

1. [20 marks] Digital Logic.

a) [10 marks] 'M' is the ternary minority connective. 'Mpq'r' is true iff at most one of 'p', 'q', and 'r', is true. The connective/logical symbol/wff 'F' is always false. Consider the set {M, F}. Using only sentence symbols, and connectives from this set, find a tautological equivalent to ' $\sim p$ '.

ans: $\sim p \models M$ ____

b) [10 marks] An 'M' gate settles in 325 ps. A 2-input 'AND' gate settles in 125 ps. 'C' is a 12-input circuit built from four 'M' gates and three 2-input 'AND' gates ('C' is true iff all 'M' gates report true). After all 'M-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 10 s, while perfectly parallel portion B consumes 90 s. We want a program run time not to exceed 14 s. Many cores are required. What is the run time of program P with this many cores? (Answer to two decimal places).

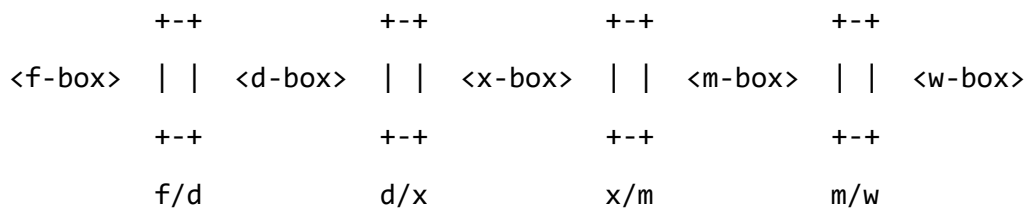
ans: ____ s

b) [10 marks] On a uniprocessor, perfectly serial portion A of program P consumes 10 s, while perfectly parallel portion B consumes 990 s. We want a program run time not to exceed 140 s. Many cores are required. What is the run time of program P with this many cores? (Answer to two decimal places).

ans: ____ s

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

Consider our instruction-execution pipeline:



a) [5 marks] In executing 'l.d f4,0(r2)', which box needs to know that it is 'f4' rather than, say, 'f6'?

ans: _____

b) [5 marks] The 'd-box' localizes all operands from which on-chip hardware device?

ans: _____

c) [5 marks] In executing 'l.d f4,8(r2)', which box computes the 32-bit form of the immediate?

ans: _____

d) [5 marks] Register 'PC' lives in the 'f/d latch'. Which box writes to 'PC'?

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 data-transfer instruction is:

D: opcode rs rt immediate -- data transfer

2 bits 3 bits 3 bits 8 bits

a) [10 marks] Consider 'l.d f6,119(r2)'. Show the hexadecimal representation of the 16-bit integer that will be added to base register 'r2'.

ans: ____ ____ ____ ____

b) [10 marks] Consider 'l.d f6,-119(r2)'. Show the hexadecimal representation of the 16-bit integer that will be added to base register 'r2'.

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 17.625? Do not round. Show your work.

ans: ____ ____ ____ ____

b) [10 marks] What is the hexadecimal representation of the floating-point format for 2.7? Do not round. Show your work.

ans: ____