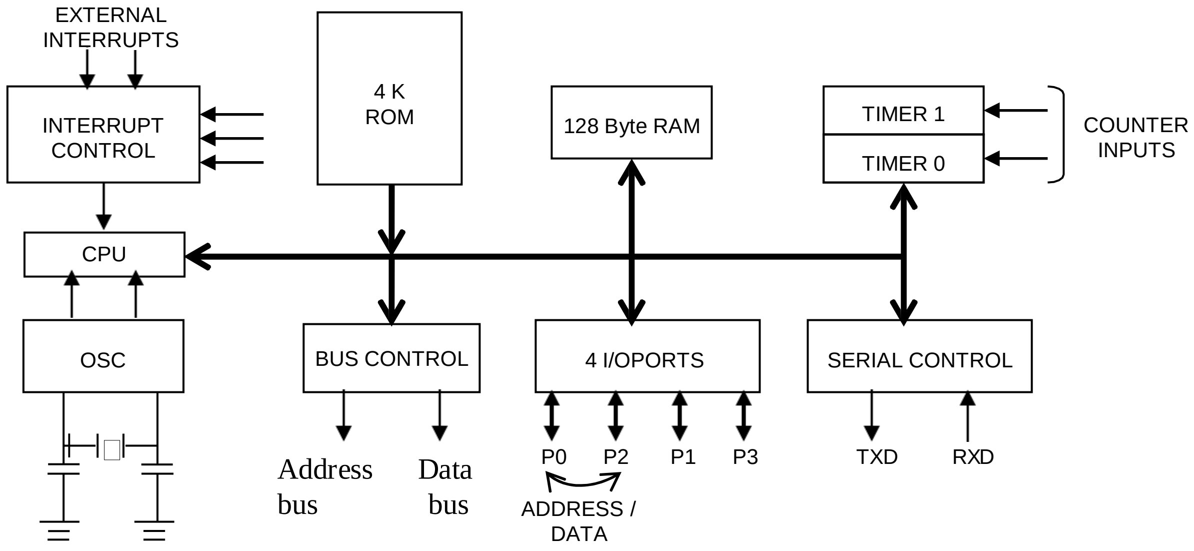
INTRODUCTION

MCS 8051 is an 8-bit single chip microcontroller with many built-in functions and is the core for all MCS-51devices.

The main features of the 8051 core are:

- Operates with single Power Supply+5V.
- 8-bit CPU optimized for control applications.
- 16-bit program counter (PC) and 16-bit data pointer(DPTR).
- 8-bit program status word (PSW).
- 8-bit stack pointer(SP).
- 4K Bytes of On-Chip Program Memory (Internal ROM or EPROM).
- 128 bytes of On-Chip Data Memory (Internal RAM):
  - Four Register Banks, each containing 8 registers (R0 to R7) (Total 32registers).
  - 16 bytes of bit addressable memory.
  - 80 bytes of general-purpose data memory (Scratch Pad Area).
- Special Function Registers (SFR) to configure/operate microcontroller.
- 32 bit bi-directional I/O Lines (4 ports P0 toP3).
- Two 16-bit timers/counters (T0 and T1).
- Full duplex UART (Universal Asynchronous Receiver/Transmitter).
- 6-source/5-vector interrupts (2 external and 3 internal) with two priority levels.
- On-Chip oscillator and clock circuitry.

Figure below shows the general block diagram



General Block Diagram of 8051 Microcontroller Architecture

Special Function Registers:

1. Timer Mode Control Register(TMOD):

TMOD can be considered to be two duplicate 4-bit registers, each of which controls the action of one of the timers. The “Timer” or “Counter” function is selected by control bits C/T, and in different operating modes, which are selected by bit-pairs (M1, M0) in TMOD.

MSB LSB

GATE	C / T	M1	M0	GATE	C / T	M1	M0
Timer1				Timer 0			

GATE	Gating control when set. Counter “x” is enabled only while “INTx” pin is high and “TRx” control pin is set. When cleared Timer “x” is enabled whenever “TRx” control bit is set.
C/T	Timer or Counter Selector cleared for Timer operation (input from internal system clock.) Set for Counter operation (input from “Tx” input pin).
M1 M0	**OPERATI0N**
0 0	13-bit Timer/Counter 5-bits of “TLx” and 8-bits of “THx” are used.
0 1	16-bit Timer/Counter 8-bits of “TLx” and 8-bits of “THx” are cascaded.
1 0	8-bit auto-reload Timer/Counter “THx” holds a value which is to be reloaded into “TLx” each time it overflows.
1 1	(Timer 0) TL0 is an 8-bit Timer/Counter controlled by the standard Timer 0 control bits. TH0 is an 8-bit timer only controlled by Timer 1 control bits. Timer/Counter 1 stopped.

2. Timer Control Register (TCON):

TCON has control bits and flags for the timers in the upper nibble, and control bits and flags for the external interrupts in lower nibble.

MSB LSB

TF1	TR1	TF0	TR0	IE1	IT1	IE0	IT0

Bit	Symbol	Function
TCON.7	TF1	Timer 1 overflow flag. Set by hardware on Timer/Counter overflow. Cleared by hardware when processor vectors to interrupt routine, or clearing the bit in software.
TCON.6	TR1	Timer 1 Run control bit. Set/cleared by software to turn Timer/Counter on/off.
TCON.5	TF0	Timer 0 overflow flag. Set by hardware on Timer/Counter overflow. Cleared by hardware when processor vectors to interrupt routine, or by clearing the bit in software.
TCON.4	TR0	Timer 0 Run control bit. Set/cleared by software to turn Timer/Counter on/off.
TCON.3	IE1	Interrupt 1 Edge flag. Set by hardware when external interrupts

		edge detected. Cleared when interrupt processed.
TCON.2	IT1	Interrupt 1 type control bit. Set/cleared by software to specify falling edge/low level triggered external interrupts.
TCON.1	IE0	Interrupt 0 Edge flag. Set by hardware when external interrupts edge detected. Cleared when interrupt processed.
TCON.0	IT0	Interrupt 0 Type control bit. Set/cleared by software to specify falling edge/low Level triggered external interrupts.

3.Interrupt Enable (IE) Register:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
EA	x	x	ES	ET1	EX1	ET0	EX0

Symbol	**Name and Function**
EA	Enable All. If 0, Disables all interrupts and no interrupt is acknowledged. If 1, each interrupt can be individually enabled or disabled by programming appropriate bit.
x	Reserved
x	-
ES	Enable Serial Interrupt. If 1, enables TI or RI to generate interrupt.
ET1	Enable Timer 1 interrupt. If 1, Enables the TF1 to generate the interrupt.
EX1	Enable External interrupt 1. If 1, Enables the INT1 to generate the interrupt.
ET0	Enable Timer 0 interrupt. If 1, Enables the TF0 to generate the interrupt.
EX0	Enable External interrupt 0. If 1, Enables the INT0 to generate the interrupt.

4. Interrupt Priority (IP) Register:

Each source of the interrupt can be individually programmed to be in either of the two priority levels. The priorities can be assigned to each interrupt by programming appropriate bits in the SFR Interrupt Priority Register.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
x	x	x	PS	PT1	PX1	PT0	PX0

Symbol	**Name and Function**
x	Reserved
x	Reserved
x	-
PS	Priority of Serial Interrupt. If 1, Priority of Serial Interrupt is higher.

PT1	Priority of Timer 1 interrupt. If 1, Priority of Timer 1 interrupt is higher.
PX1	Priority of External interrupt 1. If 1, Priority of the INT1 is higher.
PT0	Priority of Timer 0 interrupt. If 1, Priority of Timer 0 Interrupt is higher.
PX0	Priority of External interrupt 0. If 1, Priority of the INT0 is higher.

5. Serial Port Control Register (SCON):

The serial port control and status register is the Special Function Register **SCON.** This register contains not only the mode selection bits, but also the 9th data bit for transmit and receive (TB8 and RB8) and the serial port interrupt bits (TI and RI).

MSB LSB

SM0	SM1	SM2	REN	TB8	RB8	TI	RI

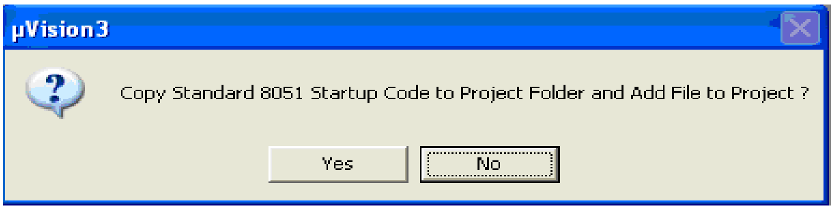
Where SM0, SM1 specify the serial port mode, as follows:

SM0	SM1	Mode	Description	Baud Rate
0	**0**	**0**	shift register	f osc / 12
0	**1**	**1**	8-bit UART	Variable
1	**0**	**2**	9-bit UART	f osc / 64 or fosc /32
1	**1**	**3**	9-bit UART	variable

SM2	Enables the multiprocessor communication feature in Modes 2 and 3. In Mode 2 or 3, if SM2 is set to 1, then Rl will not be activated if the received 9th data bit (RB8) is 0. In Mode 1, if SM2=1 then RI will not be activated if a valid stop bit was not received. In Mode 0, SM2 should be0.
REN	Enables serial reception. Set by software to enable reception. Clear by software to disable reception.
TB8	The 9th data bit that will be transmitted in Modes 2 and 3. Set or clear by software as desired.
RB8	In Modes 2 and 3, is the 9th data bit that was received. In Mode 1, it SM2=0, RB8 is the stop bit that was received. In Mode 0, RB8 is not used.
TI	Transmit interrupt flag. Set by hardware at the end of the 8th bit time in Mode 0, or at the beginning of the stop bit in the other modes, in any serial transmission. Must be cleared by softwareonly.
RI	Receive interrupt flag. Set by hardware at the end of the 8th bit time in Mode 0, or halfway through the stop bit time in the other modes, in any serial reception (except see SM2). Must be cleared by software only.

STEPS TO CREATE AND COMPILE Keil µVision-3/4 PROJECT:

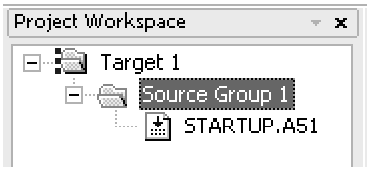
1. Double Click on the **µVision3/4** icon on thedesktop.
2. Close any previous projects that were opened using – **Project ->Close**.
3. Start **Project – New Project,** and select the CPU from the device database (Database-Atmel- AT89C51ED2 or AT89C51RD2 as per the board).On clicking **'OK'**, the following option is displayed. Choose**'No'**.



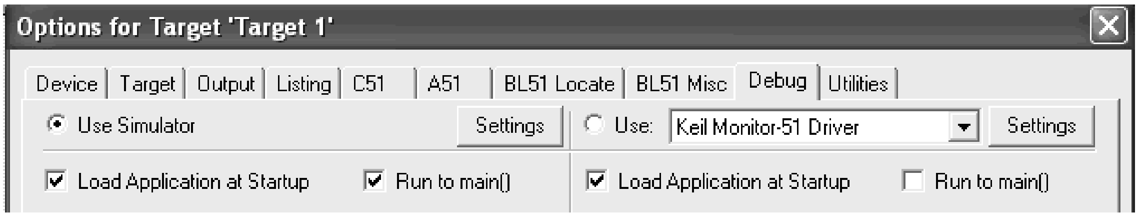
Copy Standard 8051 Startup Code to Project Folder and Add File to Project ?

4. Create a source file (using **File->New**), type in the assembly or C program and save this (filename**.asm**/filename**.c**) and add this source file to the project using either one of the following two methods. (i)**Project->Manage->Components, Environment Books->addfiles->**browse to the required file **-> OK**

   "OR" ii) right click on the Source Group in the Project Window and the **Add Files to Group** option.



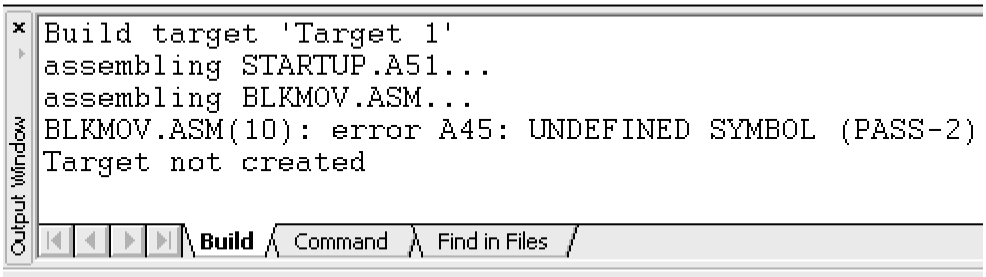
5. Set the Target options using ->**Project – Options for Target** opens the µ Vision2 **Options for Target – Target** configuration dialog. Set the **Xtal**(Crystal frequency)frequencyas11.0592MHz,andalsothe**OptionsforTarget – Debug – use either Simulator / Keil Monitor- 51 driver.**



● Use Simulator
☑ Load Application at Startup ☑ Run to main()
○ Use: Keil Monitor-51 Driver
☑ Load Application at Startup □ Run to main()

6. If **Keil Monitor- 51 driver is used click on Settings** -> COM Port settings select the COM Port to which the board is connected and select the baud rate as 19200 or 9600 (recommended). Enable **Serial Interrupt** option if the user application is not using on-chip UART, to stop programexecution.

7. Build the project; using **Project -> Build Project**. µVision translates all the user application and links. Any errors in the code are indicated by – “Target not created” in the Build window, along with the error line. Debug the errors. After an error free, to build go to Debugmode.

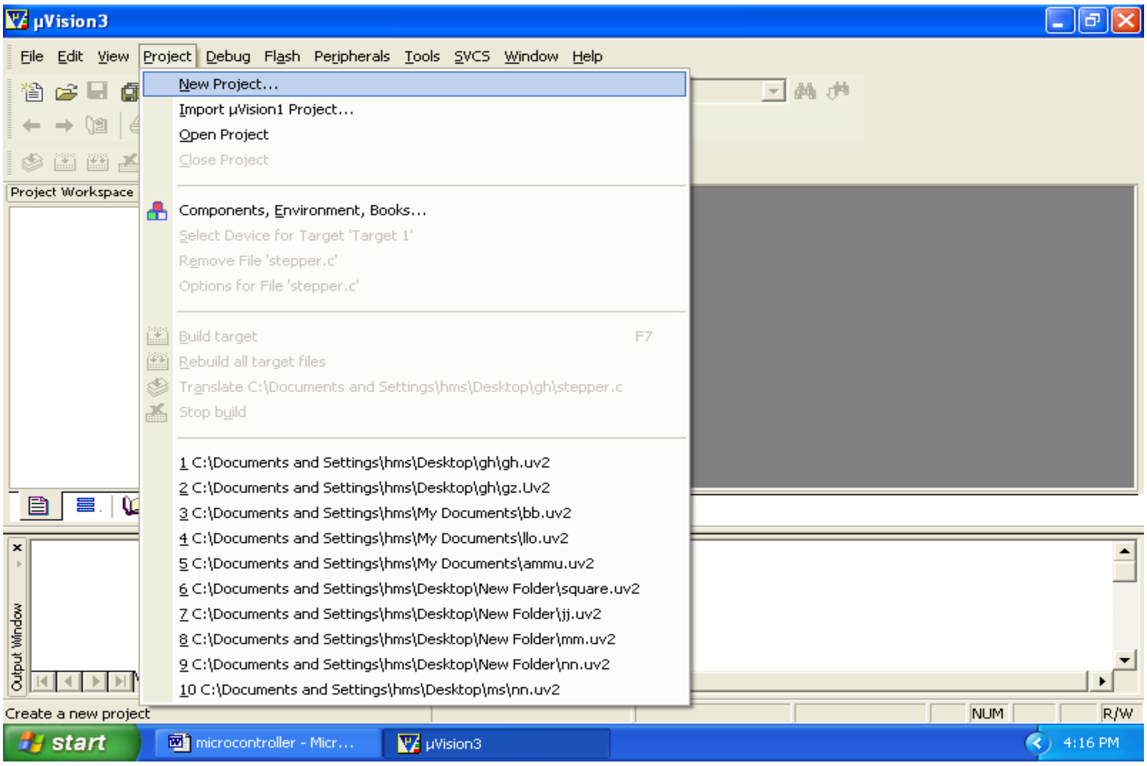


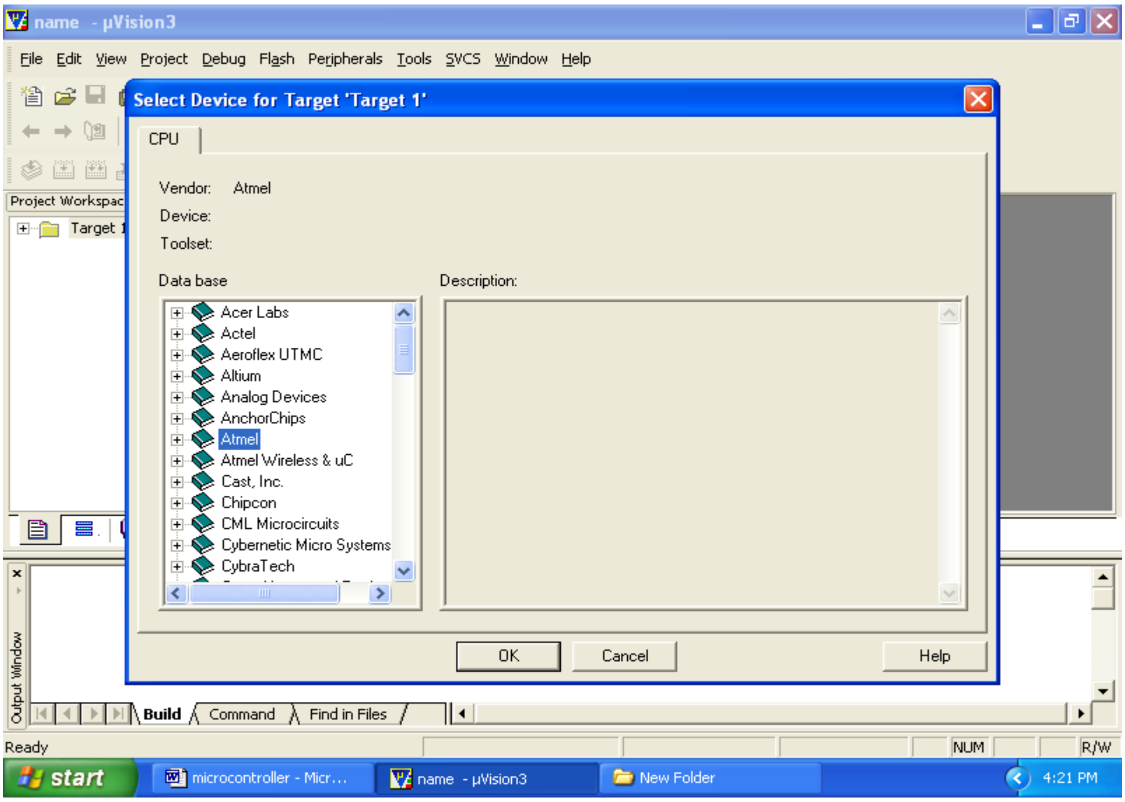
```
Build target 'Target 1'
assembling STARTUP.A51...
assembling BLKMOV.ASM...
BLKMOV.ASM(10): error A45: UNDEFINED SYMBOL (PASS-2)
Target not created
```

8. NowusercanenterintoDebugmodewith**Debug-Start/StopDebugsession** dialog. Or by clicking in the icon.
9. The program is run using the **Debug-Run** command & halted using **Debug-Stop Running.** Also the (reset, run, halt) icons can be used. Additional icons are (step, step over, and step into, run tillcursor).
10. IfitisaninterfaceprogramtheoutputscanbeseenontheLCD,CRO,motor,led status, etc. If it is a part-A program, the appropriate memory window is opened using View -> memory window (for data RAM & XRAM locations), Watch window (for timer program), serial window, etc.

Note: To access data RAM area type address as D: 0020h. Similarly to access the DPTR region (XRAM-present on chip in AT89C51ED2) say 9000h location type in X: 09000H.

EXECUTION STEPS using KEIL µ vision:

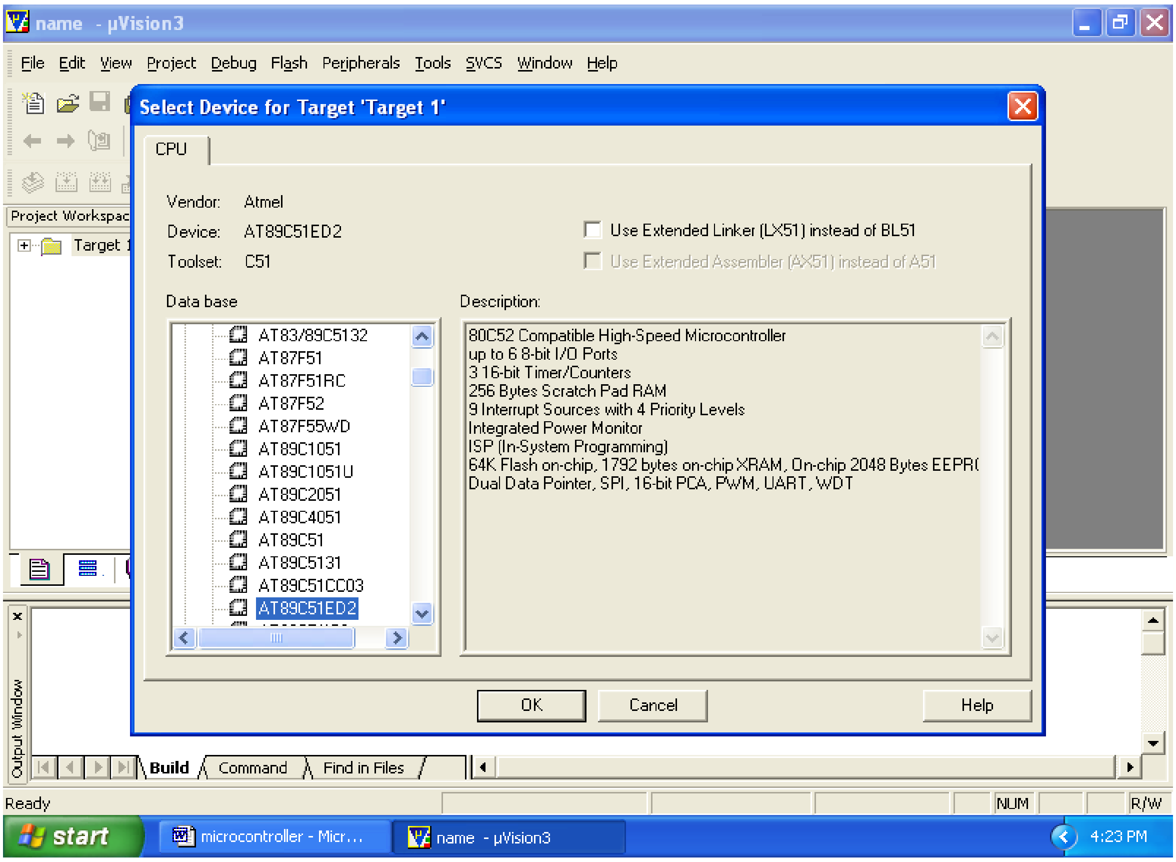

µVision3
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
New Project…
Import µVision1 Project…
Open Project
Close Project
Components, Environment, Books…
Select Device for Target 'Target 1'
Remove File 'stepper.c'
Options for File 'stepper.c'
Build target F7
Rebuild all target files
Translate C:\Documents and Settings\hms\Desktop\gh\stepper.c
Stop build
1 C:\Documents and Settings\hms\Desktop\gh\gh.uv2
2 C:\Documents and Settings\hms\Desktop\gh\gz.Uv2
3 C:\Documents and Settings\hms\My Documents\bb.uv2
4 C:\Documents and Settings\hms\My Documents\llo.uv2
5 C:\Documents and Settings\hms\My Documents\ammu.uv2
6 C:\Documents and Settings\hms\Desktop\New Folder\square.uv2
7 C:\Documents and Settings\hms\Desktop\New Folder\jj.uv2
8 C:\Documents and Settings\hms\Desktop\New Folder\mm.uv2
9 C:\Documents and Settings\hms\Desktop\New Folder\nn.uv2
10 C:\Documents and Settings\hms\Desktop\ms\nn.uv2
Project Workspace
Output Window
Create a new project
NUM
R/W
start
microcontroller - Micr…
µVision3
4:16 PM


name - µVision3
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Project Workspac
Target 1
Select Device for Target 'Target 1'
CPU

Vendor: Atmel

Device:

Toolset:



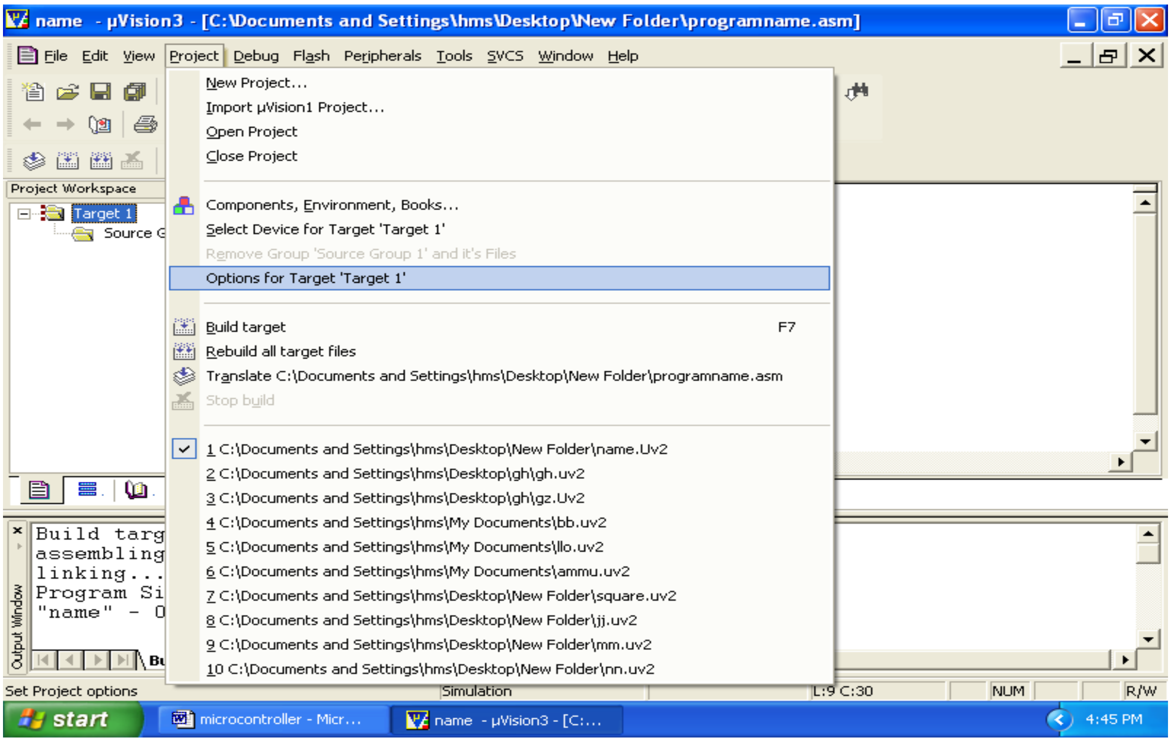
Select Device for Target 'Target 1'

Vendor: Atmel
Device: AT89C51ED2
Toolset: C51

□ Use Extended Linker (LX51) instead of BL51
□ Use Extended Assembler (AX51) instead of A51

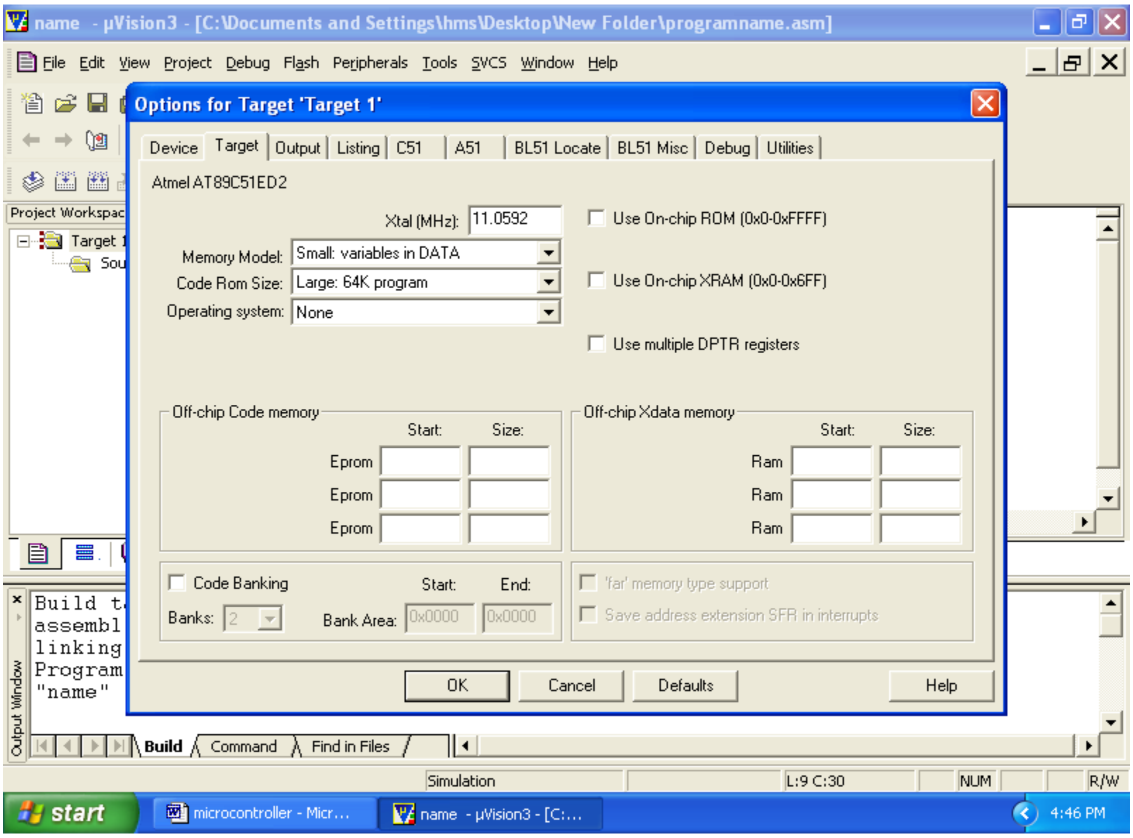
Description:
80C52 Compatible High-Speed Microcontroller
up to 6 8-bit I/O Ports
3 16-bit Timer/Counters
256 Bytes Scratch Pad RAM
9 Interrupt Sources with 4 Priority Levels
Integrated Power Monitor
ISP (In-System Programming)
64K Flash on-chip, 1792 bytes on-chip XRAM, On-chip 2048 Bytes EEPR(
Dual Data Pointer, SPI, 16-bit PCA, PWM, UART, WDT

name - µVision3
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
CPU
Data base
AT83/89C5132
AT87F51
AT87F51RC
AT87F52
AT87F55WD
AT89C1051
AT89C1051U
AT89C2051
AT89C4051
AT89C51
AT89C5131
AT89C51CC03
AT89C51ED2
OK
Cancel
Help
Project Workspace
Target 1
Build
Command
Find in Files
Output Window
Ready
NUM
R/W
start
microcontroller - Micr...
name - µVision3
4:23 PM



name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
New Project...
Import µVision1 Project...
Open Project
Close Project
Components, Environment, Books...
Select Device for Target 'Target 1'
Remove Group 'Source Group 1' and it's Files
Options for Target 'Target 1'
Build target F7
Rebuild all target files
Translate C:\Documents and Settings\hms\Desktop\New Folder\programname.asm
Stop build
1 C:\Documents and Settings\hms\Desktop\New Folder\name.Uv2
2 C:\Documents and Settings\hms\Desktop\gh\gh.uv2
3 C:\Documents and Settings\hms\Desktop\gh\gz.Uv2
4 C:\Documents and Settings\hms\My Documents\bb.uv2
5 C:\Documents and Settings\hms\My Documents\llo.uv2
6 C:\Documents and Settings\hms\My Documents\ammu.uv2
7 C:\Documents and Settings\hms\Desktop\New Folder\square.uv2
8 C:\Documents and Settings\hms\Desktop\New Folder\jj.uv2
9 C:\Documents and Settings\hms\Desktop\New Folder\mm.uv2
10 C:\Documents and Settings\hms\Desktop\New Folder\nn.uv2
Project Workspace
Target 1
Source G
Output Window
Set Project options
Simulation
L:9 C:30
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:45 PM

```
Build targ
assembling
linking...
Program Si
"name" - 0
```



name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]

Options for Target 'Target 1'

Atmel AT89C51ED2

Xtal (MHz): 11.0592

Memory Model: Small: variables in DATA

Code Rom Size: Large: 64K program

Operating system: None

□ Use On-chip ROM (0x0-0xFFFF)

□ Use On-chip XRAM (0x0-0x6FF)

□ Use multiple DPTR registers

Off-chip Code memory: Eprom Start: Size:

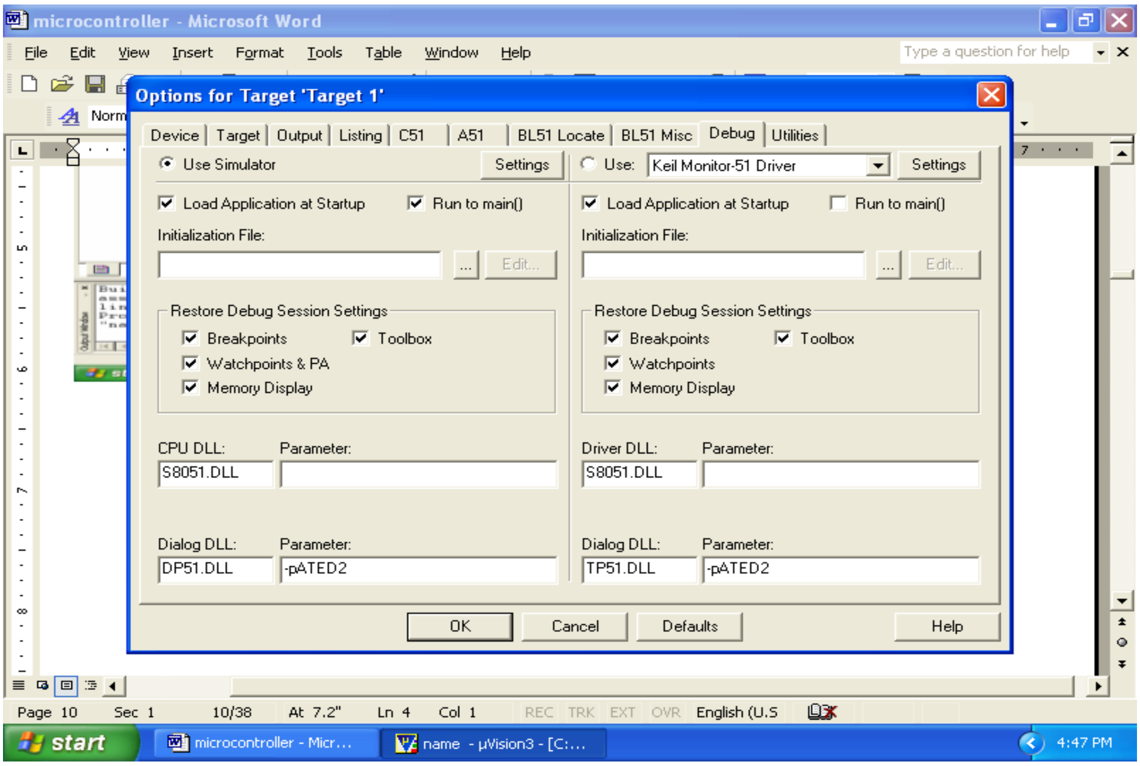
Off-chip Xdata memory: Ram Start: Size:

□ Code Banking Banks: 2 Start: End: Bank Area: 0x0000 0x0000

□ 'far' memory type support

□ Save address extension SFR in interrupts

File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Device Target Output Listing C51 A51 BL51 Locate BL51 Misc Debug Utilities
OK
Cancel
Defaults
Help
Project Workspace
Target 1
Build t
assembl
linking
Program
"name"
Build Command Find in Files
Simulation
L:9 C:30
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:46 PM



microcontroller - Microsoft Word

Options for Target 'Target 1'

● Use Simulator ○ Use: Keil Monitor-51 Driver

☑ Load Application at Startup ☑ Run to main() | ☑ Load Application at Startup □ Run to main()

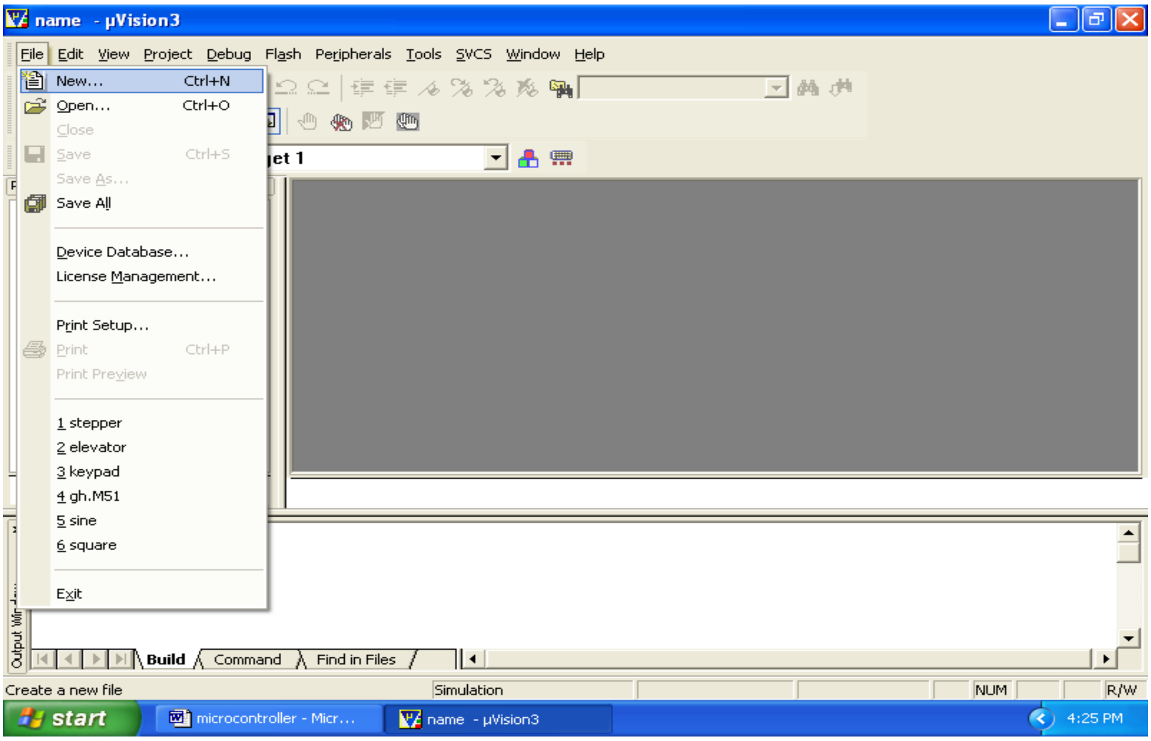
Initialization File:

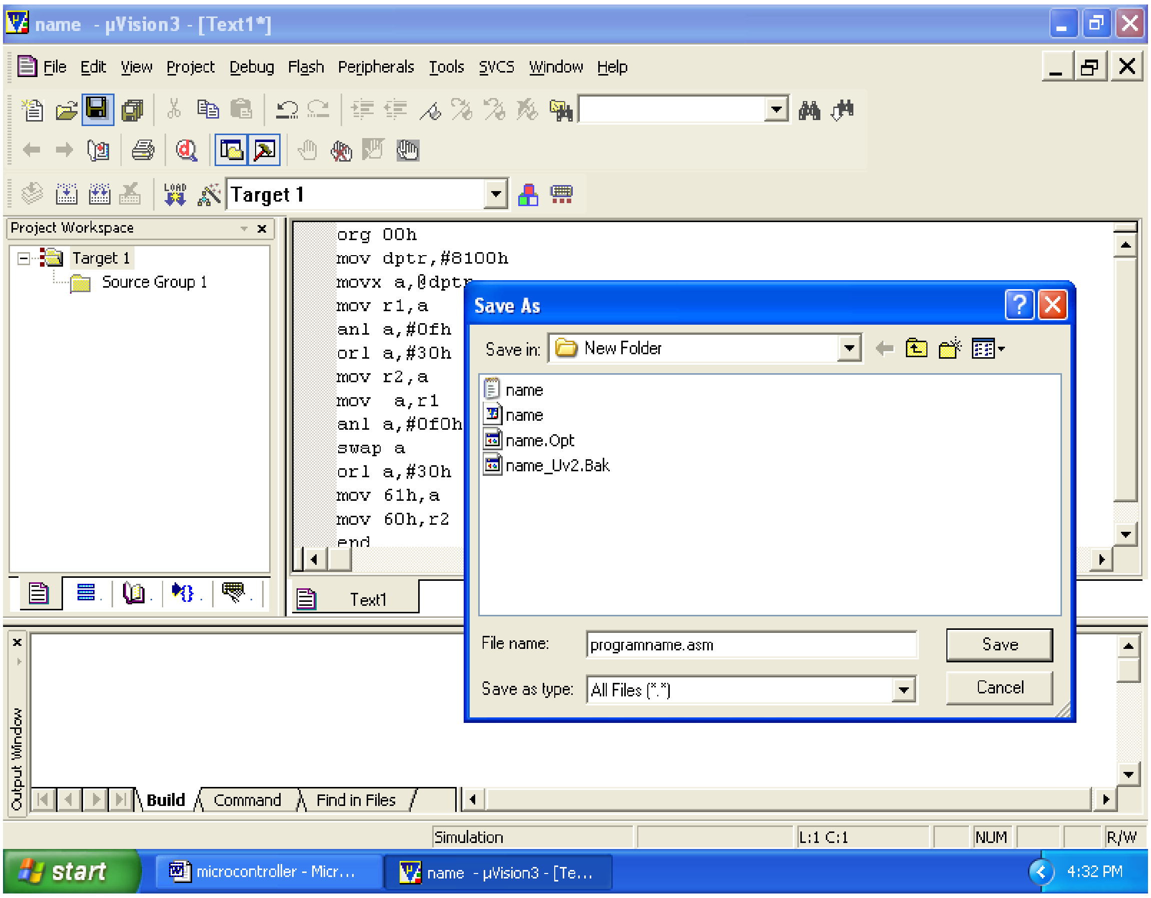
Restore Debug Session Settings: ☑ Breakpoints ☑ Toolbox ☑ Watchpoints & PA ☑ Memory Display | ☑ Breakpoints ☑ Toolbox ☑ Watchpoints ☑ Memory Display

CPU DLL: S8051.DLL Parameter: | Driver DLL: S8051.DLL Parameter:

Dialog DLL: DP51.DLL Parameter: -pATED2 | Dialog DLL: TP51.DLL Parameter: -pATED2

File Edit View Insert Format Tools Table Window Help
Type a question for help
Device Target Output Listing C51 A51 BL51 Locate BL51 Misc Debug Utilities
Settings
Edit...
OK
Cancel
Defaults
Help
Page 10 Sec 1 10/38 At 7.2" Ln 4 Col 1 REC TRK EXT OVR English (U.S
start
microcontroller - Micr...
name - µVision3 - [C:...
4:47 PM



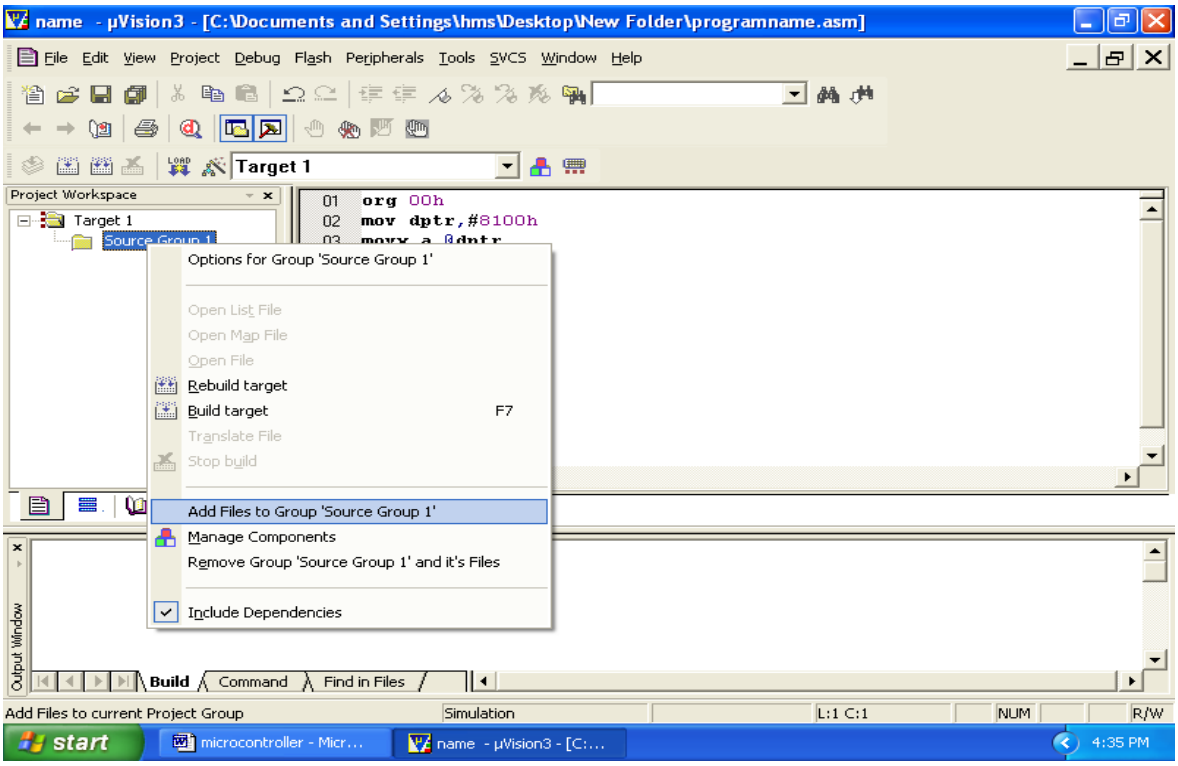


```
org 00h
mov dptr,#8100h
movx a,@dptr
mov r1,a
anl a,#0fh
orl a,#30h
mov r2,a
mov  a,r1
anl a,#0f0h
swap a
orl a,#30h
mov 61h,a
mov 60h,r2
end
```

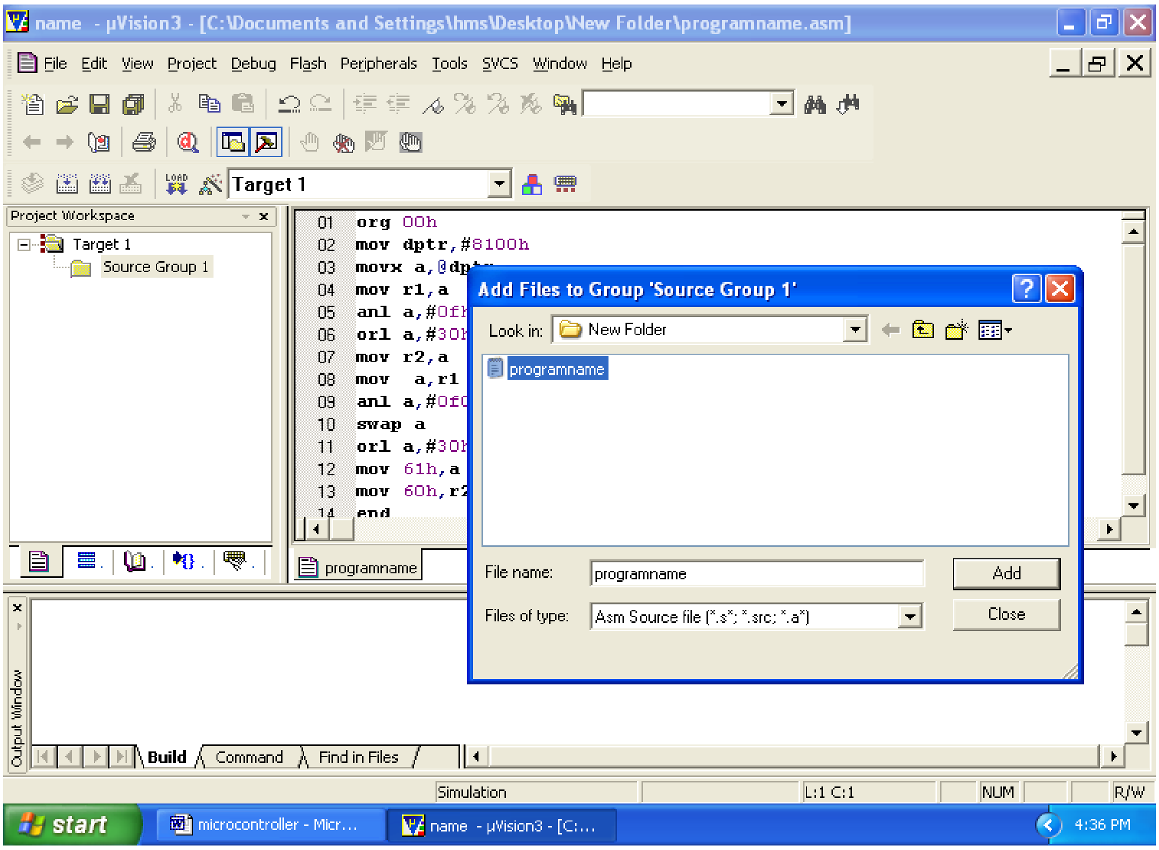
Save in: New Folder

File name: programname.asm

Save as type: All Files (*.*)


name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Target 1
Project Workspace
Target 1
Source Group 1
Options for Group 'Source Group 1'
Open List File
Open Map File
Open File
Rebuild target
Build target F7
Translate File
Stop build
Add Files to Group 'Source Group 1'
Manage Components
Remove Group 'Source Group 1' and it's Files
Include Dependencies
Output Window
Build
Command
Find in Files
Add Files to current Project Group
Simulation
L:1 C:1
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:35 PM

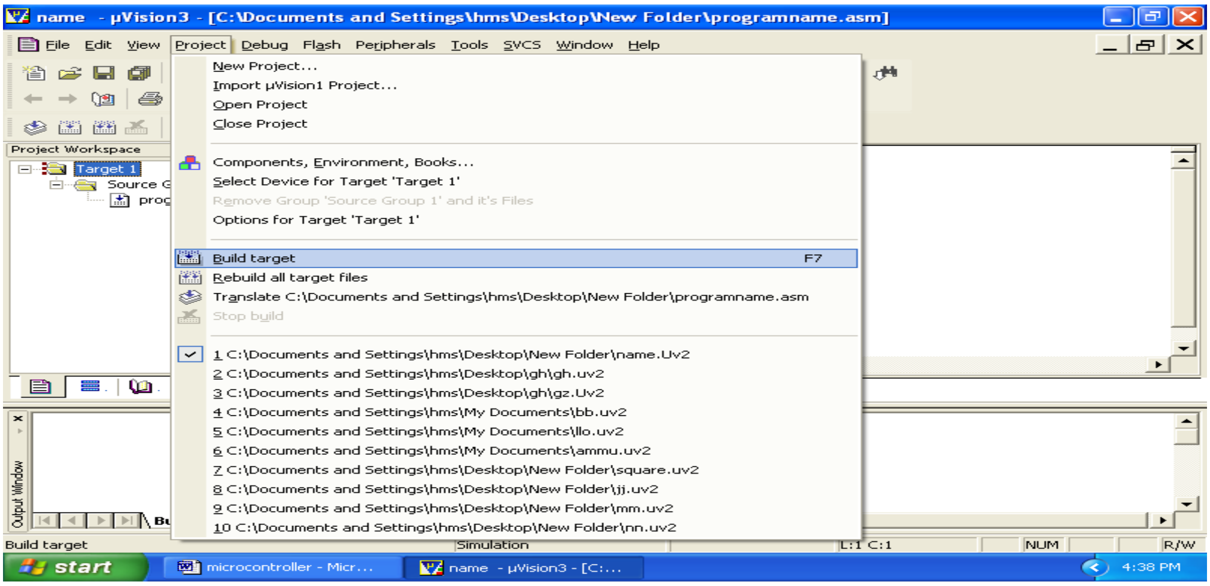
```
org 00h
mov dptr,#8100h
movx a,@dptr
```

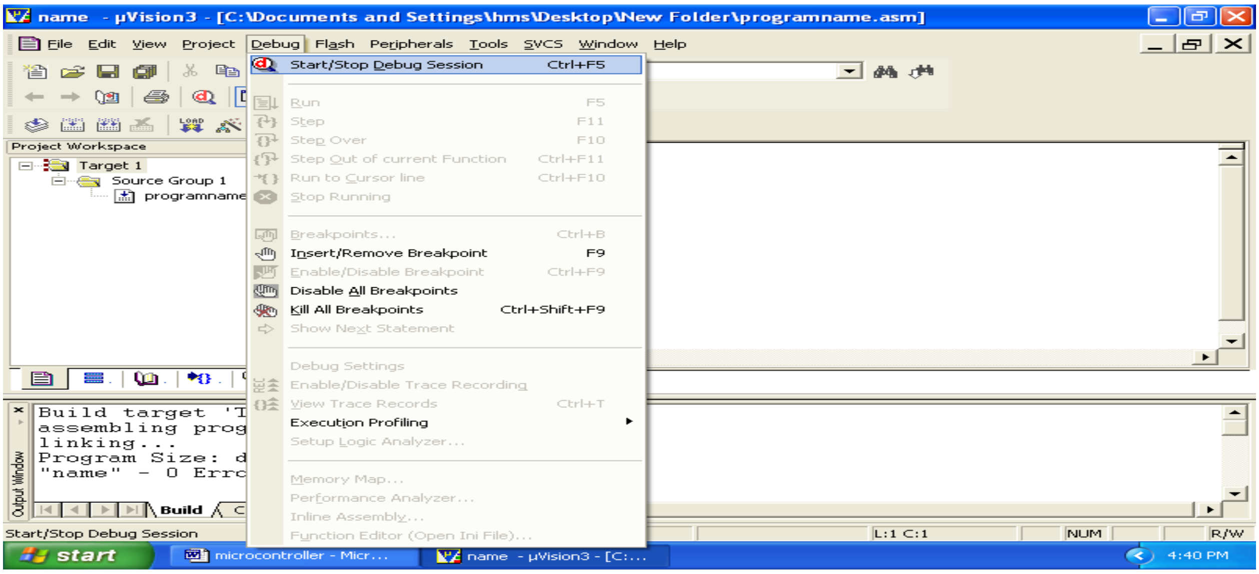

name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Target 1
Project Workspace
Target 1
Source Group 1
programname
Add Files to Group 'Source Group 1'
Look in:
New Folder
programname
Add
Close
Output Window
Build
Command
Find in Files
Simulation
L:1 C:1
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:36 PM

```
org 00h
mov dptr,#8100h
movx a,@dpt
mov r1,a
anl a,#0f
orl a,#30
mov r2,a
mov  a,r1
anl a,#0f0
swap a
orl a,#30
mov 61h,a
mov 60h,r2
end
```

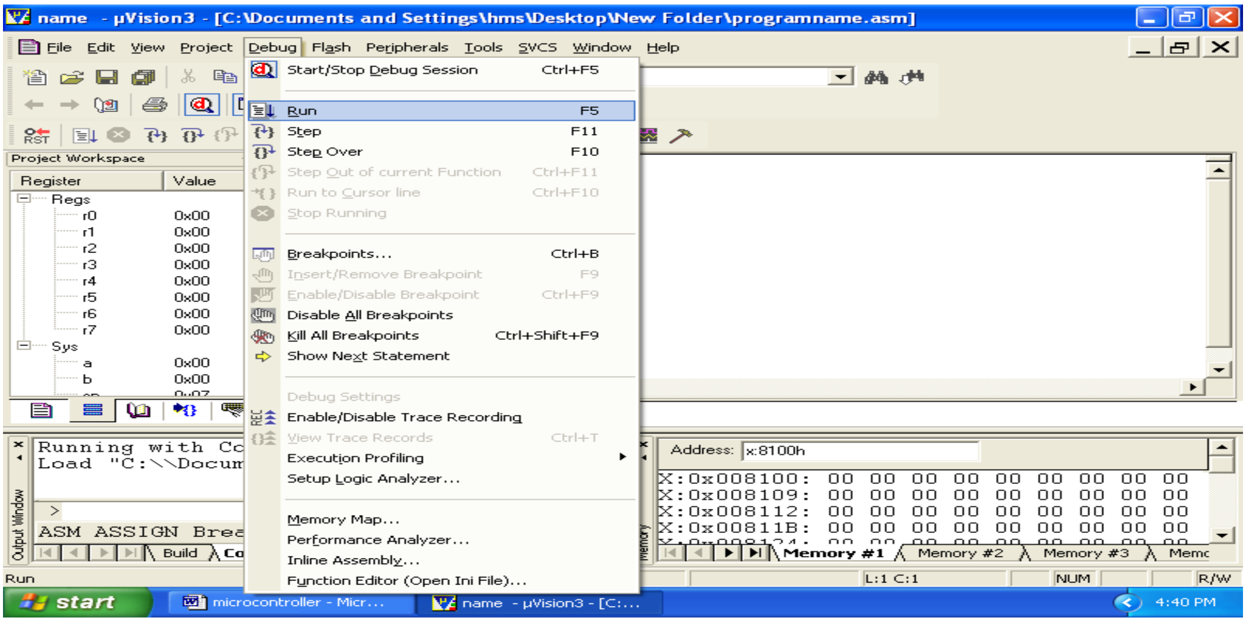
File name: programname

Files of type: Asm Source file (*.s*; *.src; *.a*)


name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
New Project...
Import µVision1 Project...
Open Project
Close Project
Components, Environment, Books...
Select Device for Target 'Target 1'
Remove Group 'Source Group 1' and it's Files
Options for Target 'Target 1'
Build target F7
Rebuild all target files
Translate C:\Documents and Settings\hms\Desktop\New Folder\programname.asm
Stop build
1 C:\Documents and Settings\hms\Desktop\New Folder\name.Uv2
2 C:\Documents and Settings\hms\Desktop\gh\gh.uv2
3 C:\Documents and Settings\hms\Desktop\gh\gz.Uv2
4 C:\Documents and Settings\hms\My Documents\bb.uv2
5 C:\Documents and Settings\hms\My Documents\llo.uv2
6 C:\Documents and Settings\hms\My Documents\ammu.uv2
7 C:\Documents and Settings\hms\Desktop\New Folder\square.uv2
8 C:\Documents and Settings\hms\Desktop\New Folder\jj.uv2
9 C:\Documents and Settings\hms\Desktop\New Folder\mm.uv2
10 C:\Documents and Settings\hms\Desktop\New Folder\nn.uv2
Project Workspace
Target 1
Source G
prog
Output Window
Build target
Simulation
L:1 C:1
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:38 PM


name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Start/Stop Debug Session Ctrl+F5
Run F5
Step F11
Step Over F10
Step Out of current Function Ctrl+F11
Run to Cursor line Ctrl+F10
Stop Running
Breakpoints... Ctrl+B
Insert/Remove Breakpoint F9
Enable/Disable Breakpoint Ctrl+F9
Disable All Breakpoints
Kill All Breakpoints Ctrl+Shift+F9
Show Next Statement
Debug Settings
Enable/Disable Trace Recording
View Trace Records Ctrl+T
Execution Profiling
Setup Logic Analyzer...
Memory Map...
Performance Analyzer...
Inline Assembly...
Function Editor (Open Ini File)...
Project Workspace
Target 1
Source Group 1
programname
Output Window
Build
Start/Stop Debug Session
L:1 C:1
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:40 PM

```
Build target 'T
assembling prog
linking...
Program Size: d
"name" - 0 Erro
```


name - µVision3 - [C:\Documents and Settings\hms\Desktop\New Folder\programname.asm]
File Edit View Project Debug Flash Peripherals Tools SVCS Window Help
Start/Stop Debug Session Ctrl+F5
Run F5
Step F11
Step Over F10
Step Out of current Function Ctrl+F11
Run to Cursor line Ctrl+F10
Stop Running
Breakpoints... Ctrl+B
Insert/Remove Breakpoint F9
Enable/Disable Breakpoint Ctrl+F9
Disable All Breakpoints
Kill All Breakpoints Ctrl+Shift+F9
Show Next Statement
Debug Settings
Enable/Disable Trace Recording
View Trace Records Ctrl+T
Execution Profiling
Setup Logic Analyzer...
Memory Map...
Performance Analyzer...
Inline Assembly...
Function Editor (Open Ini File)...
Project Workspace
RST
Output Window
Build
Memory #1
Memory #2
Memory #3
Memc
Run
L:1 C:1
NUM
R/W
start
microcontroller - Micr...
name - µVision3 - [C:...
4:40 PM

Register	Value
Regs	
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00

```
Running with Co
Load "C:\\Docum

>
ASM ASSIGN Brea
```

Address: x:8100h

```
X:0x008100: 00 00 00 00 00 00 00 00 00
X:0x008109: 00 00 00 00 00 00 00 00 00
X:0x008112: 00 00 00 00 00 00 00 00 00
X:0x00811B: 00 00 00 00 00 00 00 00 00
```

Programming Using 8051

Basic Programs

Example1: Program for addition of two 8 bit no's

```
Mov  r0,#82h        ; moves the immediate data 82h to r0 register
Mov a,r0            ; moves content or data of r0 register to accumalator
Mov  r1,#02h        ; moves the immediate data 02h to r1register
Mov  b,r1           ; moves the content or data of r1 register to b register
Add a,b             ; adds accumulator data with b register data and stores
                      Output in accumalator
Mov 60h,a           ; store Output ( data in a) in the direct data address (60h)
end
```

Intermediate outputs to observe : r0= 82h ; a=82h ; r1=02h; b=02h; a=84h

Final Output: D:60h=84h

Example 2: Program for swap function (inter changing the nibbles)

```
Mov a,#21h
Mov 30h,a
Swap a        ; interchanging lower nibble to higher
Mov 31h,a
end
```

Intermediate outputs to observe: a= ; d:30h = ; a= ; d:31h =

Output: Initially a =21 After execution a =12

Example 3: Program for rotate operations

```
mov a,#21h
clr c
mov b,a
rl a                ; rotate accumulator by left
mov 30h,a
mov a,b
rlc a               ; rotate accumulator by left through carry
mov 31h,a
mov a,b
```

```
rr a                    ; rotate accumulator by right
mov 32h,a
mov a,b
rrc a                   ; rotate accumulator by right through carry
mov 33h,a
end
```

Output: Initially a =21h

rl (d:30h)=42h

rlc(d:31h)=42h

rr(d:32h)=90h

rrc(d:33h)=10h

Example 4: Program to divide two 8-bit no’s

```
Mov r0 ,#12h            ; get first no. in r0
Mov a,r0                ; copy r0 value to accumulator
Mov r1 ,#05h            ; get second no in r1
Mov b,r1                ; copy r0 value to register b
Div ab                  ; divide A by B
Mov 60h,a               ; Quotient value stored in 60h data location
Mov 61h,b               ; reminder value to 61h data location
```

Output: D:60h=

D:61h=

Example 5: program to multiply two 8-bit no’s

```
Mov r0 ,#12h            ; get first no in r0
Mov a,r0                ; copy r0 value to accumulator
Mov r1 ,#05h            ; get second no in r1
Mov b,r1                ; copy r0 value to register b
Mul ab                  ; multiply A by B
Mov 60h,a               ; Output stored in 60h data location
```

Output: D:60h=5A

Example 6: Program AND, SWAP, ORoperations

```
 Mov r0 ,#12h            ; get first no inr0
Mov a,r0                 ; copy r0 value to accumulator
Anl a,#0F0h              ; mask lower bit
Mov 60h,a                ; store Output of AND operation in 60h data location
Mov  a,r0                ; copy r0 value to accumulator
Swap a                   ; exchange upper and lower nibbles of acc
Mov 61h,a                ;store Output of AND operation in 61h data location
Mov  a,r0                ; copy r0 value to accumulator
Orl a,0f0h               ; OR operation
Mov 62h,a                ;store Output of OR operation in 62h data location
 End
```

Output: D:60h=

D:61h=

D:62h=

Part-A

8051: Assembly Language Programs

General Procedure:

- Double click Kiel µ-vision
- Go to project Select ➐ Create New project
- Select Atmel AT89C51ED2 IDE from the Kiel µ-vision
- Select New file, Enter the program and Save as(.asm in Assembly and .c in C)and Click ➐ ok
- Add above file to the project created, build target , debug and run the program
- observe the result , by giving particular input before execution.

1. Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations for 16 bitnumbers.

(a) Addition

(b) Subtraction

(c) Multiplication

(d) Division

(e) Square of a number

(a) Addition of two 16 bit numbers:

```
mov dptr,#9001h
mov r0,#0ffh
mov r1,#0ffh
mov r2,#0ffh
mov r3,#0ffh
clr c
mova,r0
add a,r2
movx @dptr,a
dec dpl
mov a,r1
addc a,r3
movx @dptr,a
mov 00h,c
sjmp $
end
```

Output:

```
      r1 r0   =    ff ff
   +  r3 r2   =    ff ff
                  ---------

                 ----------
```

(b) Program for Subtraction of two 16 bit numbers:

```
mov dptr,#9001h   // 5673-fc22
mov  r0,#73h
mov  r1,#56h
mov  r2,#22h
mov r3,#0fch
clr c
mov a,r0
subb a,r2
movx @dptr,a
dec dpl
mov a,r1
subb a,r3
movx @dptr,a
mov 00h,c end
```

Output:

```
   r1 r0              56  73  h
-  r3 r2     ⇨        fc  22h
                    -------------

                    -------------
```

(c) Multiplication of two 16 bit numbers:

```
Mov dptr,#9003h
mov r0,#23h
mov  r1,#41h
mov  r2,#41h
mov  r3,#32h
mov  a,r3
mov b,r1
mul ab
movx @dptr,a
mov r4,b
mov a,r3
mov b,r0
mul ab
add a,r4
mov r5,a
mov r4,b
mov a,r2
mov b,r1
mul ab
add a,r5
dec dpl
movx @dptr,a
mov a,b
addc a,r4
mov r4,a
mov a,r2
mov b,r0
mul ab
add a,r4
dec dpl
movx @dptr,a
dec dpl
mova,b
movx @dptr,a
end
```

Output: r0 r1 X r2r3 → 23 41 X 41 32

```
                    ---------------------------

                      --------------------------
```

(d) Division of 16 bit by 8 bit number:

```
            org 00h
            mov r0,40h
            mov r1,41h
            mov b,43h
            mov a,r0
            div ab
            mov 45h,a
            mova,b
            mov b,#0ah
            mul ab
            add a,r1
            movb,43h
            div ab
            mov 46h,a
here:       sjmp here
           end
```

Output: r1 r0 ÷b

(e) Find square of a number:

```
mov dptr,#9000h
movx a,@dptr
movb,a
mul ab
mov r0,a
mov dptr,#900eh
mov a,b
movx @dptr,a
inc dpl
mov a,r0
movx @dptr,a
end
```

Output: X : 900e h =(accumulator)^2

2. Data transfer – Program for block data movement, sorting, exchanging, finding largest element in anarray.

a) Block transfer of data without overlap
b) Sorting ofdata
c) Block exchange ofdata
d) Finding largest number in thearray

(a). Block transfer of data without overlap

```
          mov dptr,#9000h
          mov 30h,#00h
          mov 31h,#91h
          mov r7,#05h
 back: movx a,@dptr
          inc dptr
          mov  32h,dpl
          mov  33h,dph
          mov dpl,30h
          mov dph,31h
          movx  @dptr,a
          inc dptr
          mov 30h,dpl
       mov 31h,dph
          mov dpl,32h
          mov dph,33h
          djnz r7,back
           end
```

Output:

Before execution					
Source Memory Location	9000	9001	9002	9003	9004
Source Data	01	03	05	07	09
Destination Memory location	9100	9101	9102	9103	9104
Destination data	00	00	00	00	00
After execution					
Source Memory Location	9000	9001	9002	9003	9004
Source Data	01	03	05	07	09
Destination Memory location	9100	9101	9102	9103	9104
Destination data	01	03	05	07	09

Before execution					
Source Memory Location					
Source data					
Destination Memory location					
Destination data					
After execution					
Source Memory Location					
Source Data					
Destination Memory location					
Destination data					

(b) Sorting (Ascending and descendingorder)

```
            mov    r0,#04h
            dec  r0
    back3: mov r1,00h
            mov dptr,#9000h
    back1: movx a,@dptr
            mov 7fh,a
             Inc dptr
            Movx a,@dptr
            cjne a,7fh,exc
            sjmp back2
       exc: jnc back2
            mov      r3,7fh
            xch a,r3
            movx @dptr,a
            mov a,r3
            movx @dptr,a
            inc dptr
    back2: djnz r1,back1
            djnz r0,back3
            sjmp $
            end
```

Output: for ascending order

Before execution					
Memory Location	9000	9001	9002	9003	9004
Data	05	02	08	03	01
After execution					
Memory Location	9000	9001	9002	9003	9004
Data	01	02	03	05	08

Before execution					
Memory Location					
Data					
After execution					
Memory Location					
Data					

Output: for Descending order decdpl

Before execution					
Memory Location	9000	9001	9002	9003	9004
Data	05	02	08	03	01
After execution					
Memory Location	9000	9001	9002	9003	9004
Data	08	05	03	02	01

Before execution					
Memory Location					
Data					
After execution					
Memory Location					
Data					

Note: Change the instruction **jnc back2** in the program to sort the data in ascending order to **jc back2** to sort the data in descending order.

Date:

(c) Block exchange of data

```
          mov dptr,#9000h
          mov 30h,#00h
          mov 31h,#91h
          mov r7,#05h
    back: movx a,@dptr
          mov 32h,dpl
          mov 33h,dph
          mov r4,a
          mov dpl,30h
          mov dph,31h
          movx a,@dptr
          xch a,r4
          movx @dptr,a
          inc dptr
          mov 30h,dpl
          mov 31h,dph
          mov dpl,32h
          mov dph,33h
          mov a,r4
          movx @dptr,a
          inc dptr
          djnz  r7,back
          end
```

Output:

Before execution					
Source Memory Location	9000	9001	9002	9003	9004
Source Data	01	02	03	04	05
Destination Memory location	9100	9101	9102	9103	9104
Destination data	06	07	08	09	10
After execution					
Source Memory Location	9000	9001	9002	9003	9004
Source Data	06	07	08	09	10
Destination Memory Location	9100	9101	9102	9103	9104

Before execution					
Source Memory Location					
Source Data					
Destination Memory location					
Destination data					
After execution					
Source Memory Location					
Source Data					
Destination Memory location					
Destination data					

(d) Finding the Largest number in a given array:

```
        Mov dptr,#9000h
        mov r0,#05h
        dec r0
        movx a,@dptr
        mov 7fh,a
back2: inc dptr
        movx a,@dptr

        cjne a,7fh,back1
        sjmp back3
back1: jc back3
        mov 7fh,a
back3: djnz r0,back2
        mov 77h,7fh
        end
```

Output:

Before execution					
Memory Location	9000	9001	9002	9003	9004
Data	05	02	08	03	01
After execution					
Data Location	D:77h	08			

Before execution					
Memory Location					
Data					
After execution					
Data Location	D:77h				

** For finding the **Smallest element** in a given array:

Note: Change the instruction **jc back3** in the program to find largest element in the array to **jnc back3** to find the smallest element in the array.

Output:

Before execution					
Memory Location	9000	9001	9002	9003	9004
Data	05	02	08	03	01
After execution					
Data Location	D:77h	01			

Before execution					
Memory Location					
Data					
After execution					
Data Location	D:88h				

3. Counters (UP/DOWN)

3(a) Program for Binary up counter

```
           Mov dptr,#9000h
           mov    a,#00h
      next: movx @dptr,a

            acall delay
            inc    a
            jnz    next
      here:  sjmp here
      delay:  mov  r1,#0ffh
      loop1: mov  r2,#0ffh
      loop2: mov  r3,#0ffh
      loop3: djnz  r3,loop3
             djnz  r2,loop2
             djnz  r1,loop1
             ret
             end
```

Output: x:9000h=00,01,02. ff

3(b). Program for Binary down counter

```
         mov dptr,#9000h
         mov a,#0ffh
next:    movx @dptr,a
         acall delay
         dec a
         jnz  next
          movx@ dptr, a
here:     sjmp   here

delay:movr1,#0ffh

        loop1:movr2,#0ffh

        loop2:movr3,#0ffh

       loop3:djnzr3,loop3
             djnz r2, loop2
              djnz r1,loop1
      ret
     end
```

Output: x:9000h=ff,fe,fd. 00

3(c) . Program for Decimal up counter

```
                Mov dptr,#9000h
                mov     a,#00h
  next:         movx @dptr,a
                    acall    delay
                    add      a,#01h
                    da       a
                    jnz      next
      here:         sjmp     here
      delay:        mov      r1,#0ffh
      loop1:        mov      r2,#0ffh
      loop2:        mov      r3,#0ffh
      loop3:        djnz     r3,loop3
                    djnz     r2,loop2
                    djnz     r1,loop1
                    ret
                    end
```

Output: x: 9000h=00,01,02. 99

3(d) Program for Decimal down counter

```
            Mov dptr,#9000h
            mov    a,#99h
next:       movx @dptr,a
            acall  delay
            add    a,#99h
            da     a
            jnz    next
            movx@dptr,a
here:       sjmp   here
delay:       mov   r1,#0ffh
loop1:      mov    r2,#0ffh
loop2:      mov    r3,#0ffh
loop3 :     djnz   r3,loop3
            djnz   r2,loop2
            djnz   r1,loop1
            ret
            end
```

Output: x: 9000h=99,98,97… 00

4. Boolean and Logical instructions (Bit Manipulation):

4(a) Write an ALP to compare two eight bit numbers NUM1 and NUM2 stored in external memory locations 8000h and 8001h respectively. Reflect your result as: If NUM1<NUM2, SET LSB of data RAM location 2FH (bit address 78H). If NUM1>NUM2, SET MSB of location 2FH (bit address 7FH). If NUM1 = NUM2, then Clear both LSB & MSB of bit addressable memory location 2FH.

```
              mov dptr,#8000h
              movx a,@dptr
              mov r0,a
              incdptr
              movx a,@dptr
              clr c
              sub  a,r0
              jz equal
              jnc small
              setb 7fh
              sjmp end1
       small: setb 78h
              sjmp end1
       equal: clr 78h
              clr 7fh
        end1: end
```

Result:

1) Before Execution: X: 8000h = & X: 8001 =
After Execution: D: 02FH =
2) Before Execution: X: 8000h = & X: 8001 =
After Execution: D: 02FH =
3) Before Execution: X: 8000h = & X: 8001 =
After Execution: D: 02FH =

4(b) Write an assembly language program to count number of ones and zeros in a eight bit number.

```
        mov r1,#00h // to count number of 0s
        mov r2,#00h // to count number of 1s
        mov r7,#08h // counter for 8-bits
        mov a,#97h // data to count number of 1s and 0s
again: rlc a
        jc next
        inc r1
        sjmp here
 next: incr2
here: djnz r7,again
       end
```

Result:

Input: **Output:**

Number of zero’s = r2 =

Number of one’s = r1

4(c) Write an assembly language program to find whether given eight bit number is odd or even. If odd store 00h in accumulator. If even store FFh in accumulator.

```
       mov a,20h      // 20h=given number, to find is it even or odd
       jb acc.0,odd    //jump if direct bit is set i.e., if lower bit is1
                         then number is odd
       mov a,#0FFh
       sjmp next
odd: mov a,#00h
next:end
```

Result:

Input: **Output:**

20h: a:

4(d) Write an assembly language program to perform logical operations AND, OR, XOR on two eight bit numbers stored in internal RAM locations 21h, 22h.

```
        mov a, 21h //do not use #, as data ram 21h is to be accessed
        anl a, 22h     //logical andoperation
        mov 30h, a //and operation result stored in 30h
        mov a, 21h
        orl a,22h      //logical or operation
        mov 31h, a //or operation result stored in 31h
        mov a,21h
        xrl a,22h     //logical xoroperation
        mov 32h,a // xor operation result stored in 32h
        end
```

Result:

```
        Before Execution: D:21H =                D:  22H =
        After Execution:  D:30H=                    //AND operation
          D: 31H=                                   //OR operation
          D: 32H=                                   //XOR operation
```

4(e) Write a Program to check whether given number is palindrome or not. If palindrome store FFh in accumulator else store 00h inaccumulator.

```
        mov 30h,#81h
        mov r0,30h
        mov r1,#08h
        mov 31h,#00h
        clr c
back: mov a,30h
        rlc a
        mov  30h,a
        mov  a,31h
        rrc a
        mov 31h,a
        djnz r1,back
        cjne a,00h,npal
        mov a,#0ffh
        sjmp  next
npal: mov a,#00h
next: end
```

Result:

Input: **Output:**

5. Code conversion programs

a) **BCD to ASCII**

b) **ASCII to BCD**

c) **ASCII to Decimal**

d) **Decimal toASCII**

e) **Hexa to decimal**

f) **Decimal to Hexa**

a) Program to convert a BCD number into ASCII code:

```
          mov dptr,#9000h
          movx a,@dptr
          mov r0,a
          swap a
          mov dptr,#900dh
          acall ascii
          mov a,r0
          acall ascii
          sjmp $
   ascii: anl a,#0fh
          add a,#30h
          movx @dptr,a
          inc dptr
          ret
          end
```

Result:

Before execution			
Memory Location	9000	900d	900e
Data	45	00	00
After execution			
Memory Location	9000	900d	900e
Data	45	34	35

Before execution			
Memory Location	9000	900d	900e
Data	97	00	00
After execution			
Memory Location	9000	900d	900e
Data	97	39	37

b) Program to convert a ASCII to BCD

```
mov a,#’4’
anl a,#0fh
swap a
mov b,a
mov a,#’7’
anl a,#0fh
orl a,b
```

Output: a=

c) Program to convert a ASCII number into decimal

```
Mov dptr,#9000h
movx a,@dptr
Clr c
subb a,#30h
movx dptr,a
end
```

Result:

Before execution	
Memory Location	9000
Data	33
After execution	
Memory Location	9000
Data	03

Before execution	
Memory Location	9000
Data	97
After execution	
Memory Location	9000
Data	

Date:

d) Program to convert decimal number to ASCII

```
mov dptr,#9000h
movx a,@dptr
add a,#30h
mov dptr,#900dh
movx @dptr,a
end
```

Result:

Before execution	
Memory Location	9000
Data	03
After execution	
Memory Location	9000
Data	33

Before execution	
Memory Location	9000
Data	63
After execution	
Memory Location	9000
Data	

e) Program to convert Hex number to Decimal:

```
org 00h
mov a,#0a9h
mov b,#0ah
div ab
mov  r0,b
mov b,#0ah
div ab
mov r1,b
mov r2,a
end
```

Result: r0=01
r1=06
r2=09

f) Program to convert decimal number to HEX:

```
mov dptr,#9000h
movx a,@dptr
mov r0,a
anl a,#0f0h
swap a
movb,#0ah
mul ab
mov r1,a
mov a,r0
anl a ,#0fh
adda,r1
movx @dptr,a
end
```

Result:

Before execution	
Memory Location	9000
Data	55
After execution	
Memory Location	9000
Data	37

Before execution	
Memory Location	9000
Data	99
After execution	
Memory Location	9000
Data	

6. Programs to generate delay, Programs using serial port and on-chip timer/counters.

a) Program to configure 8051 microcontroller to transmit characters "ENTER YOUR NAME" to a PC using the serial port and display on the serial window.
b) Program to generate 1second delay continuously using on chiptimer.

Note :To use result of this program, after selecting DEBUG session in the main menu use View-> serial window #1. On running & halting the program, the data is seen in the serial window.
(11.0592MHz)/(12) by 32 before it is being used by the timer to set the baud rate.

To get 9600, 28800/3 is obtained by loading timer1 with -3 (i.e., FF – 3 = FD) for further clock division. For 2400 baud rate, 28800/12 => -12 = F4 in TH1

a) Program to configure 8051 microcontroller to transmit characters "ENTER YOUR NAME" to a PC using the serial port and display on the serial window

```
           mov tmod,#20h //setting Timer-1 in mode-2
           mov scon,#70h
           mov th1,#-3
           setb tr1
   again:  mov r0,#03h
            mov dptr,#8000h
nextchar: movx a,@dptr
           acall transfer
           incdptr
           djnz r0,nextchar
           sjmp again
 transfer: mov sbuf,a
     wait: jnb ti,wait
          clr ti
          ret
          end
```

RESULT:
Each time the program is executed, "ENTER YOUR NAME" will be displayed on the serial window.

Baud rate Calculation:

Crystal freq/ (12*32) = (11.0592MHz)/(12*32) = 28800.

Serial communication circuitry divides the machine cycle frequency

b) Program to generate 1 second delay continuously using on chip timer.

```
       mov tmod,#02h
        mov th0,#00h
        clr P1.0
        clr a
        setb tr0
again: mov r7,#0ffh
loop: mov r6,#14d
wait: jnb tf0, wait
       clr tf0
       djnz r6,wait
       djnzr7,loop
       cpl P1.0
       sjmp again
       end
```

RESULT:

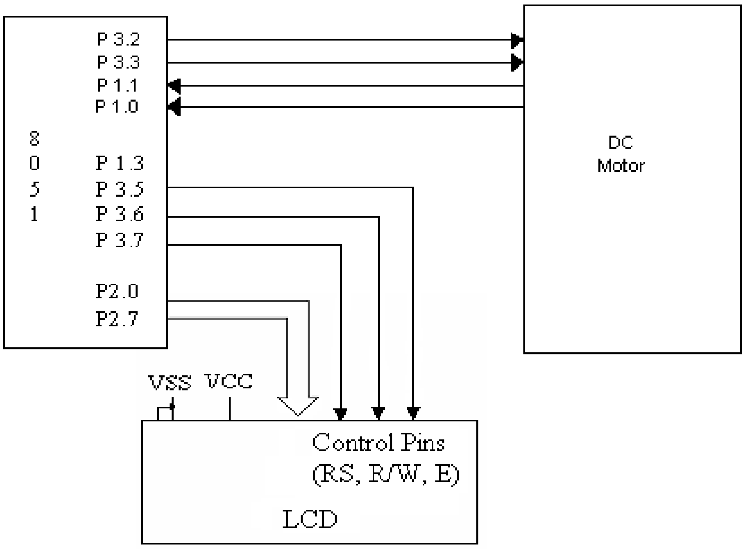
Accumulator A is incremented in binary from 00, 01,02…09,0A, 0B, …, 0F, 10,11, …FF every 1 second (for 33MHz clock setting & every 3 seconds for11.0598MHz)

Part –B

Interfacing Programs

7. Program for DC motor interface for direction and speed control using PWM.

BlockDiagram:



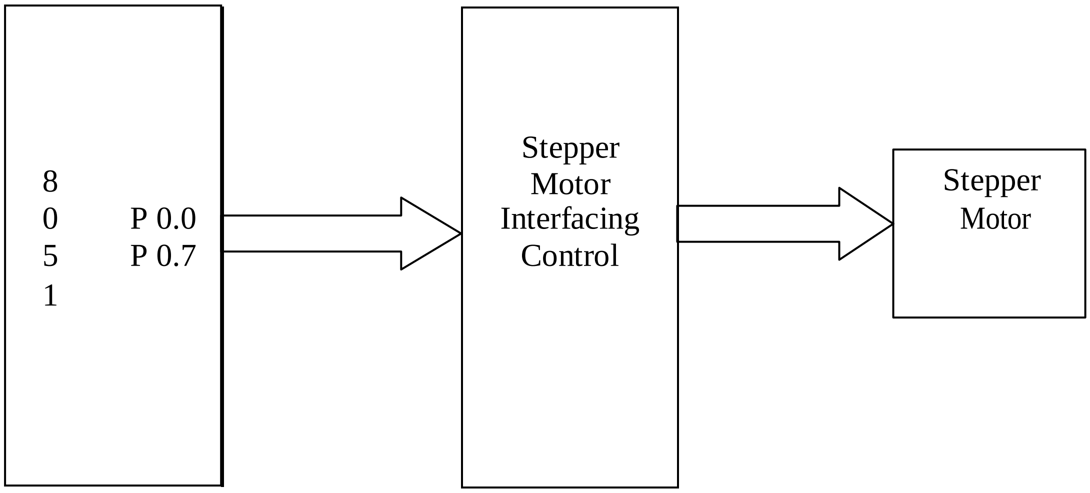
This program measures the motor speed and displays it on LCD
This Program uses Po for DAC data i.e. for speed increment or decrement

```
#include <REG51xD2.H>
Sbit inr= P3^2; //speed increment switch
sbit dcr= P3^3; //speed decrement switch
main()
{
    unsigned char i=0x80;
    P0 =0x7f;              /*Run the motor at half speed.*/
while(1)
    { if (!inr)
       {while (!inr);
         if(i>10)
          i=i-10;          //increase the DC motor speed
         }
       if(!dcr)
      {
        while(!dcr);
          if(i<0xf0)
         i=i+10;           //decrease the DC motorspeed
       }
     P0=i;
    }
}
```

8.

8. Program for stepper motor interface.

Block Diagram:

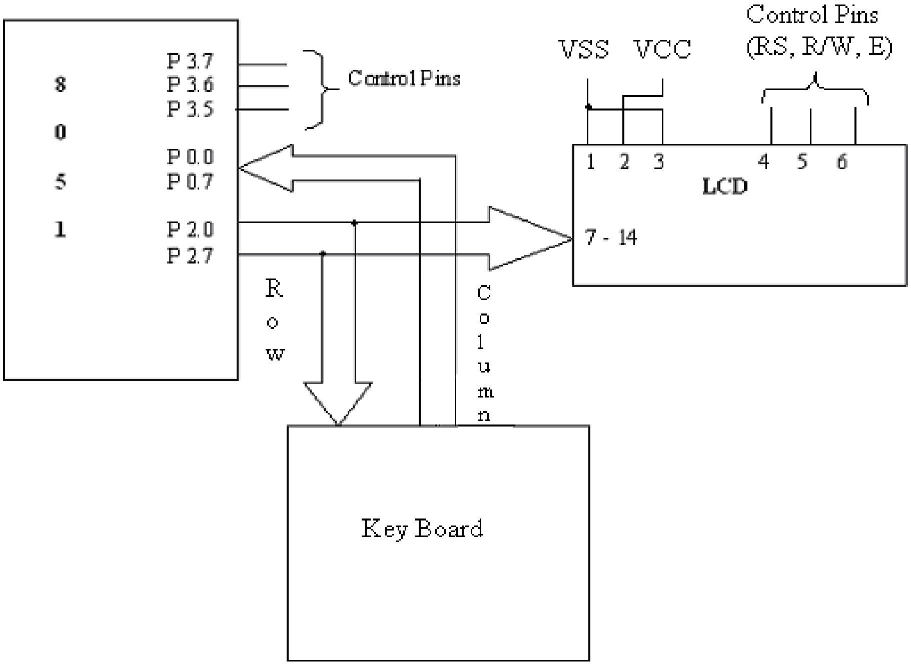


```
#include <REG51xD2.H>
void delay (unsigned int x)                /* Delay Routine*/
{
 for(;x>0;x--);
 return;
}
main ( )
{
  unsigned char Val, i;
  P0=0x00;
while(1)
{
  Val = 0x11;
  for (i=0;i<4;i++)
             {
              P0 = Val;
              Val=Val<<1;              /* Val= Val>>1; for clockwise direction*/
              delay(500);
             }
 }
}
```

Output

9. Program to interface Alphanumerical LCD panel and Hex keypad to 8051.

Block diagram :



LABEL ON THE KEYTOP	HEX CODE	LABEL ON THE KEYTOP	HEX CODE
0	0	-	0C
1	1	*	0D
2	2	/	0E
3	3	%	0F
4	4	AC	10
5	5	CE	11
6	6	CHK	12
7	7	=	13
8	8	MC	14
9	9	MR	15
.	0A	M	16
+	0B	M+	17

```
#include <REG51xD2.H>
#include "lcd.h"

unsigned char getkey();
void delay(unsigned int);

main()
{
  unsigned char key,tmp;
```

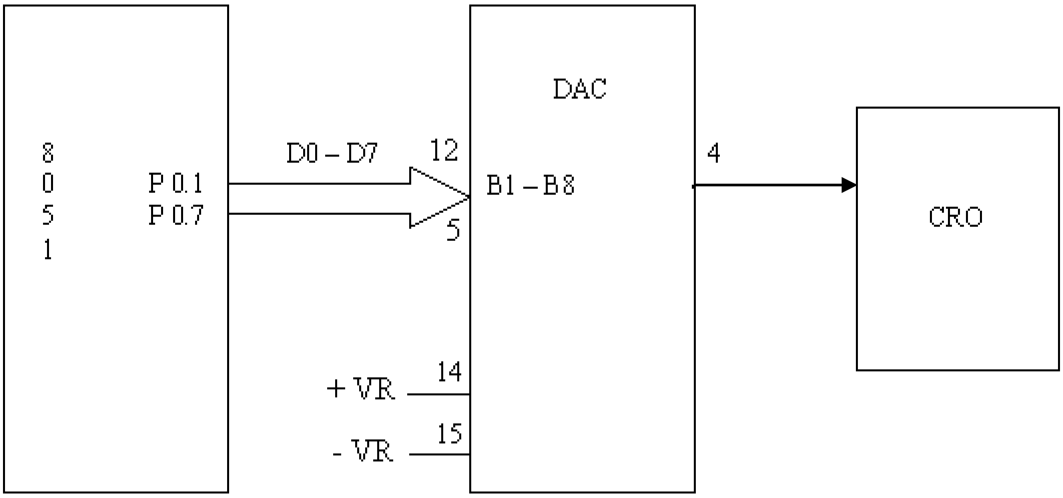
```
   InitLcd();                                        /* Initialise LCD*/
   WriteString("KeyPressed=");                       /* Display msg on LCD */
   while(1)
   {
     GotoXY(12,0);                                   /* Set Cursor Position */
            key= getkey();                           /* Call Getkey method*/
   }
}

unsigned char getkey()
{
  unsigned char i,j,k,indx,t;
  P2=0x00;                                   /* P2 as Output port */

  indx=0x00;                                 /* Index for storing the first value of
                                                the scanline*/
  for(i=1;i<=8;i<<=1)                        /* for 4 scanlines*/
  {
           P1 = 0x0f&~i;                     /* write data to scanline*/
           t =P0;                            /* Read readlines connected to P0*/
           t =~t;
           if(t>0)                           /* If key press is true*/
           {
             delay(6000);                    /* Delay for bouncing*/
             for(j=0;j<=4;j++)              /* Check for 8 lines*/
             {
               t >>=1;
                    if(t==0)                /* if get pressedkey*/
                    {
                     k =indx+j;             /* Display that by converting to Ascii*/
                     if(k >9)
                k+=0x37;
                     else
                k+=0x30;
                     WriteChar(k);
                     return(indx+j);       /* Return index of the key pressed*/
                    }
             }
           }
           indx+=0x04;                    /* If no key pressed increment index*/
  }
}

void delay(unsigned int x)              /* delay routine*/
{
 for(;x>0;x--);
}
```

Signature o Staff

10. Generate different waveforms using dual DAC interfacing

(a) Program for to generate square wave of frequency ‘f’.

Block Diagram:



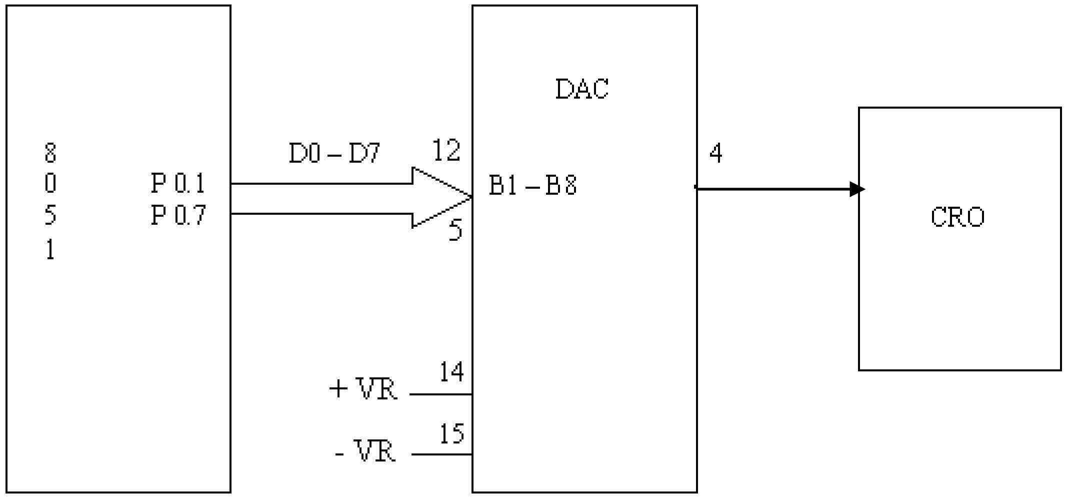
```
#include <REG51xD2.H>

sbit Amp=P3^3;                    /* Port line to change amplitude*/
sbitFre=P3^2;                     /* Port line to change frequency*/


void delay(unsigned int x)       /* delay routine*/
{
  for(;x>0;x--);
}

main()
{
 unsigned char on = 0x7f,off=0x00;
 unsigned int fre = 100;

 while(1)
 {
   if(!Amp)                          /* if user choice is to change amplitude*/
   {
     while(!Amp);                   /* wait for key release */
           on+=0x08;                /* Increase the amplitude*/
   }

   if(!Fre)                         /* if user choice is to change frequency*/
   {
    if(fre>1000)                    /* if frequency exceeds 1000 reset to default */
           fre =100;
```

```
        while(!Fre);              /* wait for key release */
     fre+=50;                     /* Increase the frequency*/
   }
   P0=on;                                          /* write apmlitude to port*/
   delay(fre);
   P0=off;                                         /* clear port*/
   delay(fre);

 }
}
```

Date:

(b). Program for dual DAC interfacing to generate ramp waveform.

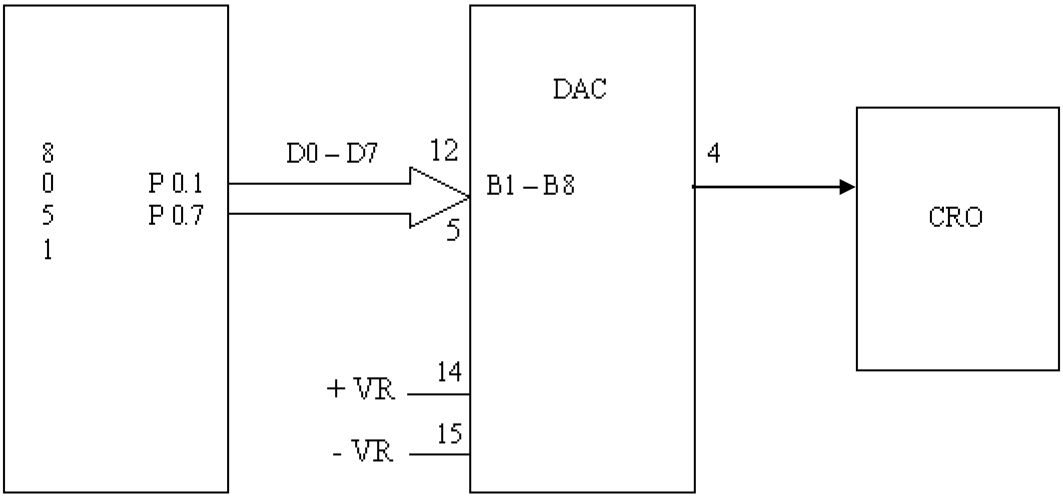
Block Diagram:



```
#include

<REG51xD2.H>main()
{
 unsigned char i=0;

 P0=0x00;                                  /* P0 as Output port */
 while(1)
 {
  {
   for(i=0;i<0xff;i++)                    /* Generate ON pulse */
    P0 =i;
 }

}
```

(c) Program for dual DAC interfacing to generate triangular wave.

Block Diagram:

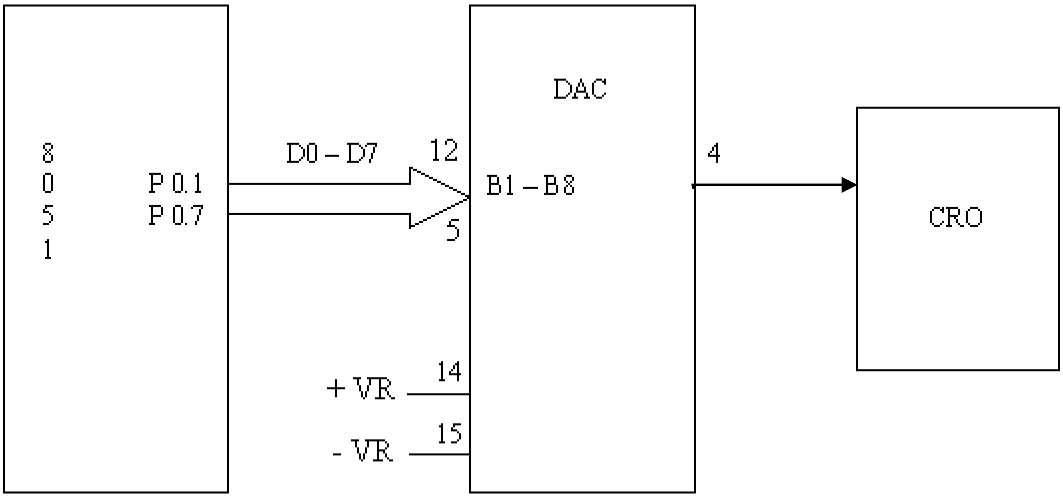


```
#include

<REG51xD2.H>main()
{
  unsigned char i=0;

  P0=0x00;                          /* P0 as Output port */
  while(1)
  {
    for(i=0;i<0xff;i++)                    /* Generate ON pulse */
     P0 =i;
          for(i=0xfe;i>0x00;i--)           /* Generate OFF pulse */
            P0 =i;
  }
}
```

Date:

(d) Program for dual DAC interfacing to generate sine waveform.

Circuit Diagram:



,

```
#include <RE51xD2.H>

void main( )
{
unsigned char i, wave[36]={128,148,171,192,209,225,238,245,253,255,253,
245,238,225,209,192,171,128,104,82,64,43,28,15,07,01,00,01,07,15,28,43,64,82,104};
P0 = 0x00;
while(1)
{
for (i==0; i<36; i++)
P0= wave[i];
}
}
```

Question bank

Part A:

1. Write an assembly language program to transfer N=_bytes of data from location A:______h to location B:_______h (without overlap) using8051
2. Write an assembly language program to exchange N=__________bytes of data from location A:_________h to location B:__________h (without overlap) using8051
3. Write an assembly language program to sort an array of N=________h bytes of data in ascending /descending order using8051
4. Write an assembly language program to find largest number in a given array of 'N' elements using 8051 , where , N=______________h
5. Write an assembly language program to perform addition of two 16 bit numbers using8051
6. Write an assembly language program to perform subtraction of two 16 bit numbers using8051
7. Write an assembly language program to perform multiplication of two 16 bit numbers using8051
8. Write an assembly language program to perform division of two 16 bit numbers using8051
9. Write an assembly language program to find square of a given numbers using8051
10. Write an assembly language program to count numbers fromN=____h to N=____h (Up counter/Down counter) using8051
11. Write an assembly language program to implement(display) an eight bit Up /Down binary(hex) counter on watch window using8051
12. Write an assembly language program to count number of one's and zero's in given 8 bit number using8051
13. Write an assembly language program to convert an 8 bit BCD number to ASCII using8051
14. Write an assembly language program to convert ASCII to an 8 bit BCD number to using8051
15. Write an assembly language program to convert ASCII to decimal using8051
16. Write an assembly language program to convert decimal to ASCII using8051
17. Write an assembly language program to convert Hexa decimal to decimal using 8051
18. Write an assembly language program to convert decimal to Hexa decimal using 8051
19. Write an assembly language program to generate delay of______seconds using 8051

Part B(using C program)

A. Write a program for stepper motor interface with8051
B. Write a program for DC motor interface with 8051 and control its speed
C. Write a program to interface LCD panel and hexa keypad to8051
D. Write a program for dual DAC interfacing to generate sine wave
E. Write a program for dual DAC interfacing to generate square wave
F. Write a program for dual DAC interfacing to generate triangular wave
G. Write a program for dual DAC interfacing to generate ramp wave

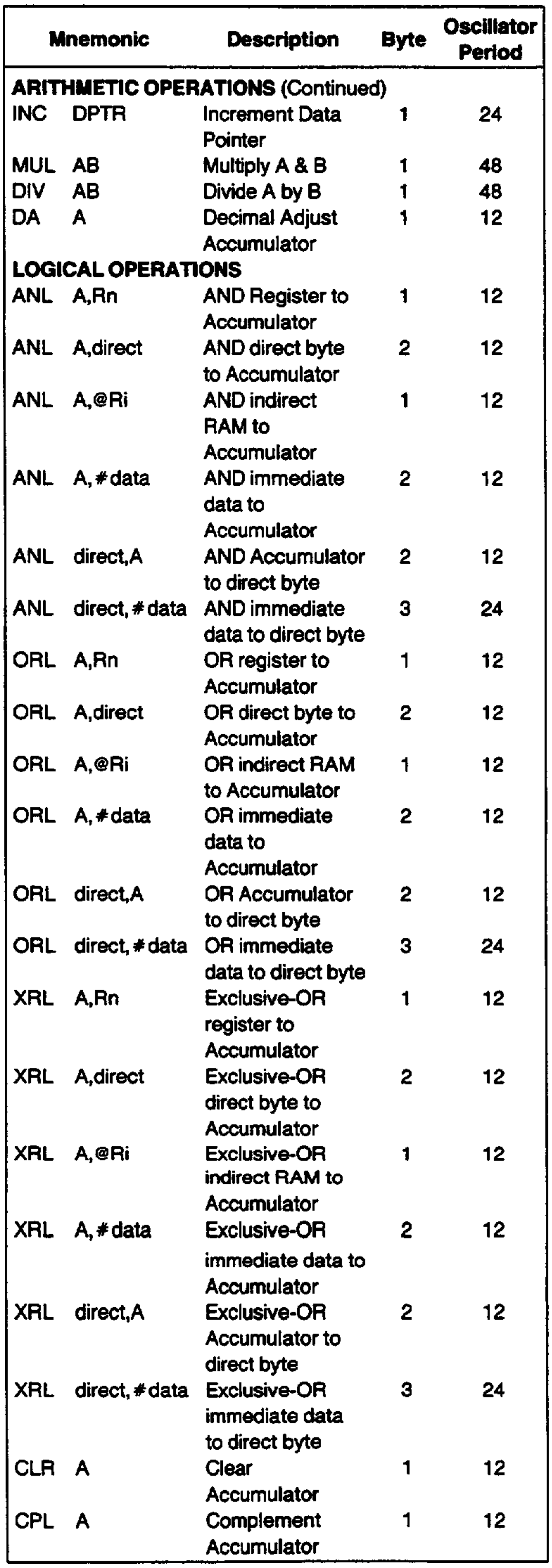
Viva Questions

1. What do you mean by Embedded System? Give examples.
2. Why are embedded Systems useful?
3. What are the segments of Embedded System?
4. What is Embedded Controller?
5. What is Microcontroller?
6. List out the differences between Microcontroller and Microprocessor.
7. How are Microcontrollers more suitable than Microprocessor for Real Time Applications?
8. What are the General Features of Microcontroller?
9. Explain briefly the classification of Microcontroller.
10. Explain briefly the Embedded Tools.
11. Explain the general features of 8051Microcontroller.
12. How many pins the 8051has?
13. Differentiate between Program Memory and Data Memory.
14. What is the size of the Program and Data memory?
15. Write a note on internal RAM. What is the necessity of register banks? Explain.
16. How many address lines are required to address 4K of memory?
    Show the necessary calculations.
17. What is the function of accumulator?
18. What are SFR's? Explain briefly.
19. What is the program counter? What is its use?
20. What is the size of the PC?
21. What is a stack pointer(SP)?
22. What is the size of SP?
23. What is the PSW? And briefly describe the function of its fields.
24. What is the difference between PC and DPTR?
25. What is the difference between PC and SP?
26. What is ALE? Explain the functions of the ALE in8051.
27. Describe the 8051 oscillator and clock.
28. What are the disadvantages of the ceramic resonator?
29. What is the function of the capacitors in the oscillator circuit?
30. Show with an example, how the time taken to execute an instruction can be calculated.
31. What is the Data Pointer register? What is its use in the8051?
32. Explain how the 8051 implement the Harvard Architecture?
33. Explain briefly the difference between the Von Neumann and the Harvard Architecture.
34. Describe in detail how the register banks are organized.
35. What are the bit addressable registers and what is the need?
36. What is the need for the general purpose RAM area?
37. Write a note on the Stack and the Stack Pointer.
38. Why should the stack be placed high in internal RAM?
39. Explain briefly how internal and external ROM gets accessed.
40. What are the different addressing modes supported by 8051 Microcontroller?
41. Explain the Immediate Addressing Mode.
42. Explain the Register Addressing Mode.
43. Explain the Direct Addressing Mode.
44. Explain the Indirect Addressing Mode.
45. Explain the Code Addressing Mode.
46. Explain in detail the Functional Classification of 8051 Instruction set
47. What are the instructions used to operates tack?
48. What are Accumulator specific transfer instructions?
49. What is the difference between INC and ADD instructions?
50. What is the difference between DEC and SUBB instructions?
51. What is the use of OV flag in MUL and DIV instructions?
52. What are single and two operand instructions?
53. Explain Unconditional and Conditional JMP and CALL instructions.
54. Explain the different types of RETURN instructions.

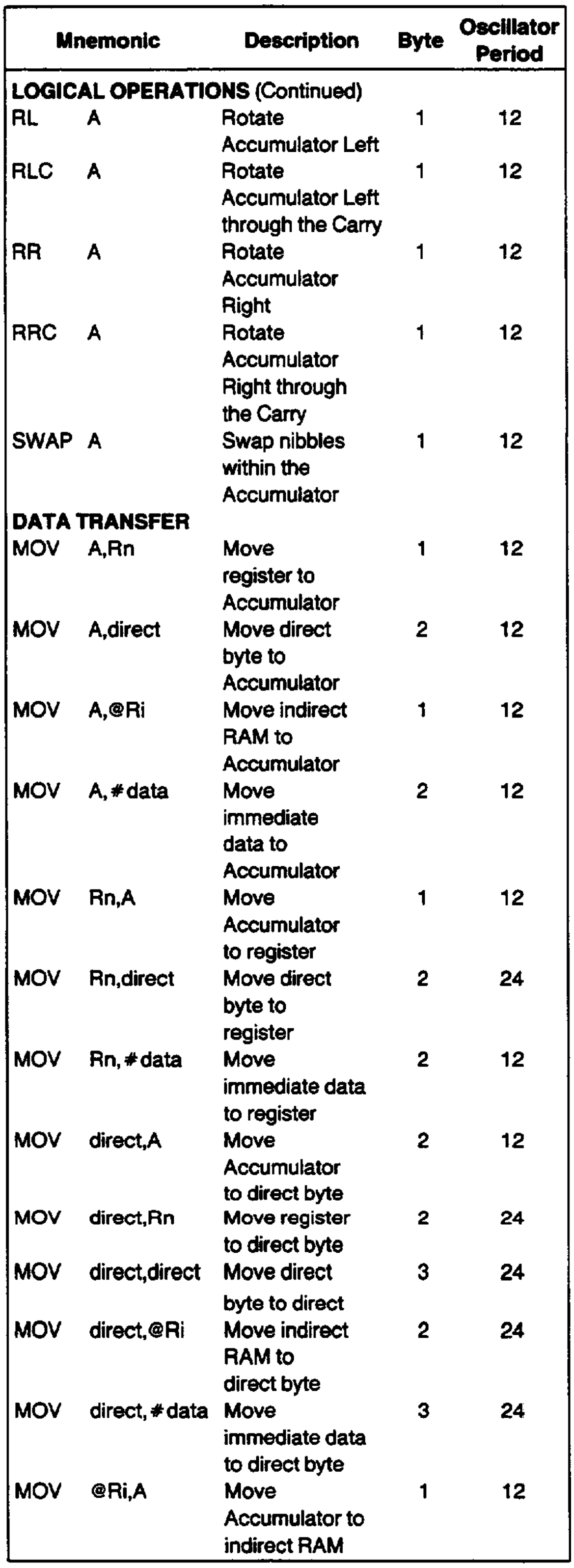
55. What is a software delay?
56. What are the factors to be considered while deciding a software delay?
57. What is a Machine cycle?
58. What is a State?
59. Explain the need for Hardware Timers and Counters?
60. Give a brief introduction on Timers /Counter.
61. What is the difference between Timer and Counter operation?
62. How many Timers are there in8051?
63. What are the three functions of Timers?
64. What are the different modes of operation of timer/counter?
65. Give a brief introduction on the various Modes.
66. What is the count rate of timer operation?
67. What is the difference between mode 0 and mode1?
68. What is the difference Modes 0,1,2 and 3?
69. How do you differentiate between Timers and Counters?
70. Explain the function of the TMOD register and its various fields?
71. How do you control the timer/counter operation?
72. What is the function of TF0/TF1bit
73. Explain the function of the TCON register and its various fields?
74. Explain how the Timer/Counter Interrupts work.
75. Explain how the 8051 counts using Timers and Counters.
76. Explain Counting operation in detail in the 8051.
77. Explain why there is limit to the maximum external frequency that can be counted.
78. What's the benefit of the auto-reload mode?
79. Write a short note on Serial and Parallel communication and highlight their advantages and disadvantages.
80. Explain Synchronous Serial Data Communication.
81. Explain Asynchronous Serial Data Communication.
82. Explain Simplex data transmission with examples.
83. Explain Half Duplex data transmission with examples.
84. Explain Full Duplex data transmission with examples.
85. What is Baud rate?
86. What is a Modem?
87. What are the various registers and pins in the 8051 required for Serial communication? Explain briefly.
88. Explain SCON register and the various fields.
89. Explain serial communication in general (synchronous and asynchronous). Also explain the use of the parity bit.
90. Explain the function of the PCON register during serial data communication.
91. How the Serial data interrupts are generated?
92. How is data transmitted serially in the 8051? Explain briefly.
93. How is data received serially in the 8051? Explain briefly.
94. What are the various modes of Serial Data Transmission? Explain each mode briefly.
95. Explain with a timing diagram the shift register mode in the8051.
96. What is the use of the serial communication mode 0 in the8051?
97. Explain in detail the Serial Data Mode 1 in the8051.
98. Explain how the Baud rate is calculated for the Serial Data Mode1.
99. How is the Baud rate for the Multiprocessor communication Mode calculated?
100. Explain in detail the Multiprocessor communication Mode in the8051.
101. Explainthesignificanceofthe9thbitintheMultiprocessorcommunication Mode.
102. Explain the Serial data mode 3 in the8051.
103. What are interrupts and how are they useful in Real Time Programming?
104. Briefly describe the Interrupt structure in the8051.
105. Explain about vectored and non-vectored interrupts in general.
106. What are the five interrupts provided in the8051?

107. What are the three registers that control and operate the interrupts in8051?
108. Describe the Interrupt Enable(IE) special function register and its various bits.
109. Describe the Interrupt Priority (IP) special function register and its need.
110. Explain in detail how the Timer Flag interrupts are generated.
111. Explain in detail how the Serial Flag interrupt is generated.
112. Explain in detail how the External Flag interrupts are generated.
113. What happens when a high logic is applied on the Reset pin?
114. Why the Reset interrupt is called a non-maskable interrupt?
115. Why do we require a reset pin?
116. How can you enable/disable some or all the interrupts?
117. Explain how interrupt priorities a reset ?And how interrupts that occur simultaneously are handled.
118. What are the actions taken when an Interrupt Occurs?
119. What are Software generated interrupts and how are they generated?
120. What is RS232 and MAX232?
121. What is the function of RS and E pins in an LCD?
122. What is the use of R/W pin in an LCD?
123. What is the significance of DA A instruction?
124. What is packed and unpacked BCD?
125. What is the difference between CY and OV flag?
126. When will the OV flag be set?
127. What is an ASCII code?

Instruction set



Mnemonic		Description	Byte	Oscillator Period
ARITHMETIC OPERATIONS (Continued)				
INC	DPTR	Increment Data Pointer	1	24
MUL	AB	Multiply A & B	1	48
DIV	AB	Divide A by B	1	48
DA	A	Decimal Adjust Accumulator	1	12
LOGICAL OPERATIONS				
ANL	A,Rn	AND Register to Accumulator	1	12
ANL	A,direct	AND direct byte to Accumulator	2	12
ANL	A,@Ri	AND indirect RAM to Accumulator	1	12
ANL	A,#data	AND immediate data to Accumulator	2	12
ANL	direct,A	AND Accumulator to direct byte	2	12
ANL	direct,#data	AND immediate data to direct byte	3	24
ORL	A,Rn	OR register to Accumulator	1	12
ORL	A,direct	OR direct byte to Accumulator	2	12
ORL	A,@Ri	OR indirect RAM to Accumulator	1	12
ORL	A,#data	OR immediate data to Accumulator	2	12
ORL	direct,A	OR Accumulator to direct byte	2	12
ORL	direct,#data	OR immediate data to direct byte	3	24
XRL	A,Rn	Exclusive-OR register to Accumulator	1	12
XRL	A,direct	Exclusive-OR direct byte to Accumulator	2	12
XRL	A,@Ri	Exclusive-OR indirect RAM to Accumulator	1	12
XRL	A,#data	Exclusive-OR immediate data to Accumulator	2	12
XRL	direct,A	Exclusive-OR Accumulator to direct byte	2	12
XRL	direct,#data	Exclusive-OR immediate data to direct byte	3	24
CLR	A	Clear Accumulator	1	12
CPL	A	Complement Accumulator	1	12



Mnemonic		Description	Byte	Oscillator Period
LOGICAL OPERATIONS (Continued)				
RL	A	Rotate Accumulator Left	1	12
RLC	A	Rotate Accumulator Left through the Carry	1	12
RR	A	Rotate Accumulator Right	1	12
RRC	A	Rotate Accumulator Right through the Carry	1	12
SWAP	A	Swap nibbles within the Accumulator	1	12
DATA TRANSFER				
MOV	A,Rn	Move register to Accumulator	1	12
MOV	A,direct	Move direct byte to Accumulator	2	12
MOV	A,@Ri	Move indirect RAM to Accumulator	1	12
MOV	A,#data	Move immediate data to Accumulator	2	12
MOV	Rn,A	Move Accumulator to register	1	12
MOV	Rn,direct	Move direct byte to register	2	24
MOV	Rn,#data	Move immediate data to register	2	12
MOV	direct,A	Move Accumulator to direct byte	2	12
MOV	direct,Rn	Move register to direct byte	2	24
MOV	direct,direct	Move direct byte to direct	3	24
MOV	direct,@Ri	Move indirect RAM to direct byte	2	24
MOV	direct,#data	Move immediate data to direct byte	3	24
MOV	@Ri,A	Move Accumulator to indirect RAM	1	12

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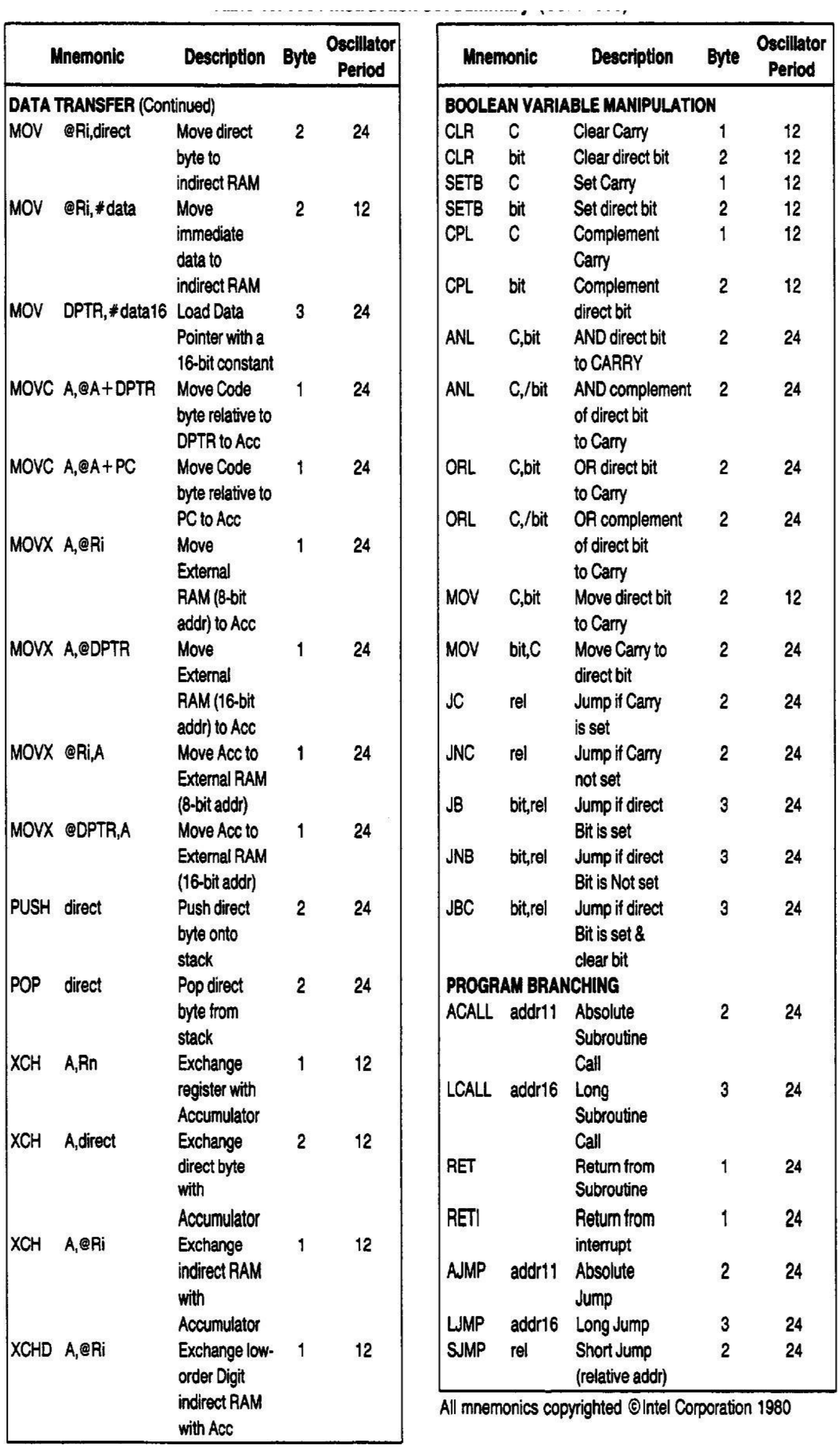

Mnemonic		Description	Byte	Oscillator Period
DATA TRANSFER (Continued)				
MOV	@Ri,direct	Move direct byte to indirect RAM	2	24
MOV	@Ri,#data	Move immediate data to indirect RAM	2	12
MOV	DPTR,#data16	Load Data Pointer with a 16-bit constant	3	24
MOVC	A,@A+DPTR	Move Code byte relative to DPTR to Acc	1	24
MOVC	A,@A+PC	Move Code byte relative to PC to Acc	1	24
MOVX	A,@Ri	Move External RAM (8-bit addr) to Acc	1	24
MOVX	A,@DPTR	Move External RAM (16-bit addr) to Acc	1	24
MOVX	@Ri,A	Move Acc to External RAM (8-bit addr)	1	24
MOVX	@DPTR,A	Move Acc to External RAM (16-bit addr)	1	24
PUSH	direct	Push direct byte onto stack	2	24
POP	direct	Pop direct byte from stack	2	24
XCH	A,Rn	Exchange register with Accumulator	1	12
XCH	A,direct	Exchange direct byte with Accumulator	2	12
XCH	A,@Ri	Exchange indirect RAM with Accumulator	1	12
XCHD	A,@Ri	Exchange low-order Digit indirect RAM with Acc	1	12

Mnemonic		Description	Byte	Oscillator Period
BOOLEAN VARIABLE MANIPULATION				
CLR	C	Clear Carry	1	12
CLR	bit	Clear direct bit	2	12
SETB	C	Set Carry	1	12
SETB	bit	Set direct bit	2	12
CPL	C	Complement Carry	1	12
CPL	bit	Complement direct bit	2	12
ANL	C,bit	AND direct bit to CARRY	2	24
ANL	C,/bit	AND complement of direct bit to Carry	2	24
ORL	C,bit	OR direct bit to Carry	2	24
ORL	C,/bit	OR complement of direct bit to Carry	2	24
MOV	C,bit	Move direct bit to Carry	2	12
MOV	bit,C	Move Carry to direct bit	2	24
JC	rel	Jump if Carry is set	2	24
JNC	rel	Jump if Carry not set	2	24
JB	bit,rel	Jump if direct Bit is set	3	24
JNB	bit,rel	Jump if direct Bit is Not set	3	24
JBC	bit,rel	Jump if direct Bit is set & clear bit	3	24
PROGRAM BRANCHING				
ACALL	addr11	Absolute Subroutine Call	2	24
LCALL	addr16	Long Subroutine Call	3	24
RET		Return from Subroutine	1	24
RETI		Return from interrupt	1	24
AJMP	addr11	Absolute Jump	2	24
LJMP	addr16	Long Jump	3	24
SJMP	rel	Short Jump (relative addr)	2	24

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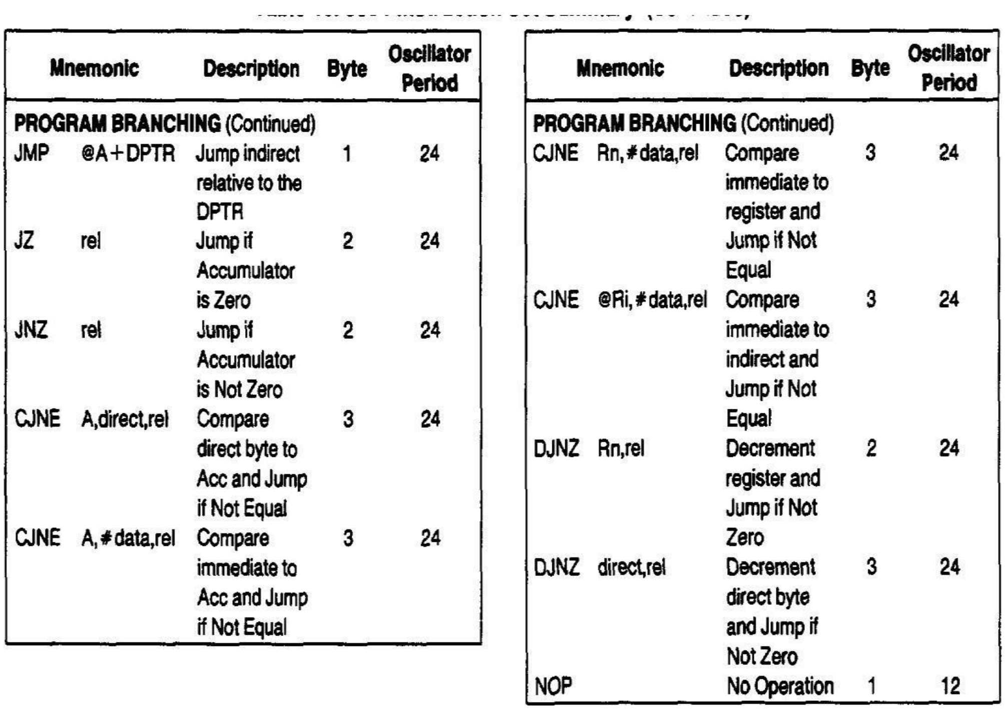


Mnemonic		Description	Byte	Oscillator Period
PROGRAM BRANCHING (Continued)				
JMP	@A+DPTR	Jump indirect relative to the DPTR	1	24
JZ	rel	Jump if Accumulator is Zero	2	24
JNZ	rel	Jump if Accumulator is Not Zero	2	24
CJNE	A,direct,rel	Compare direct byte to Acc and Jump if Not Equal	3	24
CJNE	A,#data,rel	Compare immediate to Acc and Jump if Not Equal	3	24
PROGRAM BRANCHING (Continued)				
CJNE	Rn,#data,rel	Compare immediate to register and Jump if Not Equal	3	24
CJNE	@Ri,#data,rel	Compare immediate to indirect and Jump if Not Equal	3	24
DJNZ	Rn,rel	Decrement register and Jump if Not Zero	2	24
DJNZ	direct,rel	Decrement direct byte and Jump if Not Zero	3	24
NOP		No Operation	1	12

Additional programs beyond syllabus

(a) Program to find cube of a number:

```
mov dptr,#9000h
movx a,@dptr
mov r0,a
mov b,a
mul ab
mov r1,b
mov b,r0
mul ab
mov dptr,#900e h
movx @dptr,a
mov r2,b
mov a,r1
movb,r0
mul ab
add a,r2
dec dpl
movx @dptr,a
dec dpl
mova,b
movx @dptr,a
end
```

Output: X : 900e h =(accumulator)^3

b) Logical operations:

```
    org 8000h
    mov r0, #0fh
    mov r1, #f0h
    mov r2, #66h
// And operation
    mov a, #ffh
    anl a, r0
    mov r3, a
// Or operation
    mov a, #ffh
    orl a, r1
    mov r4, a
// Xor operation
    mov a, 03h
    mov a, #ffh
    xrl a, r2
    mov r5, a
    lcall 0003h
    end
```

Output:

c) Swap and rotate instructions

```
   Org 9000h
// clear register A
    mov a, #0fh
    clr a
    mov r0, a
//swap nibbles of register A
    mov a, #56h
    swap a
    mov r1, a
// Complement the bit of register A
    mov a, #66h
    cpl a
    mov r2, a
// Rotate the register contents towards right
    mov a, #63h
```

```
 rr a
xrl a, r
mov r3, a
mov a, #43h
rl  a  // Rotate the register contents towards left
xrl a, r3
mov r4, a
lcall 0003h
end
```

Output:

d) Bit manipulation operations:

```
 org 9000h
 mov a, #0ffh
 clr c              ;clear the carry flag
 anl c, acc.7
mov r0, a
setb c            ; set the carry flag
 mov a, #00h
orl c, acc.5
mov r1, a
mov a, #0ffh
cpl acc, 3
mov r2, a
lcall 0003h
end
```

Output:

e) Program to generate a resultant byte whose 7thbit is given by b7=b2+b5+b6

```
        mov a, #86h
        mov r2, a
        anl a, #04
        rrc a
        rrc a
        rrc a
        mov r3, a
        mov a, r2
        anl  a,#20
        rlc a
        rlc a
        mov r4, a
        mov a, r2
        anl  a,#40
        rlc a
        orl a, r3
        orl a, r4
        mov P1,a
here:   sjmp here
        end
```

Output :

f) Program for subtraction of two 8 bit no's

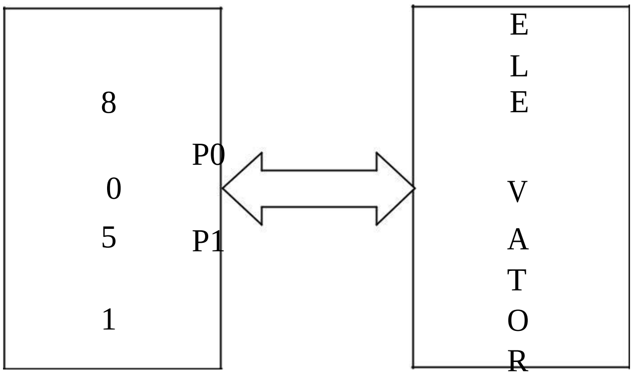
```
Mov r0,#12h                    ; get first no inro
    Mov a, r0                  ; copy toaccumulator
    Mov r1,#08h                ; get second no
   Subb a, r6                  ; subtract accumulator with registerr6
   Mov 20h, a                  ; store the Output
   end
```

```
Output: acc=12h
          r6=08h
       ---------------
        D: 20h=4h
```

1. External ADC and temperature control interface.

```
# include <at89c51xd2.h>
#include<intrins.h>
#include "lcd.h"
Unsigned int Adc;
unsigned char Low_adc,High_adc,relay; read_adc()

{

unsigned char status;
P2_3 = 1 ; // Start conversion of ADC
status = P1; //Read status of ADC
while((status & 0x01) != 0x01)

{

status = P1;

}

P2_2 =0;                  // Enable outputs
P2_0 =0;                 // Activate B1 to B8outputs
Low_adc =P0;             // Read lower byte of ADC and place in R0

P2_0 =1;                 // Deactivate B1 to B8 outputs

P2_1 =0;                 // Activate B9 to B12 and POL, over range
outputs High_adc=P0;// Read higher byte of ADC High_adc =
High_adc&0x0F;

P2_1 =1;                 // deactivate B9 to B12 and POL, over range outputs

P2_2 =1;                 // Disable outputs

P2_3 =0;                  // Stop conversion of ADC

}
main()
{
 float  Temp,Vol,Res;
 unsigned char Temp1;
 unsigned charTemp2,Temp3;
P0 = 0xFF ; // Make port 0 as input
P2 = 0xFF ; // Make port 2 as high now the relay is on.
P1_1 = 0 ; // switch OFF relay
P2_3 = 0 ; // STOP conversion of ADC

relay = 10;
while(1)

{
read_adc(); //Read ADC
Adc = High_adc;
Adc<<= 8;
Adc = Adc | Low_adc;
if( (Adc> 0x656) && (relay!=0))        //IF greater than 0x0656 Switch OFFrelay

{

ClrLcd();
WriteString("RELAY OFF");
P1_1 = 0 ;
relay = 0;

}

else if ( (Adc< 0x5b9) &&(relay!=1))           //IF less than 0x05B9 Switch ONrelay

{

ClrLcd();
WriteString("RELAY ON");
P1_1 = 1 ;
relay = 1;

}

Vol =-((Adc/10)*0.000488); //voltage before amplifier
Res =((100*(1.8-Vol)-100*Vol)*100) /(100*Vol + 100*(1.8+Vol));
                                                                    //Resistance Value

Res = Res - 100;
Temp = Res/ 0.384;
Temp1 = Temp;
Temp2 = 0x30 + (Temp1 / 0x0A);
Temp3 = 0x30 + (Temp1 % 0x0A);

GotoXY(0,1);

WriteString("Temperature ");
WriteChar(Temp2);
WriteChar(Temp3);
WriteString("'C");

}
}
```

2. Program for Elevator interface.



Theory:

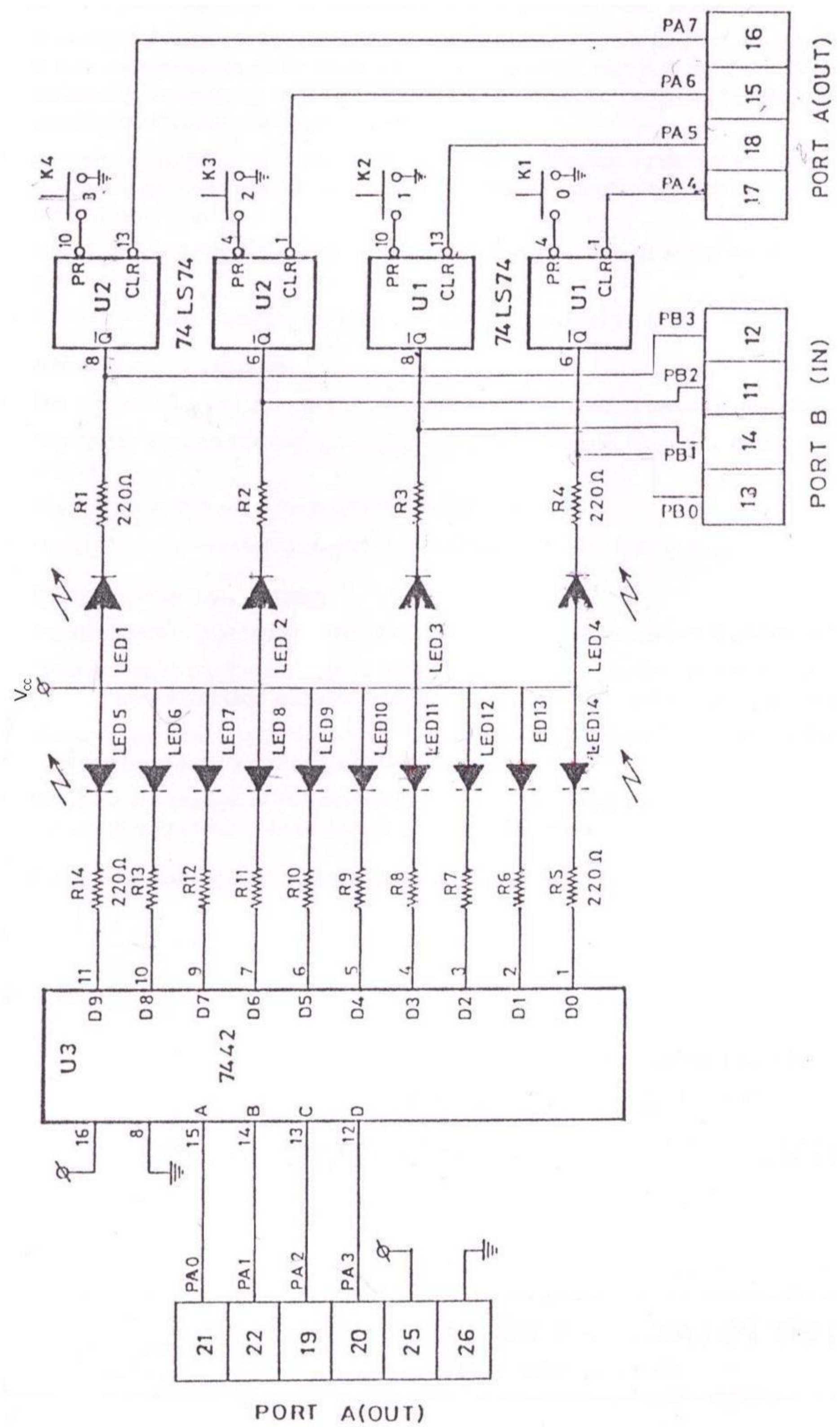
The operation of the elevator is as follows:

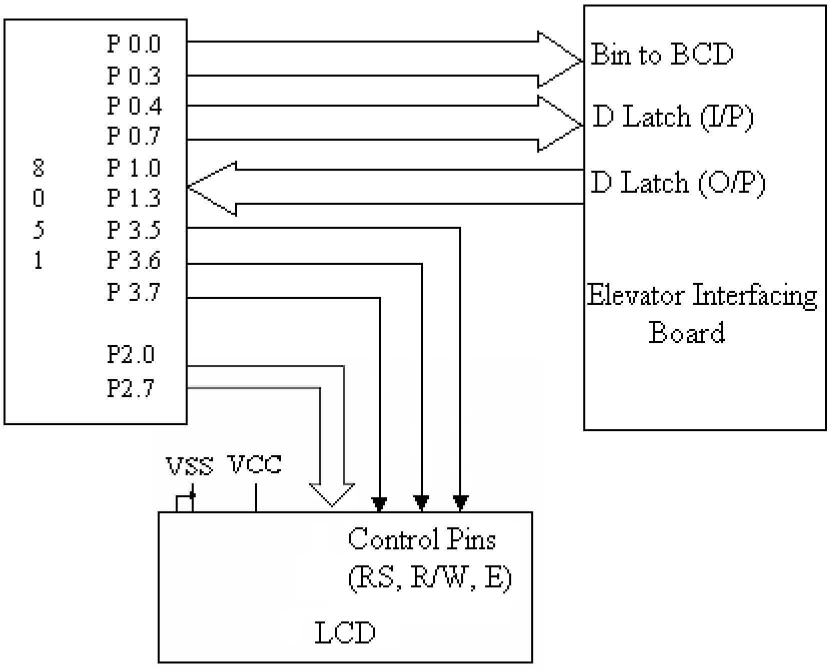
- Initially, the elevator is at ground floor.
- When the elevator reaches any floor, it stays at that floor until a request from another floor is made. When such a request is detected, it moves to that floor.
- The floor request are scanned in fixed order i.e., floors 0, 1, 2 and 3.

This interface simulates the control and operation of an elevator. Four floors assumed and for each floor a key and corresponding LED indicator are provided to serve as request buttons and request status indicator. The elevator itself is represented by a column of ten LEDs. The motion of elevator can be simulated by turning on successive LEDs one at a time. Te delay between turning off one LED and turning on the next LED can simulate the “speed” of the elevator. User can read the request status information through one port, reset the request indicators through another port and control the elevator (LED column) through another port.

Description of the Circuit

This interface has four keys, marked 0, 1, 2, and 3 representing the request buttons at the four floors. Pressing of key causes a corresponding Flip-Flop to be set. The outputs of the four Flip-flops can be read through port B (PBO, PBI, PB2 and PB3). Also, the status of these signals is reflected by a setoff 4 LEDs. The Flip-Flop can be rest (LEDs are cleared) through port A(PA54, PA5, PA6, and PA7). A column of 10 LEDs, representing the elevator can be controlled through Port A (PA0, PA1, PA2 and PA3). These port lines are fed to the inputs of the decoder 7442 whose outputs are used to control the on/off states of the LEDs which simulate the motion of the elevator.





```
#include <REG51D2.H>

void delay(unsigned int);
main()
{
 unsigned char Flr[9] = {0xff,0x00,0x03,0xff,0x06,0xff,0xff,0xff,0x09};
 unsigned char FClr[9] = {0xff,0x0E0,0x0D3,0xff,0x0B6,0xff,0xff,0xff,0x79};
 unsigned char ReqFlr,CurFlr = 0x01,i,j;
 P0 = 0x00;
 P0 = 0x0f0;
 while(1)
 {
        P1 = 0x0f;
        ReqFlr = P1 | 0x0f0;
        while(ReqFlr == 0x0ff)
          ReqFlr = P1 |0x0f0;             /* Read Request Floor from P1 */
        ReqFlr =~ReqFlr;
        if(CurFlr==ReqFlr)           /* If Request floor is equal to Current Floor*/
        {
          P0=FClr[CurFlr];                  /* Clear Floor Indicator */
          continue;                                /* Go up to read again*/
        }

        else if(CurFlr>ReqFlr)           /* If Current floor is > request floor*/
        {

  i = Flr[CurFlr]-Flr[ReqFlr];      /* Get the no of floors to travel */
          j =Flr[CurFlr];
          for(;i>0;i--)                        /* Move the indicator down*/

          {
           P0 = 0x0f0|j;
           j--;
           delay(50000);
          }
        }
        else                          /* If Current floor is < request floor*/
        {
          i = Flr[ReqFlr] - Flr[CurFlr]; /* Get the no of floors to travel*/
          j =Flr[CurFlr];
          for(;i>0;i--)                        /* Move the indicator Up*/
          {
            P0 = 0x0f0 | j;
                   j++;
            delay(50000);
          }

        }
        CurFlr=ReqFlr;                            /* Update Current floor*/
        P0=FClr[CurFlr];                          /* Clear the indicator*/
 }
}

void delay(unsigned int x)
{
  for(;x>0;x--);
              }
```