CPSC 240: Computer Organization and Assembly Language
Assignment 08, Fall Semester 2023

CWID:__________________ Name:__________________________

1. Download the "CPSC-240 Assignment08.docx" document.
2. Design the "macro.asm" program, input a value n (n=001 ~ 999) from the keyboard, calculate 1+2+3+…+n, and display the calculation result in the terminal emulator window. The corresponding C/C++ code is as follows:

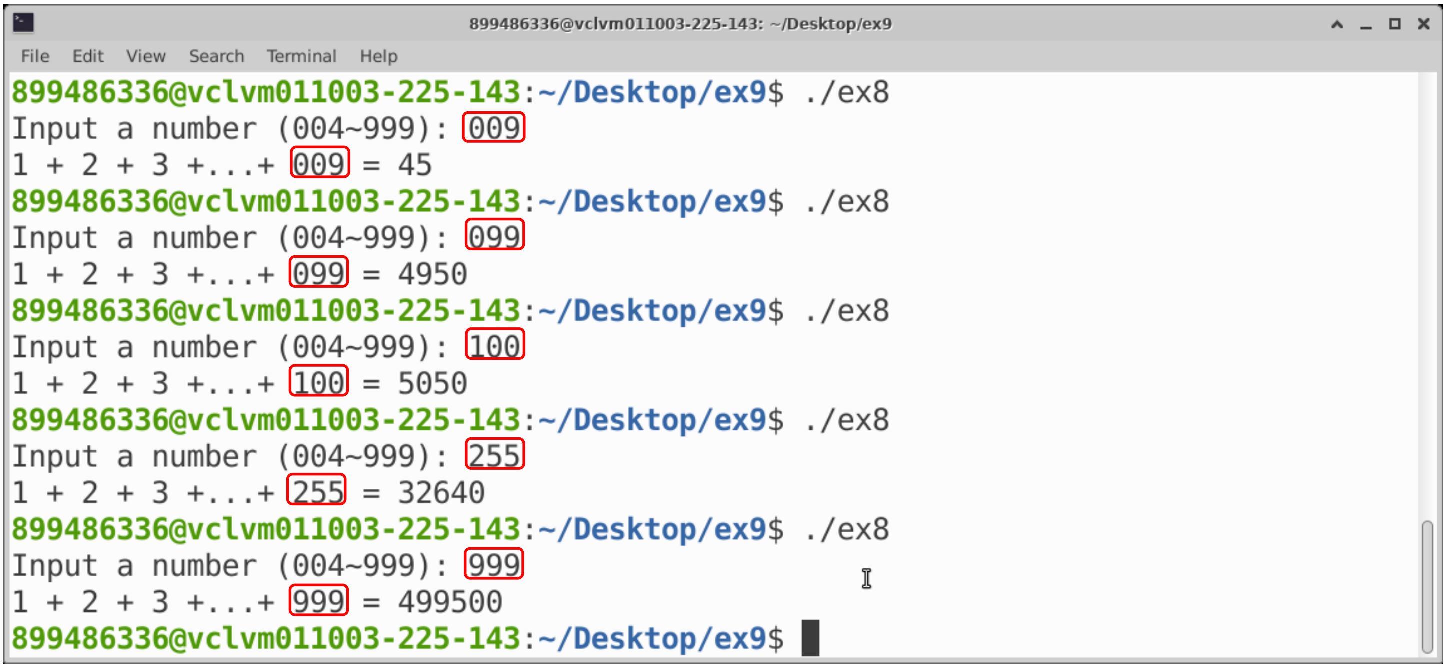
```
#begin define print(string, numOfChar)
    rax = 1;
    rdi = 1;
    rsi = &string;
    rdx = numOfChar;
    syscall;
#end
#begin define scan(buffer, numOfChar)
    rax = 0;
    rdi = 0;
    rsi = &buffer;
    rdx = numOfChar;
    syscall;
#end

char buffer[4];
int n;
int sumN;
char msg1[26] = "Input a number (004~999): ";
char msg2[16] = "1 + 2 + 3 +...+ ";
char msg3[4] = " = ";
char ascii[10];

print(msg1, 26);
scan(buffer, 4);
n = atoi(buffer);
rsi = 0;
do {
    sumN += rsi;
} while(rsi >= 0);
ascii = itoa(sumN);
print(msg2, 16);
print(buffer, 3);
print(msg3, 3);
print(ascii, 7);
```

3. Run the "macro" file to display the calculation result in the Terminal Emulator window.
4. Insert source code (macro.asm) and simulation results (Terminal Emulator window) at the bottom of the document. Write an analysis to verify the simulation results.
5. Save the file in pdf format and submit the pdf file to Canvas before 23:59 pm on 11/12/2023.

Simulation Sample:


899486336@vclvm011003-225-143: ~/Desktop/ex9
File Edit View Search Terminal Help

```
899486336@vclvm011003-225-143:~/Desktop/ex9$ ./ex8
Input a number (004~999): 009
1 + 2 + 3 +...+ 009 = 45
899486336@vclvm011003-225-143:~/Desktop/ex9$ ./ex8
Input a number (004~999): 099
1 + 2 + 3 +...+ 099 = 4950
899486336@vclvm011003-225-143:~/Desktop/ex9$ ./ex8
Input a number (004~999): 100
1 + 2 + 3 +...+ 100 = 5050
899486336@vclvm011003-225-143:~/Desktop/ex9$ ./ex8
Input a number (004~999): 255
1 + 2 + 3 +...+ 255 = 32640
899486336@vclvm011003-225-143:~/Desktop/ex9$ ./ex8
Input a number (004~999): 999
1 + 2 + 3 +...+ 999 = 499500
899486336@vclvm011003-225-143:~/Desktop/ex9$
```

[Insert macro.asm source code here]

```
; assignment08.asm
; #begin define print(string, numOfChar)
;        rax = 1;
;        rdi = 1;
;        rsi = &string;
;        rdx = numOfChar;
;        syscall;
; #end
; #begin define scan(buffer, numOfChar)
;        rax = 0;
;        rdi = 0;
;        rsi = &buffer;
;        rdx = numOfChar;
;        syscall;
; #end
;
; char buffer[4];
; int n;
; int sumN;
; char msg1[26] = "Input a number (004~999): ";
; char msg2[16] = "1 + 2 + 3 +...+ ";
; char msg3[4] = " = ";
; char ascii[10];
;
; print(msg1, 26);
; scan(buffer, 4);
; n = atoi(buffer);
; rsi = 0;
; do {
;    sumN += rsi;
; } while(rsi >= 0);
; ascii = itoa(sumN);
; print(msg2, 16);
; print(buffer, 3);
; print(msg3, 3);
; print(ascii, 7);

%macro   print    2
         mov      rax, 1                         ;SYS_write
         mov      rdi, 1                         ;standard output device
         mov      rsi, %1                        ;output string address
         mov      rdx, %2                        ;number of character
         syscall                                 ;calling system services
%endmacro

%macro   scan     2
         mov      rax, 0                         ;SYS_read
         mov      rdi, 0                         ;standard input device
         mov      rsi, %1                        ;input buffer address
         mov      rdx, %2                        ;number of character
         syscall                                 ;calling system services
%endmacro

section .bss
buffer   resb     4
n        resd     1
sumN     resd     1
ascii    resb     10

section .data
msg1     db       "Input a number (004~999): "
msg2     db       "1 + 2 + 3 +...+ "
msg3     db       " = "

section .text
         global _start
_start:
         print    msg1, 26                       ;cout << msg1
         scan     buffer, 4                      ;cin >> buffer
         mov      ax, 0                          ;clear ax
         mov      bx, 10                         ;bx = 10
         mov      rsi, 0                         ;counter = 0
inputLoop:
         mov      cl, byte[buffer+rsi]           ;cl = byte[buffer+rsi]
         and      cl, 0fh                        ;convert ascii to number
         add      al, cl                         ;al = number
         adc      ah, 0                          ;ah = 0
         cmp      rsi, 2                         ;compare rcx with 2
         je       skipMul                        ;if rsi=2 goto skipMul
         mul      bx                             ;dx:ax = ax * bx
skipMul:
         inc      rsi                            ;rcx++
         cmp      rsi, 3                         ;compare rsi with 3
         jl       inputLoop                      ;if rsi<3 goto inputLoop
         mov      word[n], ax                    ;n = ax

         ; calculates 1+2+3+...+N
         mov      ecx, 0                         ;ecx = 0
sumLoop:
         add      dword[sumN], ecx               ;sumN += ecx
         inc      ecx                            ;ecx++
         cmp      ecx, dword[n]                  ;compare ecx with n
         jbe      sumLoop                        ;if(ecx <= n) goto sumLoop

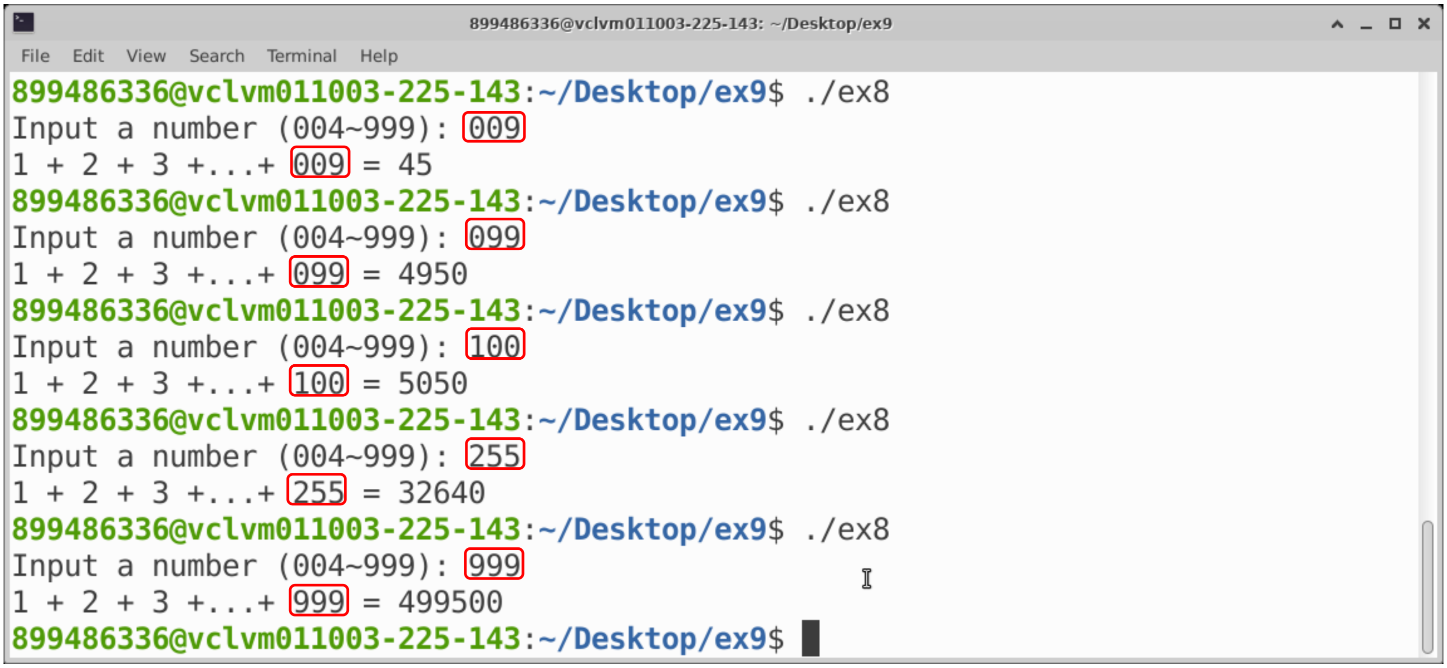
         ; converts sumN into ascii
         ; Part A - Successive division
         mov      eax, dword[sumN]               ;get integer
         mov      rcx, 0                       ;digitCount = 0
         mov      ebx, 10                      ;set for dividing by 10
divideLoop:
         mov      edx, 0
         div      ebx                          ;divide number by 10
         push     rdx                          ;push remainder
         inc      rcx                          ;increment digitCount
         cmp      eax, 0                       ;if (result > 0)
         jne      divideLoop                   ;goto divideLoop

         ; Part B - Convert remainders and store
         mov      rbx, ascii                   ;get addr of ascii
         mov      rdi, 0                       ;rdi = 0
popLoop:
         pop      rax                          ;pop intDigit
         add      al, "0"                      ;al = al + 0x30
         mov      byte [rbx+rdi], al           ;string[rdi] = al
         inc      rdi                          ;increment rdi
         loop     popLoop                      ;if (digitCount > 0) goto popLoop
         mov      byte [rbx+rdi], 10           ;string[rdi] = newline

         print    msg2, 16                     ;cout << msg2
         print    buffer, 3                    ;cout << buffer
         print    msg3, 3                      ;cout << " = "
         print    ascii, 7                     ;cout << ascii

         mov      rax, 60                      ;terminate program
         mov      rdi, 0                       ;exit status
         syscall                               ;calling system services
```

[Insert macro simulation result here]



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```

[Insert macro simulation verification here]