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

MAR 2024

This paper contains five questions
Answer all questions.

Question 1

a) John von Neumann is highly regarded as one of the leaders of Computer Science, and his IAS machine is architecturally similar to modern computers. Illustrate by means of a diagram the basic schematic of the Von Neumann machine and explain the properties of a Von Neumann machine. **[8]**

b) You are employed as a consultant to select a suitable high-performance computer for use by a small online video rental company. You make your selection and copy out the candidate computer's parameters (specifications) for your client. Because your client is non-technical, you have to explain the relevance of some of the parameters. For the following specifications figure 1 below, write a paragraph that indicates the meaning, relevance, and importance of the specified parameter. Your report should also explain why this specification corresponds to a high performance computer. **[10]**

Workstation specifications:

- Processor:
  - CPU cores: 8
  - CPU threads: 16
- Memory: 64 GB, DDR4
- CPU clock: 4.7 GHz
- Storage device:
  - 2 TB SSD
  - 10 TB HDD
- Cache memory: 64 MB

Figure 1: Computer Specifications

Question 2

Let us consider a computer executing the following mix of instructions in table 1:

Instrcution	Frequency	Clock cycles
ALU	50	1
LOAD	20	4
STORE	10	4
BRANCH	10	2
JUMP	10	2

Table 1: Instruction cycles

a) How much is the CPI average assuming a clock period of 5 ns? **[4]**

b) How much is the throughput expressed in MIPS, in the case (a)? **[6]**

c) Let us assume that, given some optimization techniques, the clock frequency has been incremented by 25% and this implies a CPI increment of ALU instructions of 50% and LOAD instructions of 25% while the remaining instructions are executed with the same CPI. How much is CPI average? **[6]**

d) How much is the Throughput expressed in MIPS, in the case. **[6]**

Question 3

a) What is the basic idea of associative mapping for cache organization? **[4]**

b) Explain one advantage and one disadvantage of the associative mapping organization? **[4]**

c) It is often useful to characterize cache misses according to their cause. Identify the three commonly-used categories of cache miss, and for each case explain the cause. **[6]**

d) Explain the effect if (if any), on each of the three categories of cache miss, when each of the following cache parameters is either increased or decreased.

i) cache capacity.

ii) cache block size.

iii) cache associativity. **[6]**

Question 4

a) Using is the following instruction sequence in Fig 2. Illustrate what is meant by fetching of wrong operands in pipelining. **[2]**

```
lw   $t1, 0($t2)
sub  $t3, $t2, $t1
sw   $t4, 0($t3)
add  $t3, $t1, $t1
sub  $t1, $t1, $t2
sra  $t3, $t2, 12
xor  $t5, $t1, $t2
```

Fig 2: instruction sequence

b) Draw a space-time graph showing the progression of the instructions through this pipeline. **[12]**

c) Modify the program above to show how NOPs can be inserted to prevent the fetching of wrong operands. **[6]**

Question 5

Figure 3 shows a sample MIPS program output of a 10x10 multiplication table

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100

Figure 3: sample MIPS program output

Write a MIPS assembly program which produces an n*m multiplication table with the same spacing as in figure 3, where n and m are specified by the user. **[20]**

END OF PAPER