University of Swaziland

Department of Computer Science

Final Examination

December 2014

TITLE OF PAPER: COMPUTER ORGANISATION II

COURSE NUMBER: CS 341

TIME ALLOWED: 3 HOURS

INSTRUCTIONS: ANSWER ANY **FOUR** QUESTIONS

This examination paper should not be opened until the invigilator grants permission.

Question 1

A. List 3 design principles associated with Instruction Set Architectures. Provide a brief explanation (or example) of each of them. [6]

B. For a single datapath cycle, list the steps AND provide a brief explanation as to what happens in each step [5]

C. Describe the concept of an expanding opcode [5]

D. Describe the following *addressing modes*, using suitable diagrams for each:
   a. Immediate [3]
   b. Direct [3]
   c. Base indexed [3]

QUESTION 2

A. What are two advantages of using virtual memory? [4]

B. Suppose that a system has a 32-bit (4GB) virtual address space. It has 1GB of physical memory, and uses 1MB pages.
   i. How many bits are there in the page offset? [2]
   ii. How many virtual pages are there in the address space? [2]
   iii. How many physical pages are there in the address space? [2]
   iv. How many bits are there in the physical page number? [2]

C. Give a definition of a counting semaphore, and list and describe the valid operations. [7]

D. Consider *internal fragmentation* and *external fragmentation*. Answer the following questions, below:
   i. Describe how each type arises [4]
   ii. How can each be minimised [2]

QUESTION 3

A. What is the requirement for the assembly language machine level? [4]

B. Describe with the aid of a diagram, Macro expansion [4]

C. Create a bitmap for the disk below. The blocks with numbers are occupied.[6]

Direction
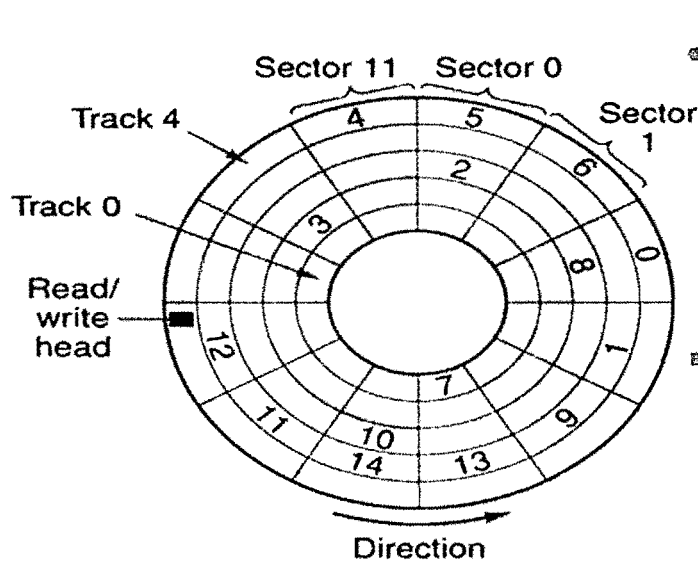
D. Compare interrupt-driven I/O and DMA based I/O [6]

E. Describe demand paging with the aid of a diagram [5]

QUESTION 4

A. Define a race condition in the context of multiprocessor communication [3]

B. Define the following, related to assembly language machine level, using suitable examples:

    i.   Linking and loading [3]
    ii.   Binding [3]

C. Which value has the speedup of a parallel program that achieves an efficiency of 75% on 32 processors? [3]

D. Derive Amdahl's law starting from the expression :
    overall_speedup (s) = execution_time_old / execution_time_new [5]

E. Explain what each of the four states represent in the MESI cache coherency protocol. [8]

QUESTION 5

A. Explain the difference between temporal locality and spatial locality [4]

B. What is a TLB? Why do we need it? [4]

C. An instruction has a 4-bit opcode and three 4-bit address fields. Design an expanding opcode that meets the following requirements

    i.   15 three-address instructions

    ii.   14 two-address instructions

    iii.   31 one-address instructions

    iv.   15 no-address instructions [12]

D. Convert the following infix expression into postfix expression:

$$(8 + 2 \times 5) / (1 + 3 \times 2 - 4)$$ [5]

QUESTION 6

Describe each of the following, using correct terminology and relevant illustrations:

A. Segmentation. [7]

B. Paging. [7]

C. Paged segmentation. [5]

D. Working set [3]

E. Cache coherence [3]

QUESTION 7

A.   A program takes 10 months to write in a high level language and takes 100 seconds to complete it's task. Two modules are responsible for 30% and 20% of the execution time of the program, respectively. These modules are of roughly equal complexity and account for 10% (each) of the total development effort. The compiler used can produce symbolic assembly language, so it only takes twice as long to tune the assembly language version as it took to write it initially. The anticipated speed up is a factor of two for each module.

B.   Can both modules be optimized prior to the one year ship date (two more months)?   [7]

C.   What is the anticipated execution time after the tuning has been performed? (even if it is past the deadline)   [6]

D.   Syntax and Semantic error messages refer to source code line numbers

     i. How are these numbers affected by Macro Expansion?   [4]
    ii. Should error messages be produced during the first pass or the second pass? (or can you say?)   [4]

E.   Describe static binding giving and an advantage and disadvantage.   [4]