University of KwaZulu-Natal
School of Engineering
Discipline of Computer Engineering
Internal Examiner: Mr. Raleigh Reddy
External Examiner: Prof. Yanxia Sun

ENEL4CO
Computer Architecture and Organization
Date: 30 May 2026
Time: 120 minutes
Total marks: 100 marks

Main Examination

Instructions:

- Mark allocations are indicated in brackets.
- The question paper consists of 2 pages, please make sure you have them all.

Question 1 (10 marks)

1.1. Explain the difference between concurrency and parallelism. (2 marks)

1.2. List the 4 levels at which parallel processing may take place. (4 marks)

1.3. List 4 examples of how system designers attempt to achieve performance balance. (4 marks)

Question 2 (20 marks)

2.1. State the 4 main components of the Von Neumann Architecture. (4 marks)

2.2. Four benchmark programs are executed on three different computers and the results are shown in the table below:

Program #	Computer A	Computer B	Computer C
Program 1	2.93	8.70	91.4
Program 2	562.5	95.4	22.7
Program 3	562.5	954	59.25
Program 4	95.4	877	59.25

The table shows the execution time in seconds, with 111,000,000 instructions executed in each of the four programs.

Using the above, calculate the following:

2.2.1. The MIPS values for each computer for each program. (4 marks)

2.2.2. Arithmetic and Harmonic means for each computer. You may assume equal weights for the four programs. (4 marks)

2.2.3. Rankings for the computers based on Arithmetic and Harmonic means. (2 marks)

2.3. A benchmark program is run on 80MHz Single-core Processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock count as below. Determine the effective CPI, MIPS rate and execution time for this program. (6 marks)

Instruction Type	Instruction Count	Cycle per Instruction
Integer Arithmetic	45000	1
Data Transfer	32000	2
Floating Point	15000	2
Control Transfer	8000	2

Question 3 (30 marks)

3.1. Using radix 2, multiply the following numbers using Booth's algorithm:

A = -215 and B = 132. (7 marks)

3.2. Using radix 4, multiply the following numbers using Booth's algorithm:

M = 238 and Q = 235. (7 marks)

3.3. Perform the 4 segment sub operations for the floating-point adder pipeline with the inputs being 2 normalized floating-point binary numbers defined as:

$X = 0.9403 \times 10^3$
$Y = 0.8301 \times 10^2$ (4 marks)

3.4. The table below shows the SPEC of integer speed ratios for the SUN Blade 6250 computer system. Determine the speed metric for the Sun Blade 6250. (5 marks)

Benchmark Program	Ratio
1	23.0
2	21.8
3	18.5
4	21.9
5	19.7
6	13.6
7	20.9
8	11.6
9	11.5
10	9.6
11	22.9
12	12.3

3.5. Briefly describe 5 ways that parallelism can be achieved in uni-processor systems using the hardware method. (5 marks)

3.6. Briefly describe the 2 ways that parallelism can be achieved in uni-processor systems using the software method. (2 marks)

Question 4 (40 marks)

4.1. Using IEEE format for representing floating point numbers, perform the following floating-point number subtraction (start with numbers in packed form and express the result in packed form too):

131.25 – 122.125 (10 marks)

4.2. Name 6 interrupts encountered with the Intel 8085 architecture. (6 marks)

4.3. Name 5 of the addressing modes that are encountered with machine instructions. (5 marks)

4.4. Provide space-time diagrams for the sequential and overlapped execution of a program with four-phase instructions. (12 marks)

4.5. Provide a block diagram of the pipeline processing for the following combined multiplication and addition arithmetic operation:

$A_i \times B_i + C_i$ for i = 1, 2, 3, ..., n (7 marks)

END OF PAPER