# Typical PhD Screening Exam Topics: Computers

Microprocessor systems:  Basic organization, CPU, memory, and I/O.

Microprocessor hardware interface: address bus, data bus, all asynchronous and synchronous control signals, peripheral interface, function codes, interrupt interface, bus exchange interface. Microprocessor buses for large microprocessor systems, such as the VME bus.

Read and write operations: bus timing and control, read-modify-write cycles.

Microprocessor memory subsystems: interface, timing and control, memory addressing and decoding schemes. Interfacing (including timing) of DRAM, SRAM, ROM, PROM, and EPROM.

Microprocessor I/O subsystems: synchronous and asynchronous, timing, and control. Memory mapped I/O. Multiple bus masters, bus arbitration, and bus exchange. Direct memory access.

Microprocessor peripherals: synchronous, asynchronous, parallel, serial, timers.

Microprocessor interrupt hardware: priority encoding/decoding and interrupt acknowledge, priority resolution, including fixed, vectored, daisy chain, round robin, and random.

Assembly language programming:  The compile, assemble, link, load, and execute process. Assembler syntax, directives, macros, and conditional assembly. Addressing modes.  Assembly language instructions. Purpose and use of the status register and condition codes. Program modularization and the use of subroutines. Parameter passing, including call by value and call by name. The use of data structures, including registers, stacks, buffers, arrays, and linked lists. Local vs. global storage allocation. Program structure, including the implementation of IF-THEN, IF-THEN-ELSE, CASE, WHILE-DO, REPEAT-UNTIL, and FOR structures. Exception processing, including interrupt, trap, trace, bus error, etc.

Basic concepts of computer performance: clock speed, MIPS, instruction counts, memory latency and bandwidth, execution time, benchmarks, and the effects of cache memory.

Number representation systems: binary, octal, decimal, hexadecimal, one's complement, two's complement, and excess. Conversion between different number systems. Arithmetic operations in different number systems, including complement, addition, subtraction, multiplication, and division.

Codes for representing data: BCD, ASCII, Gray, Parity, and Excess. Code conversion.

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Boolean Algebra: commutative, associative, distributive, absorption, involution, reflexive, duality, and DeMorgan's properties. Venn diagrams.

Boolean operations: null, NOT, AND, NAND, OR, NOR, XOR, XNOR, inhibition, transfer, implication, and identity. Product-of-sum expressions, sum-of-product expressions, and canonical form.

Design techniques for combinational logic: truth tables, algebraic manipulation, Karnaugh mapping, and the Quine-McCluskey method.

Basic logic devices: NOT, AND, NAND, OR, NOR, XOR, and XNOR gates. Totem-pole, open-collector, and h-i-state outputs. Wire-AND logic, wire-OR logic, and buses.

Combinatorial logic devices: MS1 devices - multiplexers, decoders, demultiplexers, encoders,.adders, subtracters, adder/subtracters and majority. LSI logic devices such as arithmetic logic units.

Programmable logic devices: programmable logic arrays, basic flip-flops - SR, JK, D, toggle, master/slave, and edge-triggered.

Sequential logic components: registers, shift registers, and counters.

Memory devices: static random access memory, read-only memory, and programmable read-only memory.

Finite-state sequential machines: fundamentals, Mealy machines and Moore machines. Sequential machine design techniques, state tables, transition tables, and state diagrams. Sequential machine minimization.

Timing diagrams: Rise time, fall time, propagation delay, setup and hold time.

J. McEachen 4/02

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