



UNIVERSITY OF GHANA

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BACHELOR OF SCIENCE IN COMPUTER ENGINEERING
 FIRST SEMESTER EXAMINATIONS: 2017/2018
 SCHOOL OF ENGINEERING SCIENCES
CPEN 303 COMPUTER ARCHITECTURE (3 Credits)

TIME ALLOWED: TWO AND HALF (2^{1/2}) HOURS

INSTRUCTION:

Answer **ALL** questions.

Question 1

Consider two different machines, with two different instruction sets, both of which have a clock rate of 200 MHz. The following measurements are recorded on the two machines running a given set of benchmark programs:

Instruction Type	Instruction Count (millions)	Cycles per Instruction
Machine A		
Arithmetic and logic	10	2
Load and store	6	4
Branch	4	5
Others	6	4
Machine B		
Arithmetic and logic	8	1
Load and store	4	2
Branch	2	4
Others	4	3

- (a) Calculate the following for each instruction and comment on the result.
- Calculate the effective Cycles Per Instruction (CPI) [5 marks]
 - Millions of Instruction Per Second (MIPS) [5 marks]
 - Execution time (CPU). [5 marks]
- (b) Consider a 32-bit microprocessor whose bus cycle has the same duration as that of a 16-bit microprocessor. Assume that, on average, 20% of the operands and instructions are 32 bits long, 40% are 16 bits long, and 40% are only 8 bits long. Calculate the improvement achieved when fetching instructions and operands with the 32-bit microprocessor. [5 marks]
- (c) A set-associative cache consists of 64 lines, or slots, divided into four-line sets. Main memory contains 4K blocks of 128 words each. Show the format of main memory addresses. [5 marks]

Question 2

- (a) Write a program in assembly language for MIPS processor that uses the numbers below to create an array and computes the following.
- (i) Sum all integers in the array. [4 marks]
 - (ii) Maximum value in the array. [5 marks]
 - (iii) Sum all negative integers in the array. [5 marks]
 - (iv) Average value in the array. [5 marks]

2, 4, 7, -12, 34, -36, 42, 8

Hint: The following instructions may be used.

add	div	mflo	slt, slti
addi	divu	mult	sltu, sltiu
addiu	j	multu	sra
addu	lb	nor	srl
and	lbu	or	sub
andi	lh	ori	subu
beq	lhu	sb	sw
bgez	lui	sh	xor
bltz	lw	sll	xori
bne	mfhi		

- (b) For a direct-mapped cache, a main memory address is viewed as consisting of three fields. List and define the three fields. [6 marks]

Question 3

- (a) Using 8-bits, evaluate the following in two's complement:
- (i) $11000011 - 11101000$ [3 marks]
 - (ii) $-6 - 13$ [3 marks]
- (b) Using computer algorithm, multiply 11 by 13, where each number is represented using 4 bits. [10 marks]
- (c) The following numbers use the IEEE 32-bit floating-point format. What is the decimal value equivalent?
- (i) 10000001 010000000000000000000000 [3 marks]
 - (ii) 1 10000001 100000000000000000000000 [3 marks]
 - (iii) 1 01111111 100000000000000000000000 [3 marks]

Question 4

- (a) Write a program to compute the expression below for zero-, one-, two-, three-address machines and compare the result.

$$X = (A - B \times C) / (D - E \times F)$$

The instructions available for use are as follows:

0 Address	1 Address	2 Address	3 Address
PUSH M	LOAD M	MOVE ($X \leftarrow Y$)	MOVE ($X \leftarrow Y$)
POP M	STORE M	ADD ($X \leftarrow X + Y$)	ADD ($X \leftarrow Y + Z$)
ADD	ADD M	SUB ($X \leftarrow X - Y$)	SUB ($X \leftarrow Y - Z$)
SUB	SUB M	MUL ($X \leftarrow X \times Y$)	MUL ($X \leftarrow Y \times Z$)
MUL	MUL M	DIV ($X \leftarrow X / Y$)	DIV ($X \leftarrow Y / Z$)
DIV	DIV M		

[10 marks]

- (b) Briefly explain the following:
- (i) Computer Organization [2 marks]
 - (ii) Von Neumann Architecture [2 marks]
 - (iii) Interrupt [2 marks]
 - (iv) Hamming Error-Correcting Code [2 marks]
 - (v) Complex Instruction Set Architecture (CISC) [2 marks]
- (c) List and briefly define the major types of OS scheduling. [5 marks]