Learning Goals for Computer Organization I

Main theme	***Prerequisites***	***Approaching Learning Goals***	***Reaches Learning Goals***	***Deepens Learning Goals***
Computer system structure and operation	Can explain various computer parts from user stand point: processor (CPU), memory, disk drive, CD drive, micro-phone, loudspeak-ers, display, etc. (Introduction to the Use of Computers)	• Can describe basic system components, up from hardware registers • Can explain the need and operation of bus hierarchy • Can explain processor operation when it is executing machine instructions • Can explain the goals an implementation of interrupts • Can explain different CPU execution modes (user, privileged)	• Can explain large system components speed differences and their effect on the system • Can differentiate bus hierarchy levels for devices of different speeds • Can explain the significance of interrupts and their implementation and machine instruction level • Can explain the significance of interrupt subsystem and privileged execution mode in implementing reliable systems • Can explain how and when processor execution mode changes	• Can explain, how machine instructions are executed at clock cycle level • Can use interrupt disabling in solving concurrency problems

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Implementing machine language programs	• Can program simple programs with some block structures language (Introduction to Programming)	• Can use global variables and constants • Can explain data struct. memory allocation at compilation, linking, and/or loading time • Can use 1-dimensional arrays (tables) stored row-wise • Can implement subroutine (function, method) call	• Can implement selection and loop structures and use records and multi-dimensional arrays • Can explain global and local data structure differences in space allocation and in referencing them • Can explain the significance of activation record and activation record stack in implementing subroutines and can program subroutines	• Can explain precisely , how Java objects are implemented at machine language level • Can write execution time optimized code • Can optimize subroutine call/return execution times by passing some activation record fields in special registers
Representating and storing data	• Can use integers, unsigned integers, rational numbers and real numbers in applications (Introduction to Programming)	• Can explain different representations for integers: bias, signed, one's and two's complements • Can explain the reasoning for various character encodings and explain how they work • Knows how to modify integer representations between binary, octal, decimal and hexadecimal systems	• Can implement logical data types with integers • Can explain the IEEE floating point representation • Can explain the differences between 8-bit and 16-bit character codes • Can explain roughly how (moving) images and sounds are encoded in the system • Can explain how parity bits and Hamming code are used for guarding data coherence • Can explain floating point accuracy changes due to computations	• Can explain CRC error checks in guarding data coherence • Can explain the extensions for IEEE floating point standard • Can explain the significance of device duplication in data access and in guarding data coherence • Can explain why using rational numbers is problematic in programs

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Memory hierarchy		• Can explain differences between volatile and non-volatile memory • Can explain using memory to store both the programs and the (run time) data for it • Can explain the significance of large memory device speed differences • Can list and compare various main memory technologies	• Can give reasoning for cache memories • Can explain shared disk use for files and virtual memory • Can explain the foundation and ideas for FLASH/ROM memory technology • Can explain the execution time effect of memory reference delays and memory hierarchy • Can explain the basic workings of cache and virtual memory	• Knows the history and implementation methods of memory technology • Can explain the implementation of multi-layered virtual memory

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From program to process	• Can implement programs with high level programming language (Introduction to Programming)	• Can explain why one would not always want to compile the whole program at once • Can explain the need for dynamic linking • Can explain the process concept and its operating system representation • Can explain various process states and transitions between them • Can describe the basic ideas in translating high level language programs into machine language object modules • Can describe the basic ideas of object module linking	• Can explain when process state changes and what happens in the system at that time • Can explain when the process in execution changes and how process switch in implemented at machine language level • Can reason the advantages of intermediate languages in compilation • Can explain advantages and disadvantages of static and dynamic linking • Knows many dynamic linking methods • Can explain the significance and implementation of location independent code • Can explain, how object modules are transformed into a runnable processes known by operating system • Can explain, why a program needs various resources at run time and why one must keep track of these resources	• Can explain details of some dynamic linking methods

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Operating system (OS) basic structure	• Can use basic services of some OS • Can start program execution in some OS	• Can explain, why some OS components must (not) be executed in privileged state • Can give examples on common OS services • Can explain basic OS functions in controlling resource use and processes: process management, inter-process communication (IPC) as well as memory, device, network, and file management	• Can explain OS goals and basic functionality both from user and system manager viewpoint • Can explain OS implementation with (priviledged) subroutines and processes • Can explain how OS services are invoked with subroutine and SVC calls as well as with IPC messages • Can explain how OS device control is implemented with device drivers and interrupt handlers • Can explain how OS is implemented with hierarchical services	• Knows many process scheduling policies • Knows many memory management policies • Knows many file management methods • Knows many network management methods • Knows various methods for concurrency control • Can explain various invocation methods for (privileged) OS services

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I/O and file systems	• can use keyboard, mouse, diskette, CD/DVD drive, and hard disk	• Can explain the structure and operation of disk drives • Can compute access time for data stored in hard drive • Can explain file storage with disk blocks (sectors) and block tables • Can explain the significance of device drivers and their use in I/O implementation • Can explain the operations and differences of direct (programmed) I/O, indirect I/O, and DMA I/O	• Can explain the main idea of file server and file cache • Can explain the co-operation of device driver and device controller process running on device controller in implementing I/O • Can explain advantages and disadvantages of direct (programmed) I/O, indirect I/O, and DMA I/O • Can explain the significance and basic operation of bus and bus hierarchy • Can explain the problems caused by concurrent execution of device driver running on CPU and device controller process running on device controller	• Can explain the structure and operation of CD and DVD drives • Knows basic ideas of various RAID systems • Can explain details of some file system

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Different program execution models	• Can implement simple programs with Java (Introduction to Programming)	• Can explain why java programs are first compiled into byte code • Can explain why Java program execution may be slower than that of the same program implemented in C • Can explain advantages and disadvantages of Java byte code • Can explain basic idea and operation of Java virtual machine (JVM) • Can explain various different Java program execution models and their differences	• Can explain JVM structure and operation • Can explain the differences in compiling Java source code and Java byte code • Can explain the advantages and disadvantages of JIT-compilation as compared to ordinary compilation • Can explain how JIT compilation is related to dynamic linking • Can explain how ordinary machine language programs can be executed in any system with emulation • Can explain differences between emulation and simulation	• Can explain the exact structure of JVM • Knows all instructions in JVM • Can write machine language program with Java byte code • Can explain, how complete processor operation may be based on emulation
(Web-based learning methods)	• Can use browsers and search engines	• Can use Authorware based web lectures	• Can use discussion groups as a tool for team work and learning	• Can use wiki for team work