Section PP

1. [20 marks] Digital Logic.

a) [10 marks] '#' is the ternary majority connective. '#pqr' is true iff at least two of 'p', 'q', and 'r', are true. The connective 'F' is always false. Since it connects nothing, it is also a formula all by itself. Consider the set {#, F}. Using only sentence symbols, and connectives from this set, find a tautological equvalent to 'p /\ q'.

ans: p /\ q |= =| # ___ ___ ___

b) [10 marks] A '#' gate settles in 310 ps. A 2-input 'OR' gate settles in 150 ps. 'C' is a 9-input circuit built from three '#' gates and up to three 2-input 'OR' gates ('C' is true iff at least one '#' gate reports true). After all '#-gate' inputs have stable values, how quickly does this circuit settle?

ans: ____ ps

2. [20 marks] Amdahl's Law.

a) [10 marks] On a uniprocessor, perfectly serial portion A of program P consumes 12 s, while perfectly parallel portion B consumes 88 s. We want a program speed-up of at least 7x. Many cores are required. What is the speed-up of program P with this many cores? (Answer to two decimal places).

ans: ____ x

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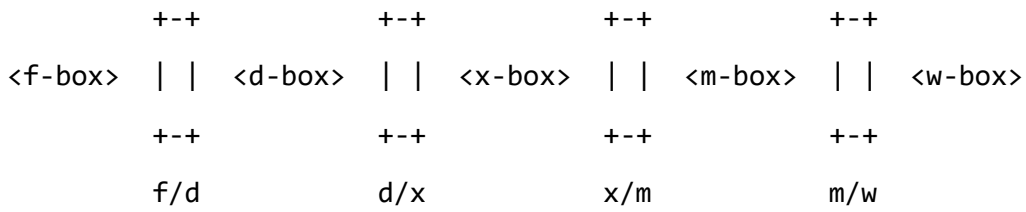
3. [20 marks] Pipelines (Single-instruction Information Flow).

Consider our instruction-execution pipeline:




a) [5 marks] In executing 's.d f4,0(r2)', which box needs to know the value of 'f4'?

ans: _____

b) [5 marks] In a conditional branch, does the 'd-box' actually need all the operands it localizes? (yes/no)

ans: _____

c) [5 marks] In executing 'l.d f4,8(r2)', which box needs to know the value of 'r2 + 8'?

ans: _____

d) [5 marks] In executing 'mul.d f4,f0,f2', the 'd-box' indirectly communicates which value, or values, to the 'x-box'?

ans: _____

Hex table:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0000 | 4 | 0100 | 8 | 1000 | c | 1100 |
| 1 | 0001 | 5 | 0101 | 9 | 1001 | d | 1101 |
| 2 | 0010 | 6 | 0110 | a | 1010 | e | 1110 |
| 3 | 0011 | 7 | 0111 | b | 1011 | f | 1111 |

4. [20 marks] Instruction formats.

A small computer has 16-bit words and 16-bit instructions. A byte is 8 bits.
The instruction format for a conditional-branch instruction is:

B: opcode rs rt immediate -- conditional branch

2 bits 3 bits 3 bits 8 bits

a) [10 marks] Consider 'bne r1,r2,loop'. Show the hexadecimal representation of the 16-bit integer that will be added to register 'PC', if 'loop' = 119.

ans: ___ ___ ___ ___

b) [10 marks] Consider 'bne r1,r2,loop'. Show the hexadecimal representation of the 16-bit integer that will be added to register 'PC', if 'loop' = -119.

ans: ___ ___ ___ ___

5. [20 marks] Floating-point formats.

A small computer has 16-bit registers. Floating-point numbers are positive. The floating-point format is: First four bits for the exponent, and the next 12 bits for the fractional part of the significand.

a) [10 marks] What is the hexadecimal representation of the floating-point

format for 5.625?  Do not round.  Show your work.

ans: ___ ___ ___ ___

b) [10 marks] What is the hexadecimal representation of the floating-point format for 3.9?  Do not round.  Show your work.

ans: ___ ___ ___ ___