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**ECE3003 MICROCONTROLLERS AND IT'S
APPLICATIONS**

EXPERIMENT – 2

THEORY

List of arithmetic instructions in 8051:

- ADD - ADDition
- ADDC - ADDition with Carry
- SUBB - SUBtraction with carry Borrow
- MUL - MULtipl
- DIV - DIVide
- INC - INCrement
- DEC - DECrement
- DA - Decimal Adjust
- CLR - CLear
- CMP - CoMPlement
- RL - Rotate Left
- RLC – Rotate Left with Carry
- RR – Rotate Right
- RRC – Rotate Right with Carry
- SWAP - SWAP

Program Status Word (PSW) Register:

D7	D6	D5	D4	D3	D2	D1	D0
CY	AC	FO	RS1	RS0	OV	-	P

CY – set when a Carry out on D7 bit

AC – set when a Carry from D3 to D4 bit

FO – future use

OV – When A overflow (greater than FFh)

P – parity (set when A have odd number of one's)

RS0 & RS1 – to select Register bank

Register bank selection bits (RS1,RS0):

RS1	RS0	starting address		ending address
1	1	1Fh	Register Bank 3	18h
1	0	17h	Register Bank 2	10h
0	1	0Fh	Register Bank 1	08h
0	0	07h	Register Bank 0	00h

• PROGRAM – 1

AIM - Write an 8051 ASM program to perform addition of two 8-bit numbers 97H and 76H and store the result at address location 55H.

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

ORG 0000H

MOV A, #97H ; 97H - 1001 0111

```

ADD A, #76H ; 76H - 0111 0110
MOV 55H, A ; 1 0DH - 1 0000 1101
END

```

The screenshot shows the Keil uVision IDE interface. The main window displays assembly code for a program. The code is as follows:

```

C:0x0000 7497 MOV A, #CKRL(0x97)
3: ADD A, #76H
C:0x0002 2476 ADD A, #0x76
4: MOV 55H, A
C:0x0004 F555 MOV 0x55, A
C:0x0006 00 NOP
C:0x0007 00 NOP
C:0x0008 00 NOP
C:0x0009 00 NOP
C:0x000A 00 NOP

```

The Registers window on the right shows the current state of the registers:

Register	Value
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
sys	
a	0x0d
b	0x00
sp	0x07
sp_max	0x07
PC	0x0006
auxr1	0x00
dp0r	0x0000
states	3
sec	0.00000109
psw	0x81

The Command window at the bottom shows the following messages:

```

Running with Code Size Limit: 2K
Load "D:\Objects\19b1c1165"
*** error 65: access violation at C:0x0006 : no 'execute/read' permission

```

The Memory window shows the memory dump starting at address 0x0055:

```

D:0x55: 0D 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x6D: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x85: 01 01 10 00 00 00 00 00 00 00 08 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x9D: 00 00 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0xB5: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

```

• PROGRAM – 2

AIM - Write an 8051 ASM program to perform subtraction of two 8-bit numbers 76H and 97H and store the result at address location 55H.

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

- ORG 0000H
- MOV A, #97H ; 97H - 1001 0111
- SUBB A, #76H ; 76H - 0111 0110
- MOV 55H, A ; 0 21H - 0 0010 0001
- END

P - 0, OV - 0, AC - 0, C - 0

The screenshot shows the uVision IDE interface. The main window displays assembly code with the following instructions:

```

C:0x0000 7497 MOV A, #CKRL(0x97)
3: SUBB A, #76H
C:0x0002 9476 SUBB A, #0x76
4: MOV 55H, A
C:0x0004 F555 MOV 0x55, A
C:0x0006 00 NOP
C:0x0007 00 NOP
C:0x0008 00 NOP
C:0x0009 00 NOP
C:0x000A 00 NOP
  
```

The Registers window on the right shows the following values:

Register	Value
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x21
b	0x00
sp	0x07
sp_max	0x07
PC \$	C:0x0006
aux1	0x00
dptr	0x0000
states	3
sec	0.00000109
psw	0x04

The Command window shows the following error message:

```

Running with Code Size Limit: 2K
Load "D:\Objects\l19blcl165"
*** error 65: access violation at C:0x0006 : no 'execute/read' permission
  
```

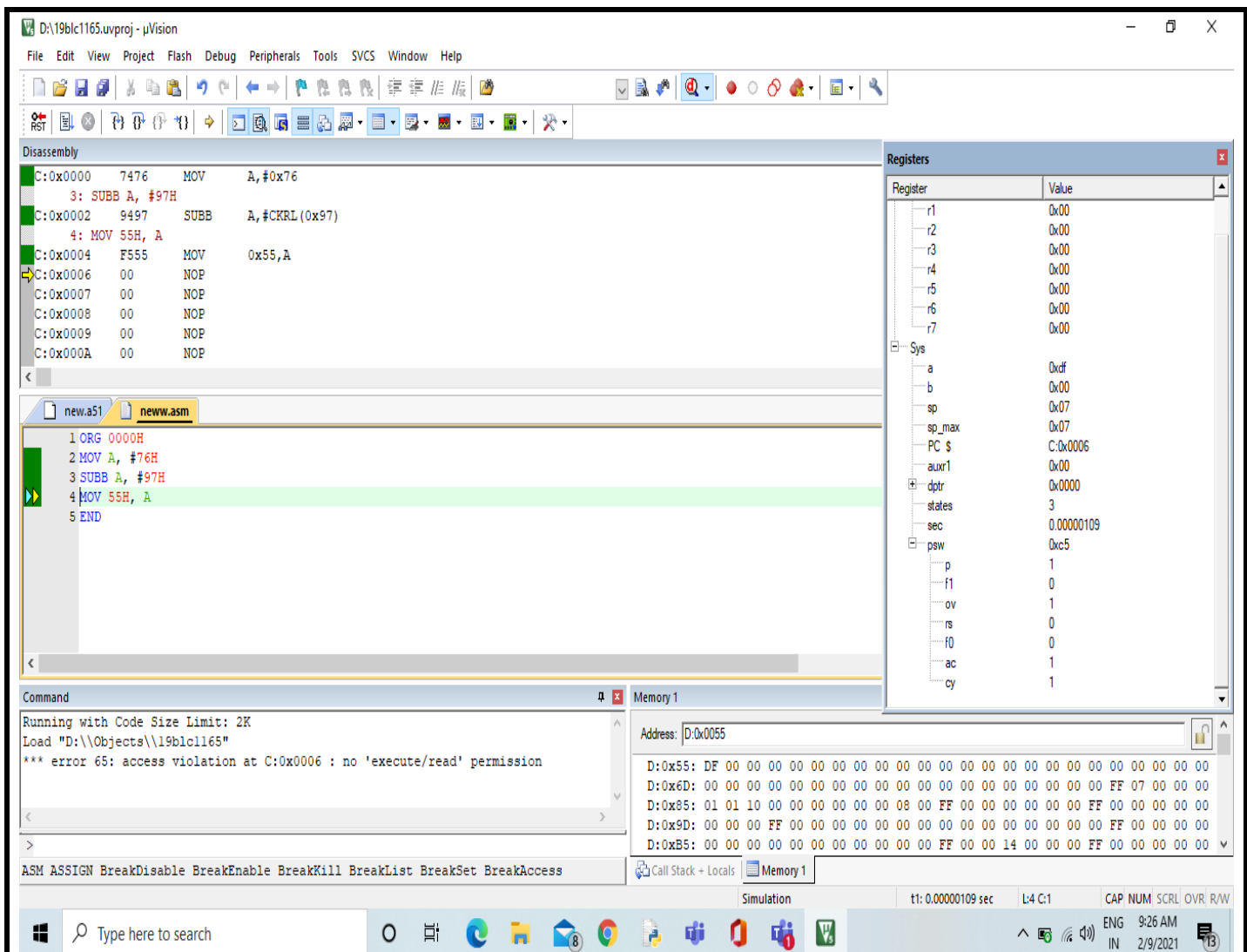
The Memory window shows the following data:

```

Address: D:0x0055
D:0x55: 21 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x6D: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x85: 01 01 10 00 00 00 00 00 08 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x9D: 00 00 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0xB5: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
  
```

- ORG 0000H
- MOV A, #76H ; 76H - 0111 0110
- SUBB A, #97H ; 97H - 1001 0111
- MOV 55H, A ; 1 DFH - 1 1101 1111
- END

P - 1, OV - 1, AC - 1, C - 1



• PROGRAM – 3

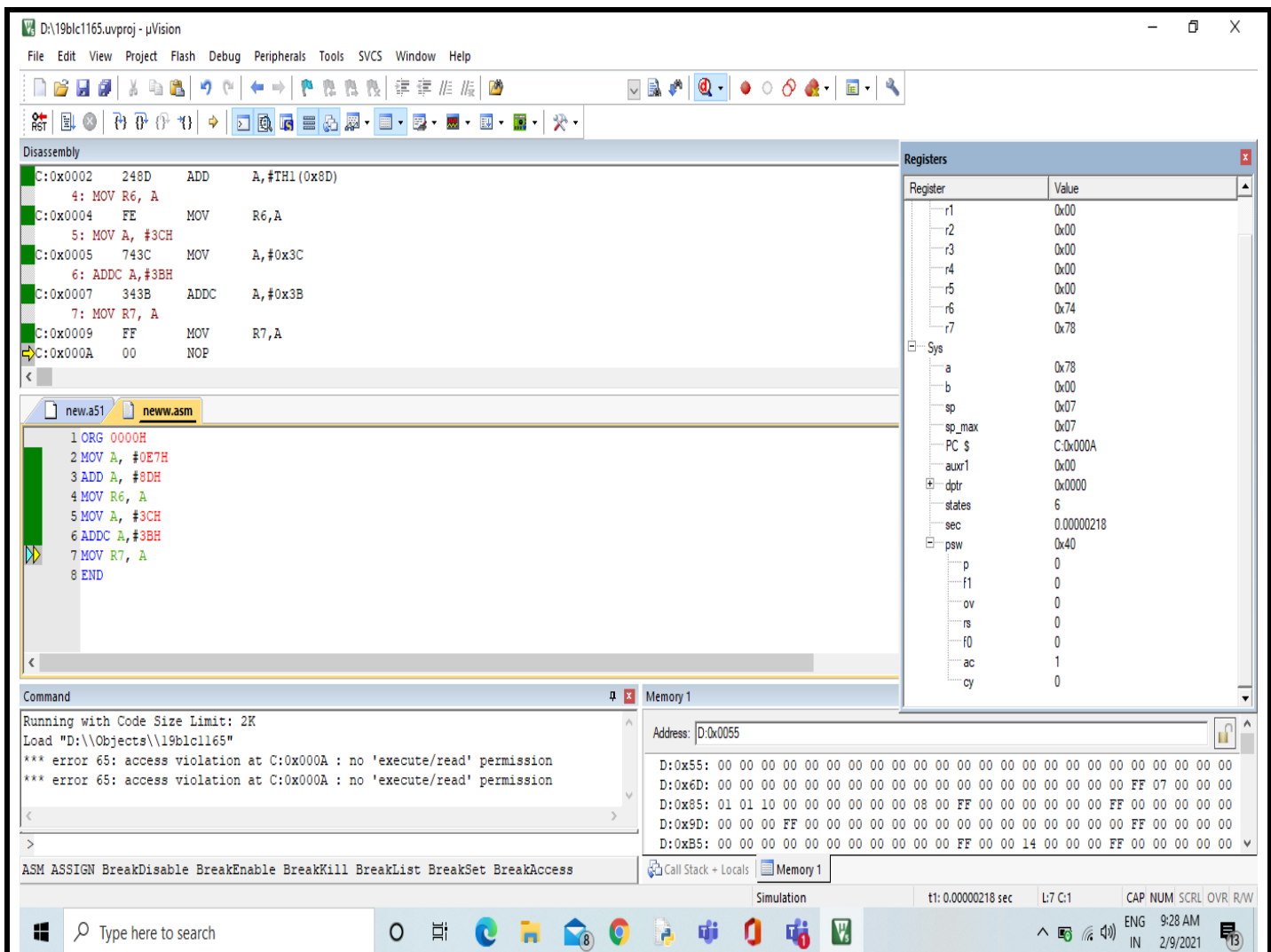
AIM - Write an 8051 ASM program to perform addition of two 16-bit numbers. The numbers are 3CE7H and 3B8DH. Place the sum in R7 and R6; R6 should have the lower byte.

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

```
ORG 0000H
MOV A, #0E7H
ADD A, #8DH
MOV R6, A
MOV A, #3CH
ADDC A, #3BH
MOV R7, A
END
```

P - 0, OV - 0, AC - 1, C - 0



• PROGRAM – 4

AIM - Write an 8051 ASM program to perform subtraction of two 16-bit numbers. The numbers are 2762H and 1296H. Place the sum in R7 and R6; R6 should have the lower byte.

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

```

ORG 0000H
MOV A, #62H
SUBB A, #96H
MOV R6, A
MOV A, #27H
SUBB A, #12H
MOV R7, A
END

```

P - 0, OV - 0, AC - 0 , C - 0

The screenshot shows the Keil uVision IDE interface. The main window displays assembly code for a program. The registers window on the right shows the current state of the registers. The command window at the bottom shows the execution status and errors.

Disassembly:

```

C:0x0002 9496 SUBB A,#0x96
4: MOV R6, A
C:0x0004 FE MOV R6,A
5: MOV A, #27H
C:0x0005 7427 MOV A,#0x27
6: SUBB A,#12H
C:0x0007 9412 SUBB A,#0x12
7: MOV R7, A
C:0x0009 FF MOV R7,A
C:0x000A 00 NOP
  
```

Registers:

Register	Value
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x14
Sys	
a	0x14
b	0x00
sp	0x07
sp_max	0x07
PC	0x000A
auxr1	0x00
dptr	0x0000
states	6
sec	0.00000218
psw	0x00
p	0
f1	0
ov	0
rs	0
f0	0
ac	0
cy	0

Command:

```

Running with Code Size Limit: 2K
Load "D:\Objects\19blc1165"
*** error 65: access violation at C:0x000A : no 'execute/read' permission
*** error 65: access violation at C:0x000A : no 'execute/read' permission
  
```

Memory 1:

```

Address: D:0x0055
D:0x55: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x6D: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x85: 01 01 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x9D: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0xB5: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
  
```

• PROGRAM – 5

AIM - Write an 8051 ASM program to perform multiplication of two 8-bit numbers present in data memory address location 33H & 34H and store the result in 35H (higher byte) & 36H (Lower byte).

MUL AB ;A x B, place 16-bit result in B and A

Multiplication	Operand 1	Operand 2	Result
byte × byte	A	B	A = low byte, B = high byte

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

- ORG 0000H
MOV A, 33H
MOV B, 34H
MUL AB
MOV 35H, B
MOV 36H, A
END

The screenshot displays the uVision IDE interface for a project named 'D:\19blc1165.uvproj'. The main window shows the assembly code for 'neww.asm' with the following instructions:

```
1 ORG 0000H
2 MOV A, 33H
3 MOV B, 34H
4 MUL AB
5 MOV 35H, B
6 MOV 36H, A
7 END
```

The Disassembly window shows the corresponding machine code instructions:

```
C:0x0000 E533 MOV A,0x33
3: MOV B, 34H
C:0x0002 8534F0 MOV B(0xF0),0x34
4: MUL AB
C:0x0005 A4 MUL AB
5: MOV 35H, B
C:0x0006 85F035 MOV 0x35,B(0xF0)
6: MOV 36H, A
C:0x0009 F536 MOV 0x36,A
C:0x000B 00 NOP
```

The Registers window shows the current state of the registers:

Register	Value
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC	C:0x000B
auxr1	0x00
dptr	0x0000
states	10
sec	0.00000364
psw	0x00
p	0
f1	0
ov	0
rs	0
f0	0
ac	0
cy	0

The Command window shows the following messages:

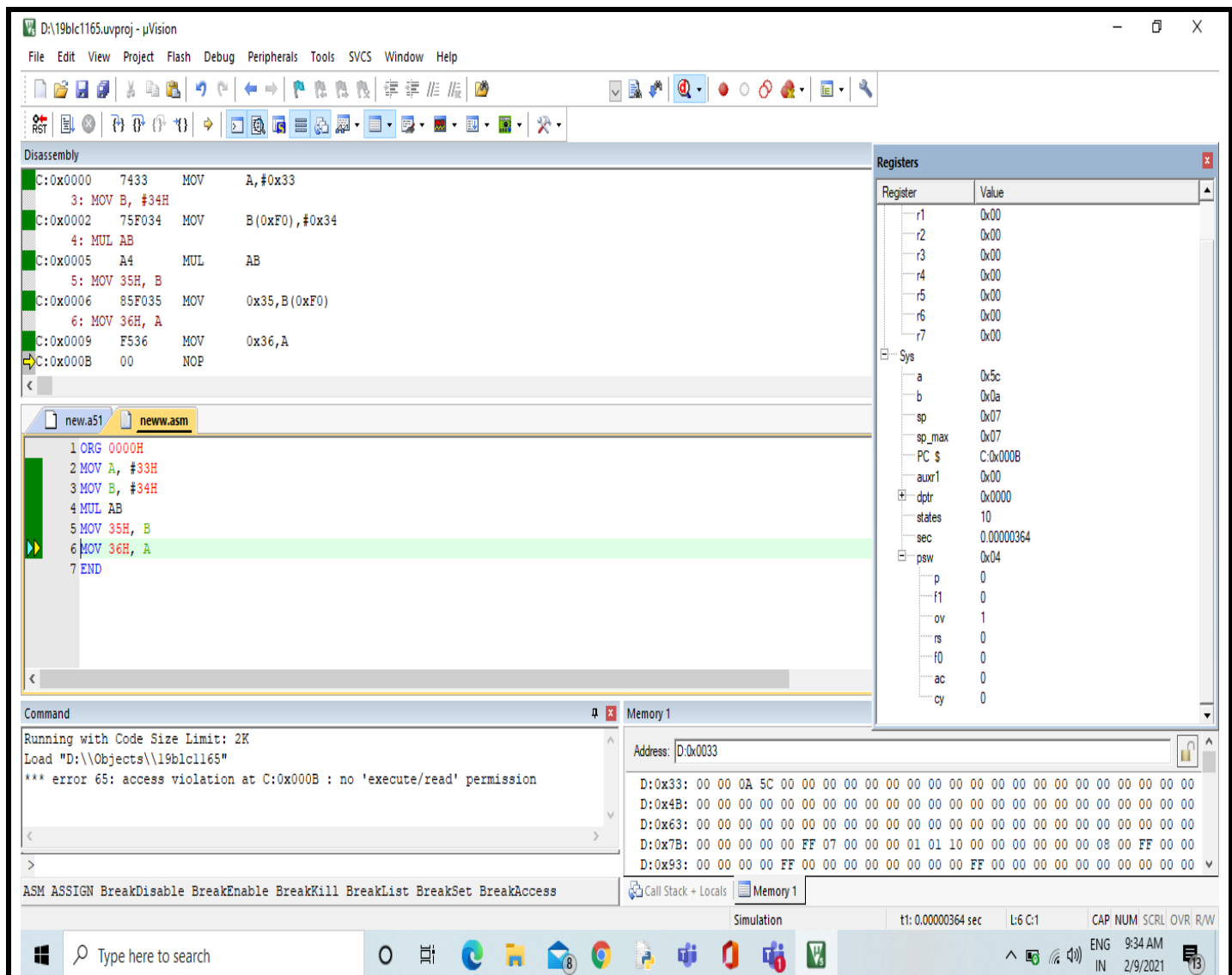
```
Running with Code Size Limit: 2K
Load "D:\\Objects\\19blc1165"
*** error 65: access violation at C:0x000B : no 'execute/read' permission
```

The Memory window shows the memory dump at address D:0x0033:

```
D:0x33: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x4B: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x63: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x7B: 00 00 00 00 00 FF 07 00 00 00 01 01 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x93: 00 00 00 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

The bottom status bar shows the simulation time as 0.00000364 sec, and the system clock as 9:34 AM on 2/9/2021.

- ORG 0000H
MOV A, #33H
MOV B, #34H
MUL AB
MOV 35H, B
MOV 36H, A
END



• PROGRAM – 6

AIM - Write an 8051 ASM program to perform division on 8-bit numbers present in data memory address location 33H & 34H and store the result in 35H (Reminder) & 36H (Quotient).

DIV AB ;divide A by B

Division	Numerator	Denominator	Quotient	Remainder
byte / byte	A	B	A	B

(If B = 0, then OV = 1 indicating an error)

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

- ORG 0000H
MOV A, 95
MOV B, 10
DIV AB
MOV 35H, B
MOV 36H, A
END

The screenshot displays the ARM KEIL software interface. The main window shows the assembly code for a program. The code is as follows:

```
1 ORG 0000H
2 MOV A, 95
3 MOV B, 10
4 DIV AB
5 MOV 35H, B
6 MOV 36H, A
7 END
```

The Disassembly window shows the compiled instructions:

```
C:0x0000 E55F MOV A,0x5F
3: MOV B, 10
C:0x0002 850AF0 MOV B(0xF0),0x0A
4: DIV AB
C:0x0005 84 DIV AB
5: MOV 35H, B
C:0x0006 85F035 MOV 0x35,B(0xF0)
6: MOV 36H, A
C:0x0009 F536 MOV 0x36,A
C:0x000B 00 NOP
```

The Registers window shows the state of the registers:

Register	Value
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC	\$ C:0x000B
auxr1	0x00
dptr	0x0000
states	10
sec	0.00000364
psw	0x04

The Command window shows the simulation status:

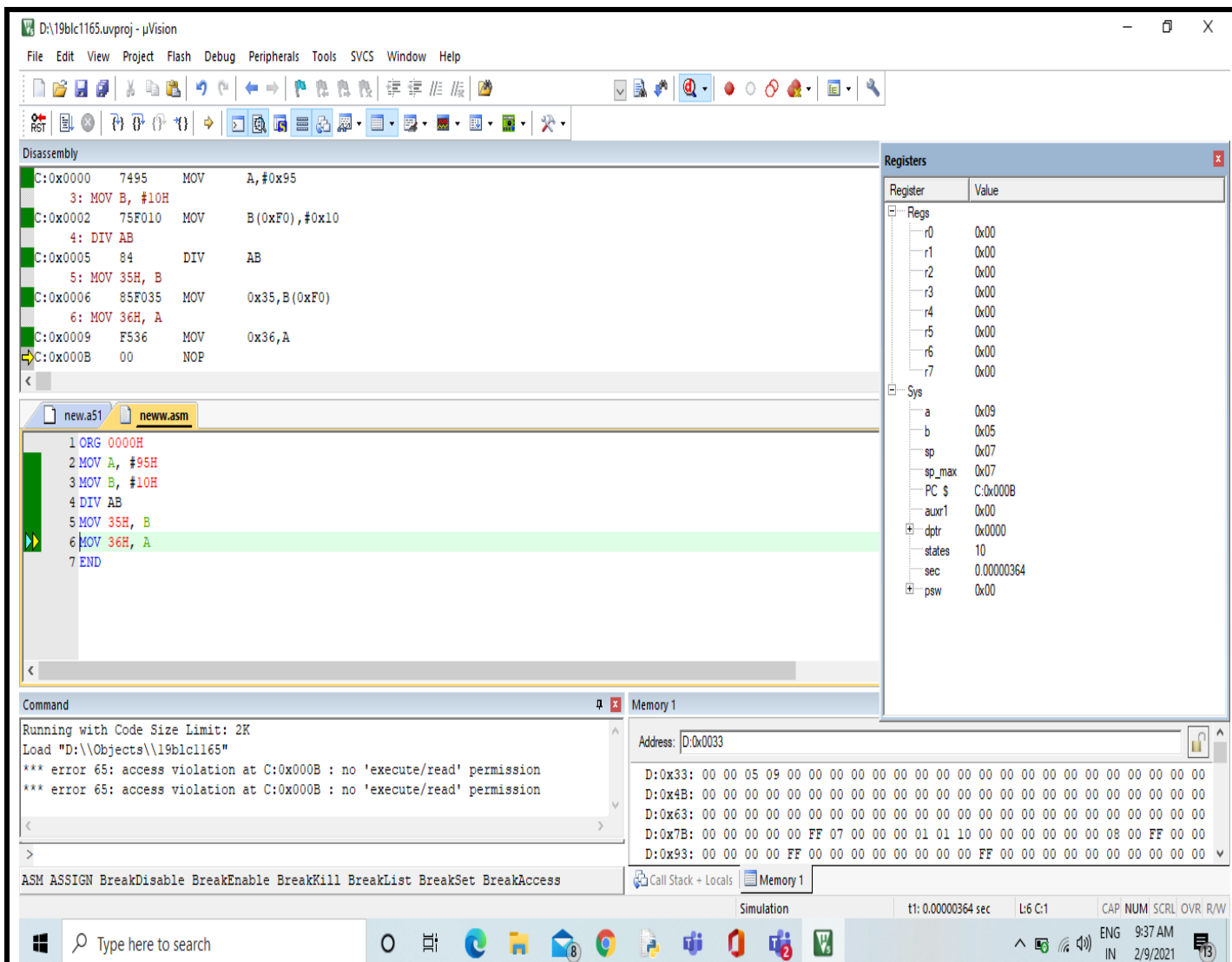
```
Running with Code Size Limit: 2K
Load "D:\Objects\l19blcl165"
*** error 65: access violation at C:0x000B : no 'execute/read' permission
```

The Memory window shows the memory contents at address D:0x0033:

```
D:0x33: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x4B: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x63: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x7B: 00 00 00 00 00 FF 07 00 00 00 01 01 10 00 00 00 00 00 00 00 00 00 08 00 FF 00 00 00 00 00 00 00 00
D:0x93: 00 00 00 00 FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

The bottom status bar shows the simulation time: t1: 0.00000364 sec, L6 C:1, CAP NUM SCRL OVR R/W, and the date: 2/8/2021.

- ORG 0000H
MOV A, #95
MOV B, #10
DIV AB
MOV 35H, B
MOV 36H, A
END



CHALLENGING TASKS

• TASK 1

AIM - Write an 8051 ASM program to solve the following mathematical equation:

$$W=(Y+3Z-6X)/6D$$

Where D=03H, X=02H, Y=25H and Z=12H

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

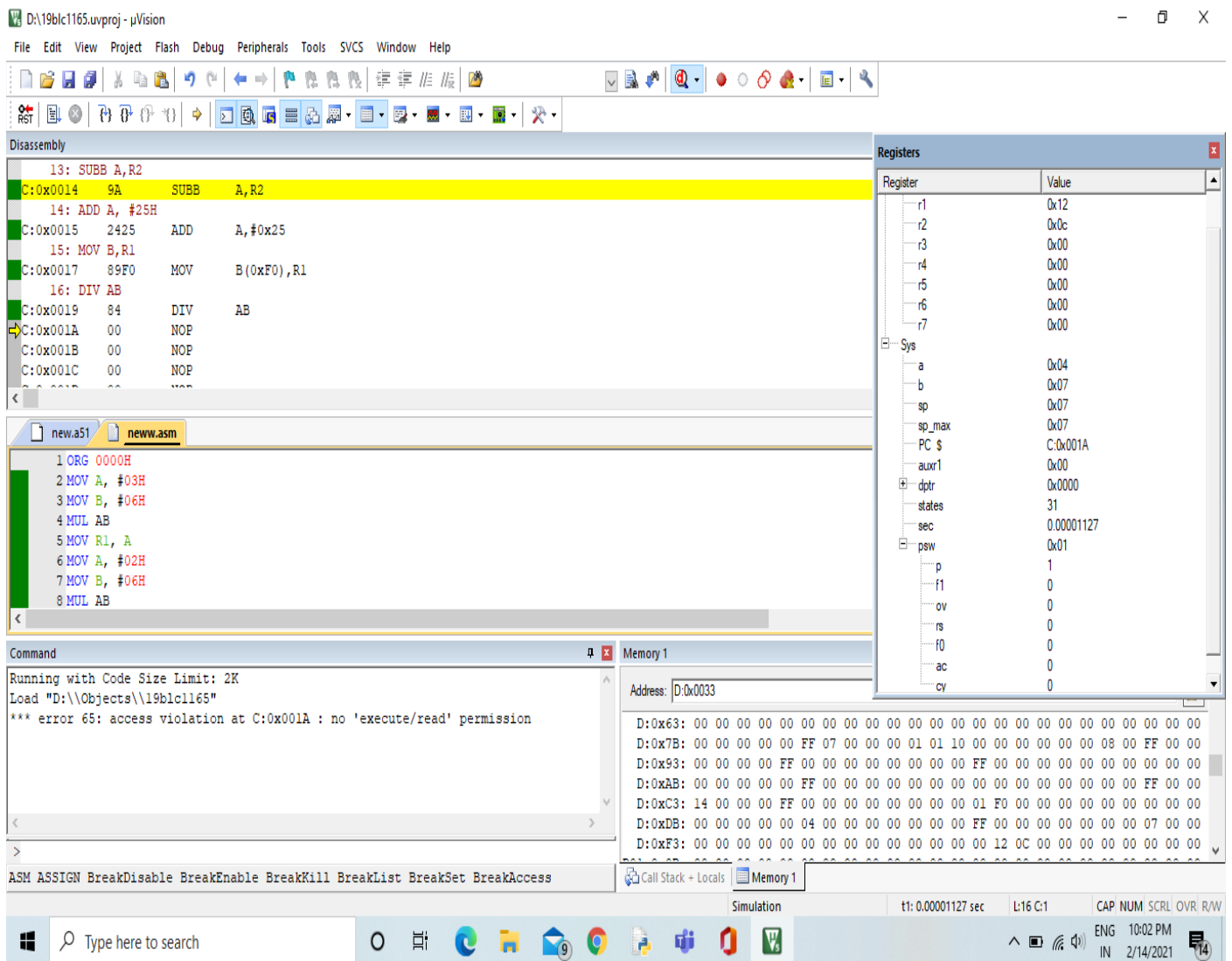
```

ORG 0000H
MOV A,#03H
MOV B,#06H
MUL AB
MOV R1,A
MOV A,#02H
  
```

```

MOV B,#06H
MUL AB
MOV R2,A
MOV A,#12H
MOV B,#03H
MUL AB
SUBB A,R2
ADD A,#25H
MOV B,R1
DIV AB
END

```



• TASK 2

AIM - Write an 8051 ASM program to solve the following mathematical equation:

$$(a-b)^2 = a^2 + b^2 - 2ab$$

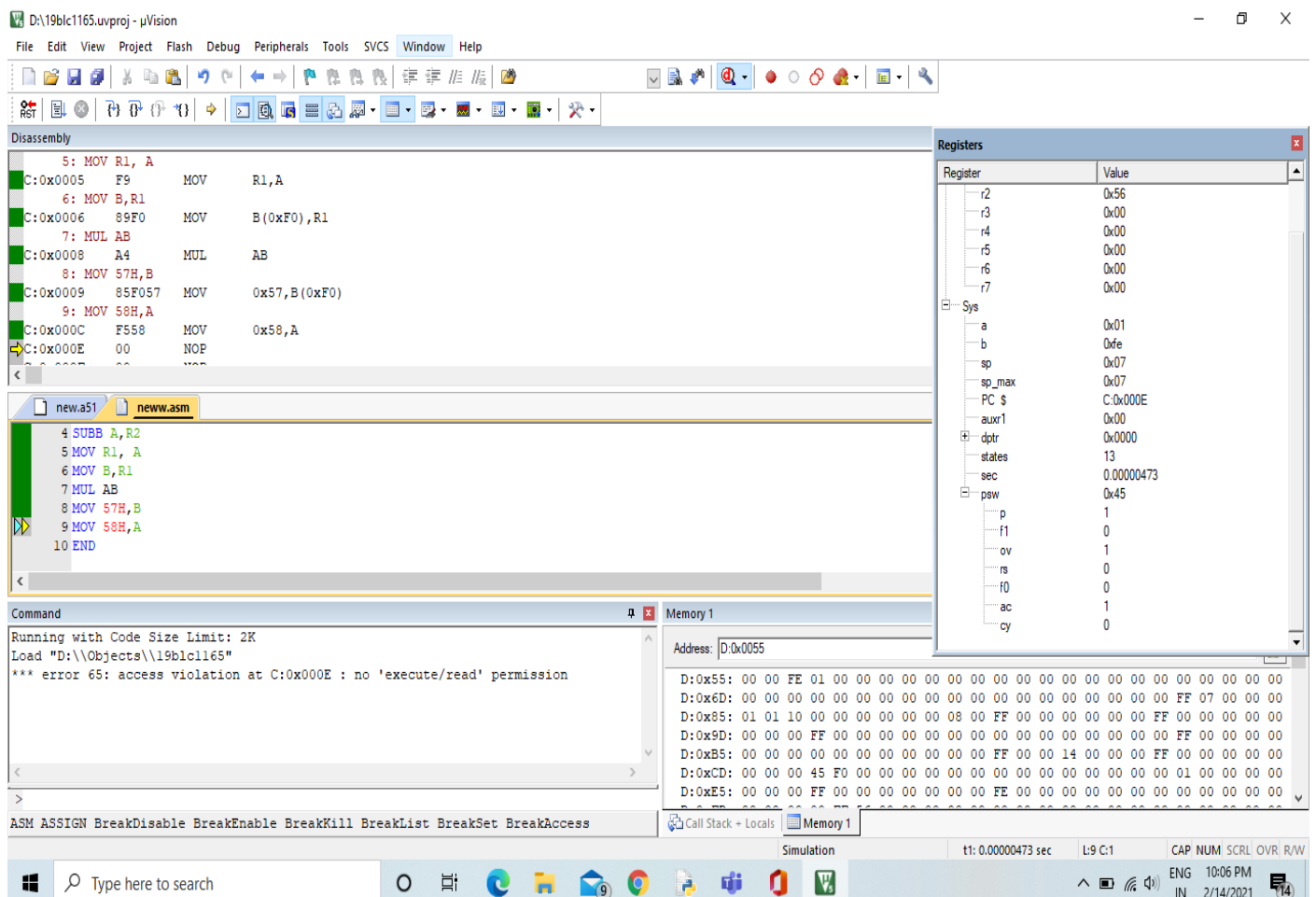
Where “a” & “b” are values at memory location 55H & 56H and store the result in 57H (High byte) & 58H (Low Byte).

MATERIAL REQUIRED – ARM KEIL software along with C51.

CODE –

```
ORG 0000H
MOV A,55H
```

```
MOV R2,56H
SUBB A,R2
MOV R1,A
MOV B,R1
MUL AB
MOV 57H,B
MOV 58H,A
END
```



RESULT –

This is the simulation result of the experiment on ARM KEIL simulation software.