

Computer Architecture I Mid-term Exam 1

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Run \LaTeX again to produce the table

- This test contains ?? numbered pages, including the cover page, printed on both sides of the sheet.
 - We will use blackboard for grading, so only answers filled in at the obvious places will be used.
 - Use the provided blank paper for calculations and then copy your answer here.
 - Please turn **off** all cell phones, smart-watches, and other mobile devices. Remove all hats and headphones. Put everything in your backpack. Place your backpacks, laptops and jackets out of reach.
 - Unless told otherwise always assume a 32bit machine.
 - The total estimated time is 120 minutes.
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- You have 120 minutes to complete this exam. The exam is closed book; no computers, phones, or calculators are allowed. You may use two A4 pages (front and back) of handwritten notes in addition to the provided green sheet.
 - There may be partial credit for incomplete answers; write as much of the solution as you can. We will deduct points if your solution is far more complicated than necessary. When we provide a blank, please fit your answer within the space provided.
 - Do **NOT** start reading the questions/ open the exam until we tell you so!
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- 1
1. First Task (worth one point): Fill in you name
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- Fill in your name and email on the front page and your ShanghaiTech email on top of every page (without @shanghaitech.edu.cn) (so write your email in total ?? times).

2 2. **Introduction [2 points]**

- (1) Moore's Law
- (2) Amdahl's Law

9 3. **Number representation [9 points]**

4. C basics [10 points]**5****(a) Q1 [5 points]****5****(b) Q2 [5 points]****12****5. C memory management [12 points]****6. RISC-V assembly [12 points]****4****(a) Arithmetic [4 points]****8**

(b) In this question, you need to calculate the Factorial of the n-th term of Fibonacci number sequence. The first two items are (0, 1) by default, and n is not included.

For example, if n=3, you should print 6 (3!). [8 points]

Hint : Factorial part is realized by recursion.

```
1  main:
2      li    t0, 0
3      li    t1, 0                # Default 0 item
4      li    t2, 1                # Default 1 item
5      li    a0, n                # Input parameter n
6      li    a1, 0
7      beq   a0, t0, End
8  Fibonacci_loop:
9      add   t3, t1, t2
10     add   t1, t2, x0
11
12     -----
13     add   a1, t3, x0
14     addi  t0, t0, 1
15     -----
16     jal   ra, Factorial
17 End:
18     li    a0, 1
19     ecall
20     li    a0, 10
21     ecall
22 Factorial:
23     addi  sp, sp, -8
24     sw    ra, 4(sp)
25     sw    a1, 0(sp)
26     addi  t4, a1, -1
27     bge   t4, x0, Factorial_loop
28     addi  a1, x0, 1
29     addi  sp, sp, 8
```

```
29      jalr  x0, ra, 0
30  Factorial_loop:
31      addi  a1, a1, -1
32      _____
33      addi  t5, a1, 0
34      lw    a1, 0(sp)
35      lw    ra, 4(sp)
36      addi  sp, sp, 8
37      _____
38      jalr  x0, ra, 0
```

Fill in the missing code below.

line 11: _____

line 14: _____

line 32: _____

line 37: _____

- 2 (c) Translate instructions to machine code written in **hexadecimal**. [2 points]

line 12: add a1, t3, x0 _____

line 38: jalr x0, ra, 0 _____

- 12 7. **Call convention/linker/loader/assembler** [12 points]

- 12 8. **Logic** [12 points]

- 15 9. **SDS/FSM** [15 points]

- 15 10. **RISC-V datapath** [15 points]