

# CPSC 240: Computer Organization and Assembly Language

## Assignment 07, Spring Semester 2023

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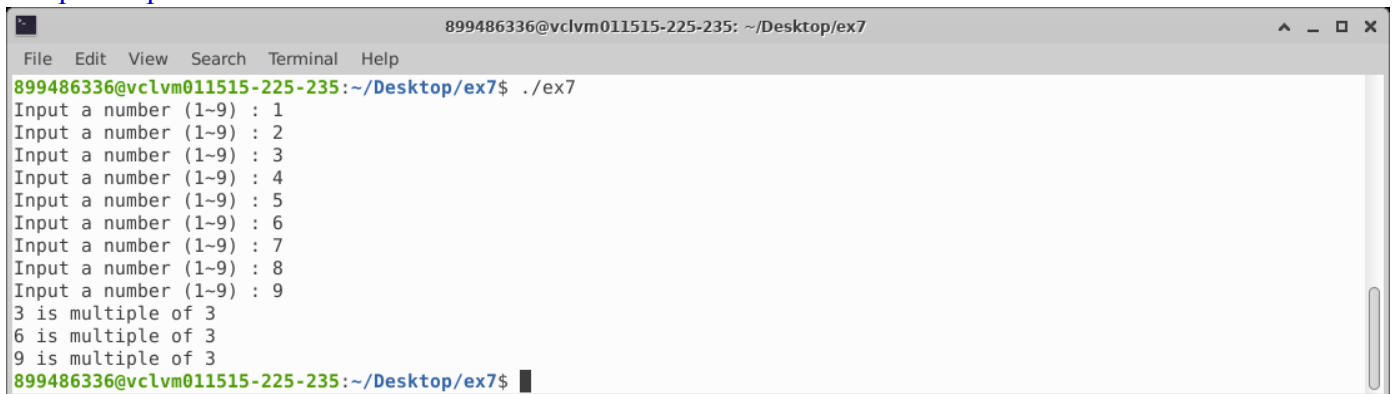
1. Download the "CPSC-240 Assignment07.docx" document.
2. Design the "input.asm" program, input 9 values from 1 to 9 from the keyboard, find out the multiples of 3 from the input values, and display the multiples of 3 in the terminal emulator window. The corresponding C/C++ code is as follows:

```
char msg1[] = "Input a number (1~9) : ";
char msg2[] = "Multiple of 3 include: ";
char buffer;
char num;
char ascii[10];

register int r10 = 0;
do {
    cout << msg1;
    cin >> buffer;
    ascii[r10] = buffer;
    r10++;
} while(r10 < 9);
r10 = 0;
do {
    num = atoi(ascii[r10]);
    if(num%3 == 0) {
        cout << ascii[r10] << msg2;
    }
    r10++;
} while(r10 < 9);
```

3. Assemble the "input.asm" file and link the "input.o" file to get the "input" executable file.
4. Run the "input" file to display the input **value** and **multiple of 3** in Terminal Emulator window.
5. Insert source code (input.asm) and simulation results (Terminal Emulator window) at the bottom of the document. Write an analysis to verify the simulation results.
6. Save the file in pdf format and submit the pdf file to Canvas before 23:59 pm on 04/16/2023.

Sample output:



```
899486336@vclvm011515-225-235: ~/Desktop/ex7
File Edit View Search Terminal Help
899486336@vclvm011515-225-235:~/Desktop/ex7$ ./ex7
Input a number (1-9) : 1
Input a number (1-9) : 2
Input a number (1-9) : 3
Input a number (1-9) : 4
Input a number (1-9) : 5
Input a number (1-9) : 6
Input a number (1-9) : 7
Input a number (1-9) : 8
Input a number (1-9) : 9
3 is multiple of 3
6 is multiple of 3
9 is multiple of 3
899486336@vclvm011515-225-235:~/Desktop/ex7$
```

Alternatively, the corresponding C/C++ code can be replaced as follows:

```
char num;
char buffer;
char msg1[] = "Input a number (1~9) : ";
```

```
char msg2[] = "Multiple of 3 include: ";

register int r10 = 0;
do {
    cout << msg1;
    cin >> buffer;
    num = atoi(buffer);
    if(num%3 == 0) {
        cout << msg2 << buffer;
    }
    r10++;
} while(r10 < 9);
```

Sample output:



```
899486336@vclvm011515-225-235: ~/Desktop/ex7
File Edit View Search Terminal Help
899486336@vclvm011515-225-235:~/Desktop/ex7$ ./ex7
Input a number (1-9) : 1
Input a number (1-9) : 2
Input a number (1-9) : 3
3 is multiple of 3
Input a number (1-9) : 4
Input a number (1-9) : 5
Input a number (1-9) : 6
6 is multiple of 3
Input a number (1-9) : 7
Input a number (1-9) : 8
Input a number (1-9) : 9
9 is multiple of 3
899486336@vclvm011515-225-235:~/Desktop/ex7$
```

[Insert input.asm here]

```
1 ; char num;
2 ; char buffer;
3 ; char msg1[] = "Input a number (1-9) : ";
4 ; char msg2[] = "Multiple of 3 include: ";
5 ;
6 ; register int r10 = 0;
7 ; do {
8 ;     cout << msg1;
9 ;     cin >> buffer;
10 ;     num = atoi(buffer);
11 ;     if(num%3 == 0) {
12 ;         cout << msg2 << buffer;
13 ;     }
14 ;     r10++;
15 ; } while(r10 < 9);
16
17 section .data
18     msg1    db      "Input a number(1-9) : "
19     msg2    db      " is a multiple of 3", 10
20
21 section .bss
22     num     resb     1
23     buffer  resb     1
24
25 section .text
26     global _start
27
28 _start:
29     mov     r10, 0
30 next1:
31     ; cout << msg
32     mov     rax, 1                ;SYS_write
33     mov     rdi, 1                ;write to STD_OUT
34     mov     rsi, msg1             ;address of msg
35     mov     rdx, 22               ;22 character to write
36     syscall
37
38     ; cin >> num
39     mov     rax, 0                ;SYS_read
40     mov     rdi, 0                ;read from STD_IN
41     mov     rsi, buffer           ;address of the buffer
42     mov     rdx, 2                ;input length = 1
43     syscall                       ;calling system services
44
45     ;converting buffer to int (atoi)
46     mov     al, byte[buffer]       ;al = buffer (ex: '5'=35h)
47     and     al, 0fh               ;al = block bit7~4 (ex: 05h)
48     mov     byte[num], al         ;num = al (ex: num=05h)
49
50     ;if(num % 3 == 0), its a multiple of 3
51     mov     bl, 3                 ;b1 = 3 for divisor
52     mov     ah, 0                 ;making ah 0 to prease its usage as a remainder
53     div     bl                    ;divide user inputed number by 3 and checkin if its
54     cmp     ah, 0                 ;divisible by comparing it with 0
55     je      is_divisible          ;jump to is_divisible if remainder = 0
56     jmp     skip                  ;otherwise jump to skip
```

```

58 is_divisible:
59     ; cout << num
60     mov     rax, 1                ;SYS_write
61     mov     rdi, 1                ;where to write
62     mov     rsi, buffer           ;address of buffer
63     mov     rdx, 1                ;1 character to write
64     syscall                       ;calling system services
65
66     ; cout << msg
67     mov     rax, 1                ;SYS_write
68     mov     rdi, 1                ;write to STDOUT
69     mov     rsi, msg2             ;address of msg
70     mov     rdx, 20               ;22 character to write
71     syscall
72
73 skip:
74     inc     r10                   ;r10 = r10 + 1
75     cmp     r10, 8                ;compare r10 and 8
76     jle     next1                 ;if r10 <= 8 keep looping to next1
77     jmp     end                   ;else, end program
78
79 end:
80     mov     rax, 60
81     mov     rdi, 0
82     syscall

```

[Insert input simulation result here]

```

andrewss@andrewss-ThinkPad-T480:~/CPSC_240/Assignments/assignment7/cin_programs$
yasm -g dwarf2 -f elf64 cin.asm -l cin.lst
andrewss@andrewss-ThinkPad-T480:~/CPSC_240/Assignments/assignment7/cin_programs$
ld -g -o cin cin.o
andrewss@andrewss-ThinkPad-T480:~/CPSC_240/Assignments/assignment7/cin_programs$
./cin
Input a number(1-9) : 1
Input a number(1-9) : 2
Input a number(1-9) : 3
3 is a multiple of 3
Input a number(1-9) : 4
Input a number(1-9) : 5
Input a number(1-9) : 6
6 is a multiple of 3
Input a number(1-9) : 7
Input a number(1-9) : 8
Input a number(1-9) : 9
9 is a multiple of 3
andrewss@andrewss-ThinkPad-T480:~/CPSC_240/Assignments/assignment7/cin_programs$

```

[Insert input simulation result analysis here]

OBJ:OBJ:

user input	is divisibly by 3?	display message	r10	jmp next1?
1	No	No message	1	yes
2	No	No message	2	yes
3	yes	"3 is divisible by 3"	3	yes
4	No	No message	4	yes
5	No	No message	5	yes
6	yes	"6 is divisible by 3"	6	yes
7	No	No message	7	yes
8	No	No message	8	yes
9	yes	"9 is divisible by 3"	9	No