Name: ____

1. (1 pt.)
   - **Read all material carefully.**
   - *If in doubt whether something is allowed, ask, don't assume.*
   - You may refer to **your** books, papers, and notes during this test. (No sharing of material.)
   - **E-books** may be used **subject to the restrictions** noted in class. (Briefly, do only those things with an e-book that are just as easily done with a physical book.)
   - **Computers of any kind** (including tablets, phones, and similar devices) are **not permitted** except when used exclusively as e-book readers.
   - **Network access** of any kind (cell, voice, text, data, ...) is **not permitted**.
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook **conventions** for notation, algorithmic options, etc.
   - Unless otherwise indicated, phrases such as *assembly instructions* and *machine code* refer to **RISC-V architecture** and related details as described in the class and the textbooks, and as executed in the RARS(M) environment.
   - Questions that ask for **explanations** allocate a sizable fraction of points to those. (Answers without explanations will score very poorly.)
   - Budget your **time**, noting that *number of points = number of minutes.*

Write your name in the space provided above.
Do not write anything else on this page.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

(Do not view any other pages.)

Do not write on this page.
(It is for use in grading only.)

Q	Full	Score
1	1	
2	9	
3	30	
4	10	
total	50	

2. (9 pts.) State the exact output produced by the following C program. (If there is an error of any sort then explain the error instead.) No explanation is needed unless consideration for partial credit is desired.

```c
#include <stdio.h>
#include <stdint.h>
#include <inttypes.h>
uint32_t f(uint32_t x, uint32_t y) {
  uint32_t a = 1;
  for(int i = 0; i < y; i++) a *= x;
  return a;
}
int main() {
  printf("%" PRIu32 "\n", f(3, 4));
  printf("%" PRIu32 "\n", f(5, 6));
  return 0;
}
```

3. (30 pts.) Provide a *complete assembly language program* that corresponds *as closely as possible* to the C code of Question 2, targeting an RV32M RISC-V architecture in the RARS(M) environment. Explain your program. Identify any missing parts or bugs for better partial credit.

[additional space for earlier material]

4. (10 pts.)

   (a) Identify the instructions (one or more) of the assembly language program of Question 3 that correspond most closely to the following fragment of the C program of Question 2 (end of line 6 there): `a *= x;`.

   (b) Provide *machine code* (in binary) for the instructions identified above, explaining your answer briefly.