

1. This exercise is meant to be started during the class meeting and completed individually outside class. **Please work in groups of two to four people.** (If you need help then let me know and I will assist.) List the members of your group below. Underline your name.
2. Briefly explain what the following C program does. In particular, clearly state and explain its output as precisely as possible. What, if anything, should be changed to make the for loop correspond to the division algorithm of Figure 3.9 of the textbook?¹

```
1  #include <stdio.h>
2  #include <stdint.h>
3  #include <inttypes.h>
4  #define pu32 "0x%04" PRIx32 "\t%8" PRIu32 "\n"
5  #define pu64 "0x%08" PRIx64 "\t%16" PRIu64 "\n"
6  #define pu32x4(a,b,c,d) printf(pu32 pu32 pu32 pu32, a, a, b, b, c,
7  c, d, d)
8  #define pregs printf("rsor: " pu64 "rquo: " pu32 "rrem: " pu64, \
9  rsor, rsor, rquo, rquo, rrem, rrem)
10 int main() {
11     uint32_t
12     dsor = 2,
13     dend = 7,
14     dquo = dend / dsor,
15     drem = dend % dsor;
16     pu32x4(dsor, dend, dquo, drem);
17     uint64_t rsor = (uint64_t) dsor << 32, rrem = dend;
18     uint32_t rquo = 0;
19     for(int i = 0; i < 33; i++, rsor >>= 1) {
20         rrem -= rsor;
21         if (rrem < 0) {
22             rrem += rsor;
23             rquo <<= 1;
24         }
25         else {
26             rquo = (rquo << 1) | 1;
27         }
28     }
29     pregs;
30     return 0;
}
```

¹David A Patterson and John L Hennessy, *Computer Organization and Design RISC-V Edition*, 2nd edition (Morgan Kaufmann, 2020).

3. Provide a RV32M RISC-V Assembly Language program, assuming a RARS(M) environment, that corresponds to the (possibly modified) program of Question 2 as closely as possible. Briefly explain the key portions of the program.

4. Provide the machine code (text and data segments) corresponding to the program of Question 3. Produce the code by hand first, then compare with the results using RARS(M).

5. Depict the states of the relevant registers before and after the code of Question 4 is executed, as well as after half the iterations of the loop have been executed. Explain your answer.