ICS 2104: COMPUTER ORGANIZATION AND ARCHITECTURE CAT 2 – GROUP C

TIME: 1 HOUR

Answer ALL the Questions

a) Any program written in a high-level language must be translated into machine language to be executed. Thus, the set of machine instructions must be sufficient to express any of the instructions from a high-level language. Name and briefly explains how these instruction types can be categorized. [4 Marks]

   i. Data processing: Arithmetic and logic instructions.
   ii. Data storage: Movement of data into or out of register and memory locations.
   iii. Data movement: I/O instructions.
   iv. Control: Test and branch instructions.

b) Interrupt-driven I/O is more efficient than simple programmed I/O but the two suffer from two inherent drawbacks. State the two drawbacks. [2 Marks]

   i. The I/O transfer rate is limited by the speed with which the processor can test and service a device.
   ii. The processor is tied up in managing an I/O transfer; several instructions must be executed for each I/O transfer.

c) Convert the following C++ code snippet into equivalent assembly instructions. Assume all variables are unsigned 32-bit integers stored in memory. [3 Marks]

   Result = (X + Y) * Z;

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mov eax, [X]        ; Load X into eax
add eax, [Y]        ; Add Y to eax
mul dword ptr [Z]   ; Multiply eax by Z, result in edx:eax
mov [Result], eax   ; Store lower 32 bits in Result
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d) Key characteristics serve to differentiate various types of operating systems. State and explain the two independent dimensions that these characteristics fall. [4 Marks]

   i. Interactive system, the user/programmer interacts directly with the computer, usually through a keyboard/display terminal, to request the execution of a job or to perform a transaction.

ii. Batch system, the user's program is batched together with programs from other users and submitted by a computer operator.

e) A simple voting system has three voters: V1, V2, and V3 (inputs). The output Pass is 1 if at least two voters vote YES (1).

i. Write the Boolean expression for Pass based on inputs V1, V2, and V3. [2 Marks]

Pass = (V1 AND V2) OR (V2 AND V3) OR (V1 AND V3)

ii. Draw the logic circuit using AND, OR gates. [4 Marks]

Three AND gates:

AND gate 1 inputs: V1, V2

AND gate 2 inputs: V2, V3

AND gate 3 inputs: V1, V3

One OR gate:

Inputs: outputs of the three AND gates

Output: Pass

f) The RAID scheme consists of seven levels that designate different design architectures. List the three common characteristics shared by these levels [3 Marks]

i. RAID is a set of physical disk drives viewed by the operating system as a single logical drive.

ii. Data are distributed across the physical drives of an array in a scheme known as striping.

iii. Redundant disk capacity is used to store parity information, which guarantees data recoverability in case of a disk failure.

g) Read Only Memory is created like any other integrated circuit chip, with the data wired into the chip as part of the fabrication process. Name the two problems presented by this creation. [2 Marks]

i. The data insertion step includes a relatively large, fixed cost, whether one or thousands of copies of a particular ROM are fabricated.

ii. There is no room for error. If one bit is wrong, the whole batch of ROMs must be thrown out.

h) Name and briefly discuss the three instruction execution characteristics associated with RISC machines. [3 Marks]

i. Operations performed: These determine the functions to be performed by the processor and its interaction with memory.
ii. Operands used: The types of operands and the frequency of their use determine the memory organization for storing them and the addressing modes for accessing them.
iii. Execution sequencing: This determines the control and pipeline organization.

i) Once the cache is filled up and a new block is brought into the cache, one of the existing blocks must be replaced. List and briefly describe the most common replacement algorithms that can be utilized. [3 Marks]

i. Least Recently Used (LRU): Replace that block in the set that has been in the cache longest with no reference to it.
ii. First-in-first-out (FIFO): Replace that block in the set that has been in the cache longest.
iii. Least Frequently Used (LFU): Replace that block in the set that has experienced the fewest references. He LFU could be implemented by associating a counter with each line.