

COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE

SIMPLE CALCULATOR

FACULTY OF COMPUTING

I-14 CAMPUS, ISLAMABAD

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Project Report

Problem Statement

Objective:

Create an Assembly calculator performing basic operations (addition, subtraction, multiplication, division) and two advanced functions (e.g., modulus, exponentiation, square root).

Requirements:

1. Basic Functions: Implement addition, subtraction, multiplication, and division
2. Advanced Functions: Include at least two advanced operations.
3. Assembly Concepts: Utilize the assembly concepts covered in the Lab.
4. User Interface: Prompt for inputs, allow operation selection, and handle errors (e.g., division by zero).

Solution

Software Used:

8086 Emulator

Code:

```
edit: G:\My Drive\54689 - Abdul Rafay\Semester 3\Computer Organization & AL\Project\MyCalculator\SimpleCalcuto.asm
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0001 .model small
0002 .stack 100h
0003 .data
0004     ; 0dh (move to beginning of line) & 0ah (cursor to new line)
0005     menu db 0dh,0ah,"-----SIMPLE CALCULATOR COMAL PROJECT-----",0dh,0ah
0006     db 0ah,"Group Members: 54689 - Abdul Rafay, 54481 - Hassan Zahid",0dh,0ah
0007     db "SE 3-1 RIFAH INTERNATIONAL UNIVERSITY, I-14 Campus, Islamabad",0dh,0ah
0008     db "-----",0dh,0ah
0009     db ""0dh,0ah
0010     db "1-Add",0dh,0ah,"2-Multiply",0dh,0ah,"3-Subtract",0dh,0ah,"4-Divide",0dh,0ah,"5-Exponent",0dh,0ah,"6-Factorial",0dh,0ah,"7-Exit",0dh,0ah,"$"
0011     choice_message db 0dh,0ah,"Enter your Choice: $"
0012     fno_message db 0dh,0ah,"Enter First Number (0-9): $"
0013     sno_message db 0dh,0ah,"Enter Second Number (0-9): $"
0014     sinno_message db 0dh,0ah,"Enter Number for factorial (0-9): $"
0015     result_message db 0dh,0ah,"ANSWER: ",0dh,0ah,"$"
0016     error_message db 0dh,0ah,"Error: Invalid Input",0dh,0ah,"Press any key to display the menu again...",0dh,0ah,"$"
0017     exit_message db 0dh,0ah,"Good Bye! Thanks for using our calculator.",0dh,0ah,"$"
0018     choice db ?
0019     no1 db ?
0020     no2 db ?
0021     result db ?
0022 .code
0023 main proc
0024     mov ax, 0data
0025     mov ds, ax
0026
0027 Start:
0028     call display_menu           ; Display menu
0029     lea dx, choice_message     ; Display choice prompt
0030     mov ah, 09h
0031     int 21h
0032     mov ah, 01h
0033     int 21h
0034     mov choice, al
0035
0036     cmp choice, '1'
0037     je Addition
0038     cmp choice, '2'
0039     je Multiply
0040     cmp choice, '3'
0041     je Subtraction
0042     cmp choice, '4'
0043     je Divide
0044     cmp choice, '5'
0045     je Exponent
0046     cmp choice, '6'
0047     je Factorial
0048     cmp choice, '7'
0049     je Exit
0050     ; Invalid Input
0051     lea dx, error_message
0052     mov ah, 09h
0053     int 21h
0054     mov ah, 0
0055     int 16h
0056     jmp Start
0057
0058 Addition:
0059     call two_input
0060     mov al, no1
0061     sub al, 30h
0062     mov bl, no2
0063     sub bl, 30h
0064     add al, bl
0065     add al, 30h
0066     mov result, al
0067     call display_result
0068     jmp Start
0069
0070 Subtraction:
0071     call two_input
0072     mov al, no1
0073     sub al, 30h
0074     mov bl, no2
0075     sub bl, 30h
0076     sub al, bl
0077     add al, 30h
0078     mov result, al
0079     call display_result
0080     jmp Start
0081
0082 Multiply:
0083     call two_input
0084     mov al, no1
0085     sub al, 30h
0086     mov bl, no2
0087     sub bl, 30h
0088     mul bl
0089     add al, 30h
0090     mov result, al
0091     call display_result
0092     jmp Start
0093
0094 Divide:
0095     call two_input
0096     mov al, no1
0097     sub al, 30h
0098     mov ah, 0
0099     mov bl, no2
0100     sub bl, 30h
0101     cmp bl, 0
0102     je DivisionError
0103     div bl
0104     add al, 30h
0105     mov result, al
0106     call display_result
0107     jmp Start
0108
0109 DivisionError:
0110     lea dx, error_message
0111     mov ah, 09h
0112     int 21h
0113     jmp Start
```

```

114
115 Exponent:
116 call two_input          ; Get base and exponent (no1 and no2)
117 mov al, no1             ; Convert ASCII base to binary
118 sub al, 30h
119 mov bl, no2             ; Convert ASCII exponent to binary
120 sub bl, 30h
121 mov cl, bl
122 dec cl                  ; Store exponent in CL for loop counter
123 dec cl                  ; Store base in BL
124 dec cl                  ; Decrement exponent by 1 (base*1 = base)
125
126 ExponentLoop:
127 cmp cl, 0               ; Check if exponent loop is complete
128 je ExponentDone         ; If exponent = 0, exit loop
129 mul bl                   ; Multiply AL by BL (base)
130 dec cl                  ; Decrement loop counter
131 jmp ExponentLoop        ; Repeat loop
132
133 ExponentDone:
134 add al, 30h             ; Convert result back to ASCII
135 mov result, al          ; Store result
136 call display_result     ; Display result
137 jmp Start              ; Return to menu
138
139 Factorial:
140 call one_input          ; Get input (ASCII in no1)
141 mov al, no1             ; Move input to AL
142 sub al, 30h             ; Convert ASCII to binary (decimal)
143 cmp al, 0               ; Check if input is 0
144 je FactorialIsOne       ; Factorial of 0 is 1
145 mov bl, al              ; Copy input to BL for multiplication
146 dec bl                  ; Decrement BL (n-1)
147 mov cl, bl              ; Store BL in CL for loop counter
148 mov bl, al              ; Restore input in BL
149
150 FactorialLoop:
151 cmp cl, 1               ; Check if CL <= 1
152 jl FactorialDone        ; Exit loop if counter < 1
153 mul cl                   ; Multiply AL by CL (AL *= CL)
154 dec cl                  ; Decrement counter
155 jmp FactorialLoop       ; Repeat loop
156
157 FactorialDone:
158 add al, 30h             ; Convert result to ASCII
159 mov result, al          ; Store result in 'result'
160 call display_result     ; Display result
161 jmp Start              ; Return to menu
162
163 FactorialIsOne:
164 mov result, '1'         ; Factorial of 0 is 1
165 call display_result     ; Display result
166 jmp Start              ; Return to menu
167
168 Exit:
169 call goodbye            ; Display goodbye message
170 mov ah, 4ch             ; Terminate program
171 int 21h
172
173 main endp
174
175 ; Procedure to get one input
176 one_input proc
177 lea dx, sinno_message
178 mov ah, 09h
179 int 21h
180 mov ah, 01h
181 int 21h
182 mov no1, al             ; Saving the number
183 ret
184 one_input endp
185
186 ; Procedure to get two inputs
187 two_input proc
188 lea dx, fno_message
189 mov ah, 09h
190 int 21h
191 mov ah, 01h
192 int 21h
193 mov no1, al             ; Save first number
194
195 lea dx, sno_message
196 mov ah, 09h
197 int 21h
198 mov ah, 01h
199 int 21h
200 mov no2, al             ; Save second number
201 ret
202 two_input endp
203
204 ; Procedure to display result
205 display_result proc
206 lea dx, result_message
207 mov ah, 09h
208 int 21h
209 mov dl, result
210 mov ah, 02h
211 int 21h
212 ; Display result
213 ret
214 display_result endp
215
216 ; Procedure to display goodbye message
217 goodbye proc
218 lea dx, exit_message
219 mov ah, 09h
220 int 21h
221 ret
222 goodbye endp
223
224 end main

```

Implementation details and Results:

1. Addition:

```

dx, sno_message
217 mov ah, 0
218 int 16h

```

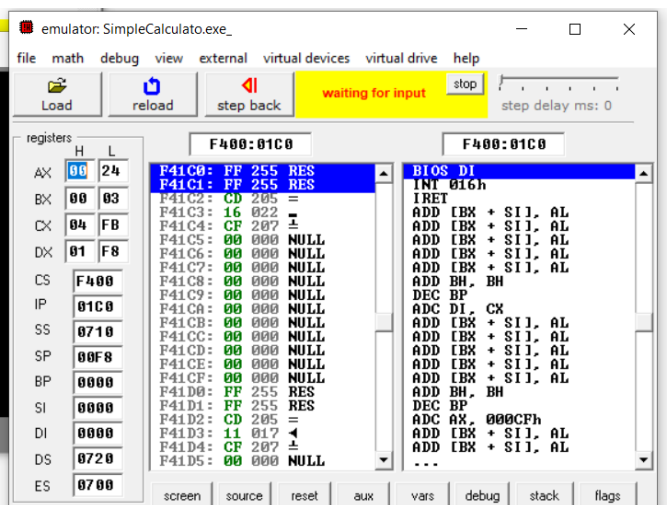
emulator screen (80x25 chars)

```

*****--SIMPLE CALCULATOR COBAL PROJECT--*****
Group Members: 54689 - Abdul Rafay, 54481 - Hassan Zahid
SE 3-1 RIPHAH INTERNATIONAL UNIVERSITY, I-14 Campus, Islamabad
*****
1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit
Enter your Choice: 1
Enter First Number (0-9): 4
Enter Second Number (0-9): 3
Press any key to display the menu again...

```

clear screen change font 0-16



2. Subtraction:

```
age db 0dh, 0ah, "Enter First Number (0-9):"
age db 0dh, 0ah, "Enter Second Number (0-9):"
int 16h

emulator screen (80x25 chars)

Press any key to display the menu...

*****SIMPLE CALCULATOR CO&AL PROJECT*****

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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 3
Enter First Number (0-9): 6
Enter Second Number (0-9): 3
ANSWER: 3
Press any key to display the menu...

clear screen change font 0/16

choice, 3
Exponent
choice, '6'
```

emulator: SimpleCalculato.exe_

file math debug view external virtual devices virtual drive help

Load reload step back waiting for input stop step delay ms: 0

registers	H	L
AX	00	24
BX	00	03
CX	04	F8
DX	01	F8
CS	F400	
IP	01C0	
SS	0710	
SP	00F8	
BP	0000	
SI	0000	
DI	0000	
DS	0720	
ES	0700	

F400:01C0	F400:01C0
F41C0: FF 255 RES	BIOS DI
F41C1: FF 255 RES	INT 016h
F41C2: CD 205 =	IRET
F41C3: 16 022 =	ADD [BX + SI], AL
F41C4: CF 207 =	ADD [BX + SI], AL
F41C5: 00 000 NULL	ADD [BX + SI], AL
F41C6: 00 000 NULL	ADD [BX + SI], AL
F41C7: 00 000 NULL	ADD [BX + SI], AL
F41C8: 00 000 NULL	ADD [BX + SI], AL
F41C9: 00 000 NULL	ADD [BX + SI], AL
F41CA: 00 000 NULL	ADD [BX + SI], AL
F41CB: 00 000 NULL	ADD [BX + SI], AL
F41CC: 00 000 NULL	ADD [BX + SI], AL
F41CD: 00 000 NULL	ADD [BX + SI], AL
F41CE: 00 000 NULL	ADD [BX + SI], AL
F41CF: 00 000 NULL	ADD [BX + SI], AL
F41D0: FF 255 RES	ADD [BX + SI], AL
F41D1: FF 255 RES	ADD [BX + SI], AL
F41D2: CD 205 =	ADD [BX + SI], AL
F41D3: 11 017 =	ADD [BX + SI], AL
F41D4: CF 207 =	ADD [BX + SI], AL
F41D5: 00 000 NULL	...

screen source reset aux vars debug stack flags

3. Multiply:

```
age db 0dh, 0ah, "Enter First Number (0-9):"
age db 0dh, 0ah, "Enter Second Number (0-9):"
int 16h

emulator screen (80x25 chars)

Press any key to display the menu...

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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 2
Enter First Number (0-9): 3
Enter Second Number (0-9): 2
ANSWER: 6
Press any key to display the menu...

clear screen change font 0/16

choice, 3
Exponent
choice, '6'
factorial
```

emulator: SimpleCalculato.exe_

file math debug view external virtual devices virtual drive help

Load reload step back waiting for input stop step delay ms: 0

registers	H	L
AX	00	24
BX	00	02
CX	04	F8
DX	01	F8
CS	F400	
IP	01C0	
SS	0710	
SP	00F8	
BP	0000	
SI	0000	
DI	0000	
DS	0720	
ES	0700	

F400:01C0	F400:01C0
F41C0: FF 255 RES	BIOS DI
F41C1: FF 255 RES	INT 016h
F41C2: CD 205 =	IRET
F41C3: 16 022 =	ADD [BX + SI], AL
F41C4: CF 207 =	ADD [BX + SI], AL
F41C5: 00 000 NULL	ADD [BX + SI], AL
F41C6: 00 000 NULL	ADD [BX + SI], AL
F41C7: 00 000 NULL	ADD [BX + SI], AL
F41C8: 00 000 NULL	ADD [BX + SI], AL
F41C9: 00 000 NULL	ADD [BX + SI], AL
F41CA: 00 000 NULL	ADD [BX + SI], AL
F41CB: 00 000 NULL	ADD [BX + SI], AL
F41CC: 00 000 NULL	ADD [BX + SI], AL
F41CD: 00 000 NULL	ADD [BX + SI], AL
F41CE: 00 000 NULL	ADD [BX + SI], AL
F41CF: 00 000 NULL	ADD [BX + SI], AL
F41D0: FF 255 RES	ADD [BX + SI], AL
F41D1: FF 255 RES	ADD [BX + SI], AL
F41D2: CD 205 =	ADD [BX + SI], AL
F41D3: 11 017 =	ADD [BX + SI], AL
F41D4: CF 207 =	ADD [BX + SI], AL
F41D5: 00 000 NULL	...

screen source reset aux vars debug stack flags

4. Divide:

```
age db 0dh, 0ah, "Enter First Number (0-9):"
age db 0dh, 0ah, "Enter Second Number (0-9):"
int 16h

emulator screen (80x25 chars)

Press any key to display the menu...

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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 4
Enter First Number (0-9): 8
Enter Second Number (0-9): 2
ANSWER: 4
Press any key to display the menu...

clear screen change font 0/16

choice, 3
Exponent
choice, '6'
```

emulator: SimpleCalculato.exe_

file math debug view external virtual devices virtual drive help

Load reload step back waiting for input stop step delay ms: 0

registers	H	L
AX	00	24
BX	00	02
CX	04	F8
DX	01	F8
CS	F400	
IP	01C0	
SS	0710	
SP	00F8	
BP	0000	
SI	0000	
DI	0000	
DS	0720	
ES	0700	

F400:01C0	F400:01C0
F41C0: FF 255 RES	BIOS DI
F41C1: FF 255 RES	INT 016h
F41C2: CD 205 =	IRET
F41C3: 16 022 =	ADD [BX + SI], AL
F41C4: CF 207 =	ADD [BX + SI], AL
F41C5: 00 000 NULL	ADD [BX + SI], AL
F41C6: 00 000 NULL	ADD [BX + SI], AL
F41C7: 00 000 NULL	ADD [BX + SI], AL
F41C8: 00 000 NULL	ADD [BX + SI], AL
F41C9: 00 000 NULL	ADD [BX + SI], AL
F41CA: 00 000 NULL	ADD [BX + SI], AL
F41CB: 00 000 NULL	ADD [BX + SI], AL
F41CC: 00 000 NULL	ADD [BX + SI], AL
F41CD: 00 000 NULL	ADD [BX + SI], AL
F41CE: 00 000 NULL	ADD [BX + SI], AL
F41CF: 00 000 NULL	ADD [BX + SI], AL
F41D0: FF 255 RES	ADD [BX + SI], AL
F41D1: FF 255 RES	ADD [BX + SI], AL
F41D2: CD 205 =	ADD [BX + SI], AL
F41D3: 11 017 =	ADD [BX + SI], AL
F41D4: CF 207 =	ADD [BX + SI], AL
F41D5: 00 000 NULL	...

screen source reset aux vars debug stack flags

5. Exponent:

```
age db 0dh, 0ah, "Enter First Number (0-9):"
age db 0dh, 0ah, "Enter Second Number (0-9):"
mov ah, 0
int 16h
```

```
emulator screen (80x25 chars)

Press any key to display the menu...

*****SIMPLE CALCULATOR CO&AL PROJECT*****

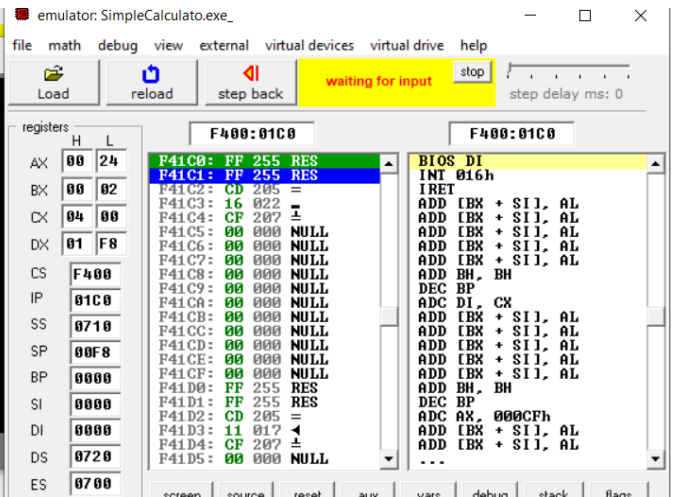
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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 5
Enter First Number (0-9): 2
Enter Second Number (0-9): 3
ANSWER: 8
Press any key to display the menu...

clear screen  change font  0/16
choice, 5
Exponent
choice, 'c'
```



6. Factorial:

```
message db 0dh, 0ah, "Enter your Choice: 5"
sage db 0dh, 0ah, "Enter First Number (0-9):"
sage db 0dh, 0ah, "Enter Second Number (0-9):"
mov ah, 0
int 16h
```

```
emulator screen (80x25 chars)

Press any key to display the menu...

*****SIMPLE CALCULATOR CO&AL PROJECT*****

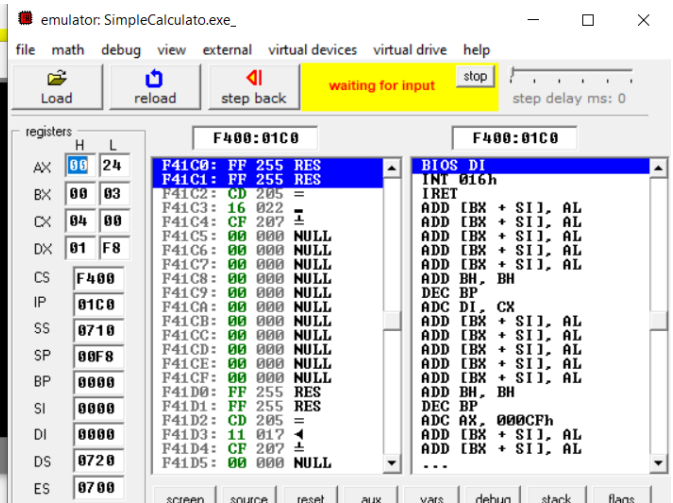
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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 6
Enter Number for factorial (0-9): 3
ANSWER: 6
Press any key to display the menu...

clear screen  change font  0/16
choice, 5
Exponent
choice, 'c'
```



7. Exit:

```
age db 0dh, 0ah, "Enter First Number (0-9):"
age db 0dh, 0ah, "Enter Second Number (0-9):"
mov ah, 0
int 16h
```

```
emulator screen (80x25 chars)

Press any key to display the menu...

*****SIMPLE CALCULATOR CO&AL PROJECT*****

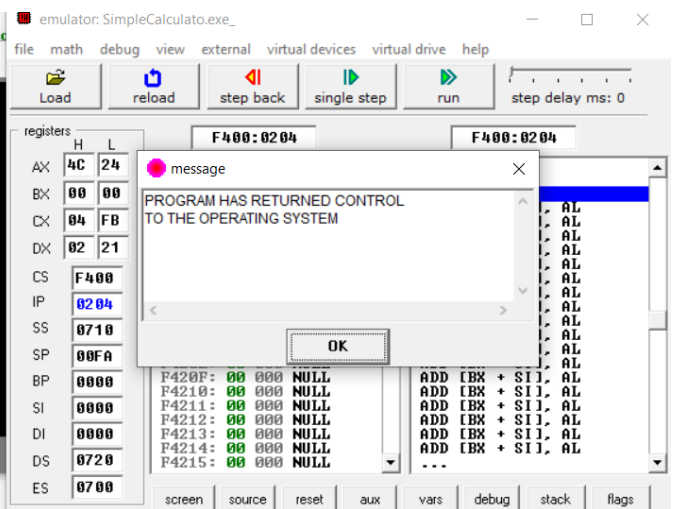
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*****

1-Add
2-Multiply
3-Subtract
4-Divide
5-Exponent
6-Factorial
7-Exit

Enter your Choice: 7
Good Bye! Thanks for using our calculator.

clear screen  change font  0/16
choice, 5
Exponent
choice, '6'
```



Conclusion

After complete execution of code, we were able to successfully compute the basic instruction of calculator like addition, subtraction, multiplication, division in 8086 emulators.

--- 😊 **The End** 😊 ---