Name: ID#: X.500:

CSCI 2021: Practice Final Exam

Spring 2023 University of Minnesota

Exam period: 20 minutes Points available: 40

Background: Nearby are several C files along with two attempts to compile them on the left. Study these and answer the questions that follow.

```
1 > gcc vf_weak_var.c vf_strong_func.c vf_main.c
                                                     # COMPILE 1
                                                                                      1 // FILE: vf_main.c
2 /usr/bin/ld: warning: size of symbol 'foo' changed from 4 to 14
                                                                                     2 #include <stdio.h>
_{\rm 3} /usr/bin/ld: warning: type of symbol 'foo' changed from 1 to 2
                                                                                     3 int foo(int x);
                                                                                     4 int main(){
5 a.out: ELF 64-bit LSB pie executable, x86-64, version
                                                                                         printf("%d\n",foo);
                                                                                         printf("%d\n",foo(2));
6 > ./a.out
7 -573193927
                                                                                         return 0;
                                                                                     8 }
8 4
9 > rm a.out
                                                                                     10 // FILE: vf_strong_func.c
10
11 > gcc vf_strong_var.c vf_strong_func.c vf_main.c # COMPILE 2
                                                                                     11 int foo(int x){
12 /usr/bin/ld: multiple definition of 'foo';
                                                                                         return 2*x;
                                                                                     12
13 collect2: error: ld returned 1 exit status
                                                                                     13 }
14 > file a.out
                                                                                     14
15 a.out: cannot open 'a.out' (No such file or directory)
                                                                                     15 // FILE: vf_strong_var.c
                                                                                     16 int foo = 0;
  Problem 1 (10 pts):
                             Why does COMPILE 1 succeed while COMPILE 2
                                                                                     18 // FILE: vf_weak_var.c
  fails? Mention pertinent properties of ELF files in your answer.
                                                                                     19 int foo;
```

Problem 2 (10 pts): Nearby is the output of pmap showing page table virtual memory mapping information for a running program called memory_parts. Answer the following questions about this output.

> pmap 7986

- (A) The mapped memory references something called libc-2.26.so. Describe this entity and what kind of information you would expect to find at the mapped locations.
- (B) Why does pmap only show a limited number of virtual addresses? What would happen if the program attempted to access an address not listed in the output? Example: address 0x00 is not in the listing.

```
7986:
        ./memory_parts
00005579a4abd000
                      4K r-x-- memory_parts
00005579a4cbd000
                      4K r---- memory_parts
00005579a4cbe000
                      4K rw--- memory_parts
00005579a4cbf000
                      4K rw---
                                  [ anon ]
00005579a53aa000
                    132K rw---
                                  [heap]
00007f441f2e1000
                   1720K r-x-- libc-2.26.so
00007f441f48f000
                   2044K ---- libc-2.26.so
                     16K r---- libc-2.26.so
00007f441f68e000
00007f441f692000
                      8K rw--- libc-2.26.so
00007f441f694000
                     16K rw---
                                  [ anon ]
                    148K r-x-- ld-2.26.so
00007f441f698000
00007f441f88f000
                      8K rw---
                                  [ anon ]
                      4K r---- gettysburg.txt
00007f441f8bb000
                      4K r---- 1d-2.26.so
00007f441f8bc000
                      4K rw--- 1d-2.26.so
00007f441f8bd000
00007f441f8be000
                      4K rw---
                                  [ anon ]
00007fff96ae1000
                    132K rw---
                                  [stack]
00007fff96b48000
                     12K r----
                                  [ anon ]
00007fff96b4b000
                      8K r-x--
                                  [ anon ]
total
                   4276K
```

Problem 3 (10 pts): Below is an initial memory/cache configuration along with several memory load operations. Indicate whether these load operations result in cache hits or misses and show the state of the cache after these loads complete.

MAIN MEMORY	DIRECT-MAPPED Cache, 8-byte lines	
Addr Addr Bits	Value 4 Sets, 8-bit Address = 3-bit tag	
10 000 10 000 14 000 10 100 18 000 11 100 16 000 11 100 16 000 11 100 100	10 INITIAL CACHE STATE 11	
Tag Set Offset		,
	++	į
	00 01	1
	10	ĺ
	11	- 1

Problem 4 (10 pts): Nearby is the definition for base_scalvec() which scales a vector by multiplying each element by a number. Write an optimized version of this function in the space provided. Mention in comments why you performed certain transformations.

```
1 int vget(vector_t vec, int idx){
    return vec.data[idx];
3 }
4 void vset(vector_t vec, int idx, int x){
    vec.data[idx] = x;
7 void base_scalevec(vector_t *vec, int *scale){
    for(int i=0; i < vec->len; i++){
      int cur = vget(*vec,i);
9
      int new = cur * (*scale);
10
      vset(*vec,i,new);
11
    }
12
13 }
```