BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT COMPUTER SCIENCE
BSC HONS DEGREE IN COMPUTER SCIENCE DEGREE/INFORMATION TECHNOLOGY

COURSE CODE CS113/NWE114/SWE203: COMPUTER ARCHITECTURE

DURATION: 2 HOURS 30 MINUTES TOTAL MARKS: 100

INSTRUCTIONS TO CANDIDATES

This paper consists of five (5) questions
Answer all questions.

Question 1

a) Over the past four decades, personal computer systems and workstations have become more and more powerful. Describe any **two** areas of a computer system that have experienced considerable growth in their performance. Your answer should include a description of the features of the component/ subsystem and an explanation of what measures have contributed to an increase in performance. You should also provide an indication of the increase in performance. **[10]**

b) What do you think are the obstacles to the continued increase in computer performance? Explain any **two**. **[10]**

c) A computer designer decides to design a new type of CPU using the idea of Very Long Instruction Words. Instead of the current trend towards regular, reduced instruction set sizes, the idea is to have a small number of very complex instructions that can carry out a lot of operations in one go. The proposed instruction design has up to three operands which can be memory or register, and has two opcodes, which can be any combination of the logical or arithmetic instructions and/or/add/sub/div/mul, and a further operand which is the address of the next instruction to be fetched and executed. What are the problems with this approach, and why is RISC preferred nowadays? **[12]**

Question 2

a) Computers can handle both integer numbers and floating-point numbers. In general, separate arithmetic units (and even separate machine-level instructions) are required for integer and floating-point operations. Why is it necessary to treat integer and floating-point numbers so differently? **[4]**

b) Convert -35.75 to its hexadecimal representation in IEEE floating point format. **[10]**

Question 3

a) With the aid of a diagram, describe the different kinds of cache organization. **[12]**

b) A cache may be organized such that:

- In one case, there are more data elements per block and fewer blocks
- In another case, there are fewer elements per block but more blocks

However, in both cases i.e. larger blocks but fewer of them or shorter blocks, but more of them, the cache's total capacity (amount of data storage) remains the same. What are the pros and cons of each organization? Support your answer with a short example assuming that the cache is direct mapped. **[8]**

Question 4

a) A computer has a five-stage instruction pipeline of one cycle each. The five stages are: Instruction Fetch (IF), Instruction Decode (ID), Operand Fetch (OF), Instruction Execution (IE), and Operand Store (OS). Consider the following code sequence, which is to be run on this computer.

```
loop: lw $t0, ($s1)
      add $s2, $s2, $t0
      sub $s3, $s3, $s2
      add $s4, $s4, $s2
      sw $s4, ($s8)
      addi $s1, $s1, 4
      addi $s8, $s8, 4
      slt $t1, $t5, $s2
      bne $t1, $0, loop
```

Analyze the execution of the above piece of code in order to calculate the number of cycles needed to execute the above code without pipelining, assuming that each instruction requires exactly 5 cycles to execute and no branch is going to be taken. **[10]**

b) Show how many cycles would be saved if the pipeline had full register bypassing. **[4]**

Question 5

Write a program, using the MIPS32 assembly language that reads a number N and prints the following:

1

1 2

1 2 3

1 2 3 4

.....

.....

.....

1 2 3 4 5 ..... N

1 2 3 4 5.....(N-1)

1 2 3 4 5.....(N-2)

.....

.....

.....

1 2 3 4 5

1 2 3 4

1 2 3

1 2

1

The program must not allow the user to input a number that is below 1 or above 100.

[20]

END OF PAPER