Virtual University

Advance Computer Architecture (CS501)

Assignment # 01

Fall 2019

Total marks = 20

Deadline Date

12^{th} Nov 2019

Please carefully read the following instructions before attempting assignment.

RULES FOR MARKING

It should be clear that your assignment would not get any credit if:

- **The assignment is submitted after the due date.**
- **The submitted assignment does not open or file is corrupt.**
- **Strict action will be taken if submitted solution is copied from any other student or from the internet.**

You should consult the recommended books to clarify your concepts as handouts are not enough.

You are supposed to submit your assignment in .doc or docx format.
Any other formats like scan images, PDF, zip, rar, ppt and bmp etc will not be accepted.

Objective:

Objective of this assignment is to increase the learning capabilities of the students about

- **Performance Measurement of a processor**
- **Performance Comparison of processors**
- **Classification of Instruction Set Architecture for different machines**

NOTE

No assignment will be accepted *after the due date via email in any case* (whether it is the case of load shedding or internet malfunctioning etc.). Hence refrain from uploading assignment in the last hour of deadline. It is recommended to upload solution file at least two days before its closing date.

If you find any mistake or confusion in assignment (Question statement), please consult with your instructor before the deadline. After the deadline no queries will be entertained in this regard.

For any query, feel free to email at:
cs501@vu.edu.pk

Questions No 01	10 marks

Suppose we have a program which contains 200 instructions of different types. We want to execute this program on a 500 MHz processor. The ratio of each type of instruction in the program as well as clocks per instruction for each type of instruction is given below:

Instruction Type	Ratio in program	Clocks/Instruction (CPI)
Load/Store	35%	2.5
ALU	55%	1.25
Control	10 %	3

1. Calculate the total execution time required by the processor to execute the program.
2. If CPI for ALU is decreased by 20% and CPI for Load/Store is increased by 10%, then calculate the execution time.

Solution (A)

The formula to calculate the execution time:

$$Execution\ Time = IC \times CPI \times T$$

IC for Load / Store Instructions $= Total\ Instructions \times Ratio\ of\ Load/Store\ Instructions$

$= 200 \times 0.35$

$= 70$ instructions

IC for ALU instructions $= Total\ Instructions \times Ratio\ of\ ALU\ Instructions$

$= 200 \times 0.55$

$= 110\ instructions$

IC for Control instructions $= Total\ Instructions \times Ratio\ of\ Control\ Instructions$

$= 200 \times 0.10$

$= 20\ instructions$

Now, we will calculate the total clock cycles required to execute each type of instructions

Total Clock Cycles for Load / Store $= IC\ for\ Load/Store \times CPI\ for\ Load/Store$

$= 70 \times 2.5$

$= 175\ clock\ cycles$

Total Clock Cycles for ALU $= IC\ for\ ALU \times CPI\ for\ ALU$

$= 110 \times 1.25$

$= 137.5\ clock\ cycles$

Total Clock Cycles for Control $= IC\ for\ control \times CPI\ for\ control$

$= 20 \times 3$

$= 60\ clock\ cycles$

$\textbf{Time required (in seconds) for each clock cycle (T)} = 1/CPU\ frequency$

$$1/500 \times 10^6 = 0.002 \times 10^{-6} seconds$$
$$= 2 \times 10^{-9} seconds$$

Now finally, we will calculate the execution time

$$Execution\ Time\ (ET) = Total\ Clock\ Cycles \times 1/CPU\ Frequency$$
$$= (175 + 137.5 + 60) \times (1/500 \times 10^6)\ seconds$$
$$= 372.5 \times 2 \times 10^{-9} seconds \qquad \therefore\ 1/500 \times 10^6 = 2 \times 10^{-9} seconds$$
$$= 745 \times 10^{-9} seconds$$
$$= \textbf{745 nanoseconds}$$

Solution (B)

If decrease the average CPI for ALU by 20%, the new average CPI

$$\textbf{New CPI for ALU} = 1.25 \times (100 - 20)/100$$
$$= 1.25 \times 0.8$$
$$= 1\ CPI$$

If average CPI for Load / Store instruction is increased by 10%, new average CPI

$$\textbf{New CPI for Load/Store} = 2.5 \times (100 + 10)/100$$
$$= 2.5 \times 1.1$$
$$= 2.75\ CPI$$

Hence, new execution time will be

$$Execution Time (E.T) = (70 \times 2.75 + 110 \times 1 + 20 \times 3)\ x\ (1/500 \times 10^6)\ seconds$$
$$= (192.5 + 110 + 60)/(5 \times 10^8)\ seconds$$
$$= 362.5 \times 2 \times 10^{-9} seconds$$
$$= 725 \times 10^{-9}\ seconds$$
$$= \textbf{725 nanoseconds}$$

Questions No 02 — 10 marks

Write assembly language program for 0-address and 1-address machines to evaluate the following expression.

D = A(B+C) – 2AC/B + C^2

Note: A, B, C and D are memory labels.

Solution A (0-Address Code)

```
PUSH B
PUSH C
ADD         ; gives B+C
PUSH A
MUL         ; gives A(B+C)
PUSH 2
PUSH A
MUL         ; gives 2A
PUSH C
MUL         ; gives 2AC
PUSH B
DIV         ; gives 2AC/B

SUB         ; gives A(B+C) - 2AC/B

PUSH C
PUSH C
MUL         ; gives C²

ADD         ; gives     A(B+C) - 2AC/B + C²
POP D
```

Solution A (1-Address Code)

```
LDA C       ; loads the value stored at memory location C in Accumulator
MULA C      ; gives C²
STA X       ; stores C² at memory location X

LDA A       ; loads the value stored at memory location A in Accumulator
MULA C      ; gives AC
MULA 2      ; gives 2AC
DIVA B      ; gives 2AC/B
ADDA X      ; adding 2AC/B with C2 stored in X gives 2AC/B + C2
STA Y       ; stores 2AC/B + C2 at memory location Y

LDA B       ; loads the value stored at memory location B in Accumulator
ADDA C      ; gives (B+C)
MULA A      ; gives A(B+C)
SUB Y       ; subtracts 2AC/B + C2 from A(B+C)
STA D       ; stores the result at memory location D
```