Tshwane University of Technology We empower people	N.DIP. ENG: Computer Science **COMPUTER ARCHITECTURE AND ORGANISATION (CAO216D)**	
	CLASS TEST 1 (WEB TEST) Semester 1, 2023 **60 min** 5 pages	**Examiners** Ms PL Modisha Mr. Kolobe **Moderator** Dr. MU Olanipekun
Lecturer	**Student number**	
Campus	**Surname**	**Initials** / **%**
Signature		

Total | | **Paper Total** | **30**

Instructions to Candidates

1. No programmable calculators are allowed.
2. Make sure that your calculator is set to ENG (Engineering Mode) with a TAB amount of three (3)
3. Only answers written in the aforementioned format will be accepted as correct.
4. Calculated values must be expressed to three (3) decimal values.
5. Answers without units will not be marked.
6. All the answers, including diagram, sketches, etc, must be done in pen. Work done in pencil will not be remarked.
7. Show all your calculations in the allocated areas.
8. All the questions must be answered on the question paper in the allocated areas.
9. Diagrams and schematics will be marked as follows: Marks will be allocated for the correct components or blocks added to the diagram or schematic and marks will be deducted for each wrong connection of these components or blocks on the diagram or schematic or for any additional components or blocks unnecessarily added to the diagram or schematic.

Question 1:

For sequence 1: CPI = $(2 \cdot 1 + 1 \cdot 3 + 2 \cdot 4) / (2+1+2) = 13/5 = 2.6$

For sequence 2: CPI = $(4 \cdot 1 + 3 \cdot 3 + 1 \cdot 4) / (4+3+1) = 19/8 = 2.375$

Which code sequence is faster? Answer: To determine which code sequence is faster, we need to calculate the total number of clock cycles required for each sequence. This can be done by multiplying the instruction count of each instruction class with its respective CPI and then summing up the results.

For sequence 1: Total clock cycles = 2*1*10^6 + 1*3*10^6 + 2*4*10^6 = 22*10^6

For sequence 2: Total clock cycles = 4*1*10^6 + 3*3*10^6 + 1*4*10^6 = 19*10^6

Therefore, sequence 2 is faster than sequence 1.

Question 2:

Consider a program that runs in 50 s on computer A, which has a 500 MHz clock. We would like to run the same program on another machine, B, in 20 s. If machine B requires 2.5 times as many clock cycles as machine A for the same program, what clock rate must machine B have in MHz?

Answer: Machine B must have a clock rate of 1.25 GHz in order to run the same program in 20 s, assuming that it requires 2.5 times as many clock cycles as machine A.

Question 3:

Name any three operands that are typical in machine instruction sets.

(1) Addresses,

(2) Numbers, (3) Characters,

Question 4:

If an instruction contains four addresses, what might be the purpose of each address? (Answer by typing 'One address for ....., two addresses for...., three addresses for...")

(1) Two addresses for operands

(2) One address for result

(3) One address for the address of next instruction

Question 5:

For a given machine if the following performance measures were recorded when executing a set of benchmark programs. Assume the clock rate of the machine is 400MHz. answer the following questions:

Instruction category	Percentage of occurrence	No. of cycles per instruction
ALU	40	2
Load & store	18	4
Branch	39	3
Others	3	2

a) What is the total number of cycles performed by the machine?

b) Calculate the overall CPI of the machine.

c) Evaluate the MIPS of the machine

a) The total number of cycles performed by the machine= 40*2+18*4+39*3+3*2 = 275

b) CPIa = (40*2+18*4+39*3+3*2)/100 = 2.75

c) $MIPS = \frac{Instruction\ Count}{Execution\ time \times 10^6} = \frac{400 \times 10^6}{2.75 \times 10^6} = 145.45$

Question 6:

Perform the following hexadecimal subtraction using 2's complement arithmetic:

0x3ABCD - 0x76543

Solution:

To perform the subtraction using 2's complement arithmetic, we need to first convert the operands to their binary 2's complement representation:

0x3ABCD = 0011 1010 1011 1100 1101

0x76543 = 0111 0110 0101 0100 0011

Now to subtract the second number from the first. To do this, we can take the 2's complement of the second number and add it to the first:

0011 1010 1011 1100 1101 (3ABCD) + 1000 1001 1010 1011 1101 (2FAB3) = 0100 0100 0110 1100 1010 (44C6A)

So the result is 0x44C6A.

Question 7:

What is the primary function of the processing unit in a computer?

Answer: To execute instructions

Question 8:

____________________is not a technique used in processor design to improve performance?

Answer: Virtualization

Note: pipelining, caching and superscalar execution are some of the techniques used to improve performance in processor design.

Question 9:

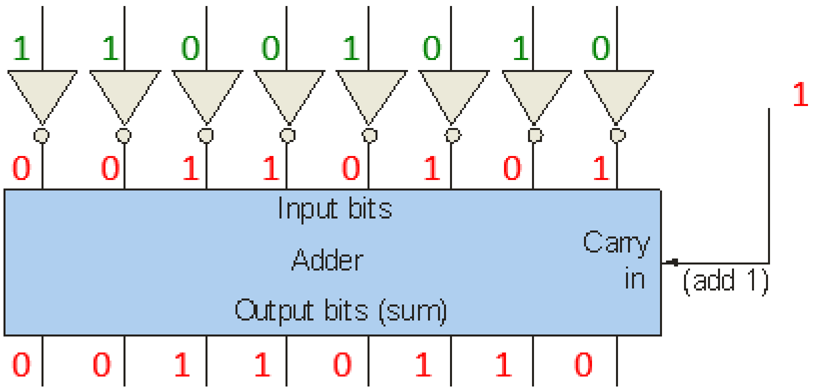
What is the correct binary equivalent of decimal number 82?

$$82 = 64 + 16 + 2 = 2^6 + 2^4 + 2^1 \xrightarrow{\qquad\qquad\qquad} 1010010$$

Answer: 1010010

Question 10:

What is the correct 2's complement of binary number 11001010?



Answer: 00110110

Question 11:

Which of the following express the decimal number -39 as an 8-bit number in the sign magnitude form?

***In the 2's complement form, a negative number is the 2's complement of the corresponding positive number. Positive numbers in 2's complement form are represented the same way as in the sign-magnitude and 1's complement forms. Negative numbers are the 2's complements of the corresponding positive numbers. ***

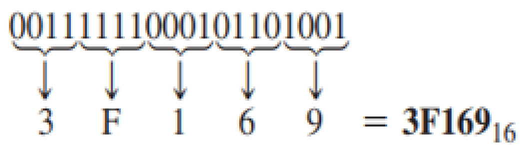
Answer: 00100111.

Question 12:

What is the correct hexadecimal equivalent for the binary number: 1111110001011010001

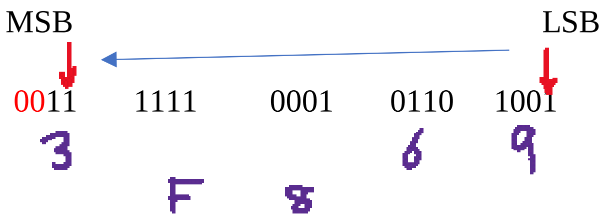
Binary to hex

- Converting from binary to hex is straightforward:
  - Simply break the binary number into 4-bit groups
  - Starting at the right-most bit and replace each 4-bit group with the equivalent hex symbol



Answer: 3F169

Further illustration: consider putting the bits in groups of 4 bits each from the LSB to MSB and converting each to decimal.



Question 13:

What does the following micro-operation do?

MAR ← (PC); PC ← (PC) +4

Answer: Increment the program counter and load its content into the memory address register.

From Chapter 5, Page 92 of [Fundamentals of computer organization and architecture]

Question 14:

What does the following micro-operation do?

IR ← (MDR)

Answer: content of memory data register is loaded into instruction register.

From Chapter 5, Page 92 of [Fundamentals of computer organization and architecture]

Question 15:

After the execution of an instruction, a test is performed to check for pending interrupts. What steps are taken if there is an interrupt request waiting?

Answer:

(1) The contents of PC are loaded into MDR (to be saved) and

(2) the MAR is loaded with the address at which the PC contents are to be saved then(3) PC is loaded with the address of the first instruction of the interrupt handling routine (4) the content of MDR are stored in the memory.

From Chapter 5, Page 94-95 of [Fundamentals of computer organization and architecture]

END OF PAPER