

Computer Science Department
California State University, Fullerton

CPSC 240-11 Computer Organization and Assembly Language
Final Exam
1:00 PM to 2:30 PM
Tuesday, December 12, 2023

Student Name: _____

Last 4 digits of ID: _____

Note:

- University regulations on academic honesty will be strictly enforced.
 - You have 90 minutes to complete this Quiz.
 - Open books, slides and sample programs.
 - Turn off or turn vibration your cell phone.
 - Use YASM assembler for the program design.
 - Copy and paste your assembly source code and Terminal Emulator window to the end of the word file and save it in pdf or docx format.
 - Submit you pdf or docx file to Canvas before the deadline.
- NOTE: Email submissions will not be graded.**
- Any content submitted after the due date will be regarded as a make-up exam.

Final Exam

1. Download the “CPSC-240-11 Final Exam.docx” document.
2. Convert the following C/C++ variable declarations and arithmetic operations to x86-64 assembly language. Use the “yasm” assembler to assemble the program, the “ld” linker to link the object code, and the “ddd” debugger to simulate the executable code.

NOTE: variable sizes and program functions should be equivalent to C/C++ instructions.

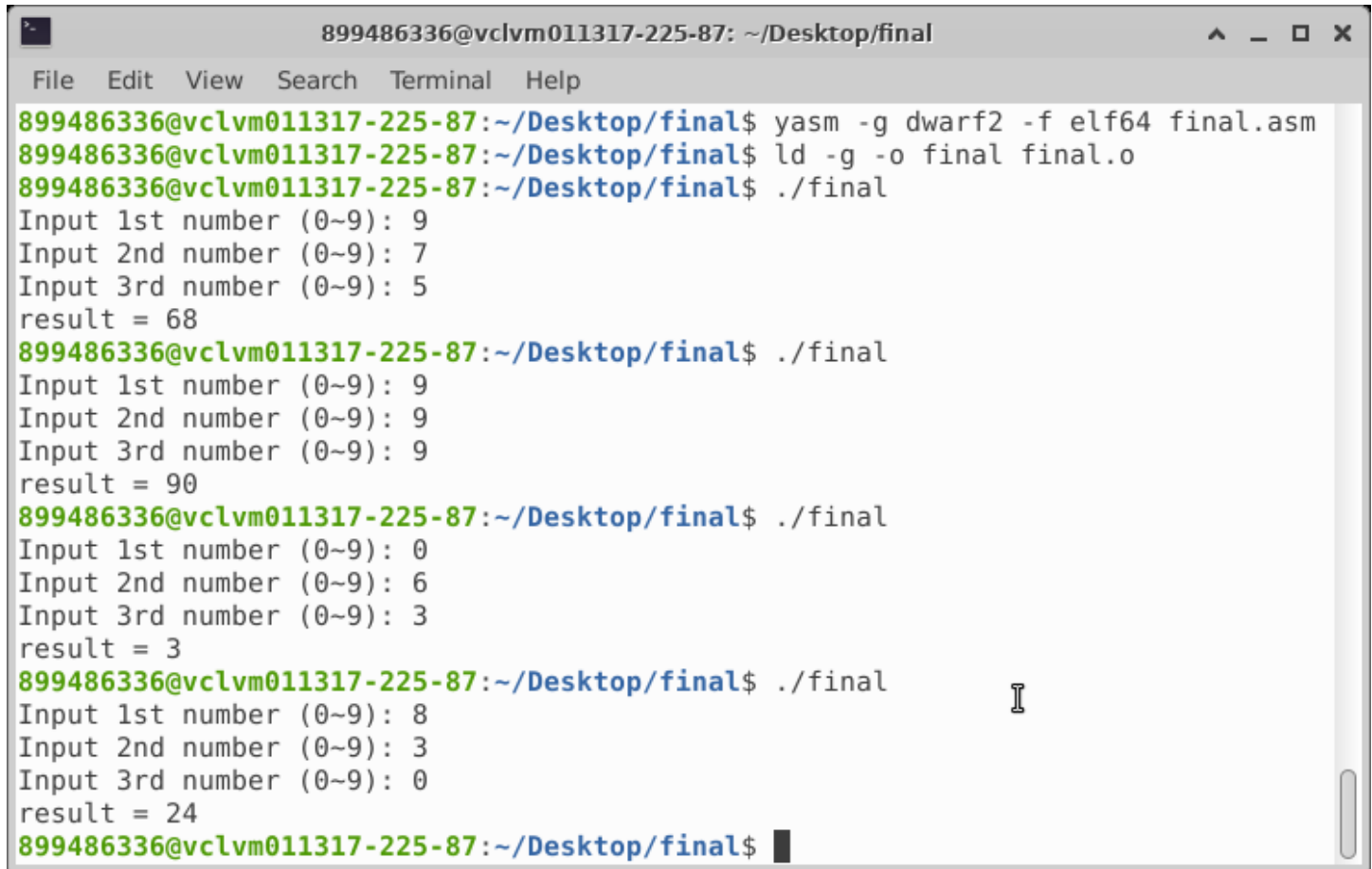
```
#begin define print(addr, n)
    rax = 1;
    rdi = 1;
    rsi = addr of string;
    rdx = n;
    syscall;
#end
#begin define scan(&addr, n)
    rax = 1;
    rdi = 1;
    rsi = &addr;
    rdx = n;
    syscall;
#end
char num1, num2, num3, result;
char buffer[2];
char ascii[3];
char msg1[24] = "Input 1st number (0~9): ";
char msg2[24] = "Input 2nd number (0~9): ";
char msg3[24] = "Input 3rd number (0~9): ";
char msg4[9] = "result = ";
void main() {
    print msg1, 24;
    scan buffer, 2
    num1 = atoi(buf);
    print msg2, 24;
    scan buffer, 2
    num2 = atoi(buf)
    print msg3, 24;
    scan buffer, 2
    num3 = atoi(buf)

    call calculate(num1, num2, num3, &result);

    call toString(&result, &ascii)
    print msg4, 10;
    print ascii, 4;
}
void calculate(num1, num2, num3, &result) {
    result = num1 * num2 + num3;
}
void toString(&result, &ascii) {
    ascii = itoa(result);
}
```

3. After assembling and linking, run the executable file to display the simulation results in the Terminal Emulator window as the following example.
4. Insert source code and the simulation results (Terminal Emulator window) to the bottom of the document.
5. Save the file in pdf or docx format and submit the pdf or docx file to Canvas before the deadline.
6. Deadline is 2:30 pm on 12/12/2023.

Simulation result example:



```
899486336@vclvm011317-225-87: ~/Desktop/final
File Edit View Search Terminal Help
899486336@vclvm011317-225-87:~/Desktop/final$ yasm -g dwarf2 -f elf64 final.asm
899486336@vclvm011317-225-87:~/Desktop/final$ ld -g -o final final.o
899486336@vclvm011317-225-87:~/Desktop/final$ ./final
Input 1st number (0~9): 9
Input 2nd number (0~9): 7
Input 3rd number (0~9): 5
result = 68
899486336@vclvm011317-225-87:~/Desktop/final$ ./final
Input 1st number (0~9): 9
Input 2nd number (0~9): 9
Input 3rd number (0~9): 9
result = 90
899486336@vclvm011317-225-87:~/Desktop/final$ ./final
Input 1st number (0~9): 0
Input 2nd number (0~9): 6
Input 3rd number (0~9): 3
result = 3
899486336@vclvm011317-225-87:~/Desktop/final$ ./final
Input 1st number (0~9): 8
Input 2nd number (0~9): 3
Input 3rd number (0~9): 0
result = 24
899486336@vclvm011317-225-87:~/Desktop/final$
```

[Attach your assembly source code here:]

[Attach Terminal Emulator window here:]