UNIVERSITY OF GHANA

FACULTY OF ENGINEERING SCIENCES
BACHELOR OF SCIENCE IN ENGINEERING
FIRST SEMESTER EXAMINATIONS, 2016/2017
LEVEL 300: CPEN 303 COMPUTER ARCHITECTURE (3 Credits)

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

INSTRUCTION: Answer ALL questions.

Question 1

A benchmark program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock cycle count:

Instruction Type	Instruction Count	Cycles per Instruction
Integer arithmetic	45000	1
Data transfer	32000	2
Floating point	15000	2
Control transfer	8000	2

(a) Calculate the following for each instruction and comment on the result.
(i) Calculate the effective Cycles Per Instruction (CPI)
(ii) Millions of Instruction Per Second (MIPS)
(iii) Execution time (CPU).

[15 marks]

Consider a hypothetical 32-bit microprocessor having 32-bit instructions composed of two fields: the first byte contains the opcode and the remainder the immediate operand or an operand address.

(b) What is the maximum directly addressable memory capacity (in bytes)?
(c) Explain the impact on the system speed if the microprocessor bus has
(i) A 32-bit local address bus and a 16-bit local data bus, or
(ii) A 16-bit local address bus and a 16-bit local data bus.
(d) How many bits are needed for the program counter?

[10 marks]

Question 2

(a) Write a program in assembly language for MIPS processor to evaluate the polynomial below. The value x should be taken from memory and the result stored back in memory.

$$4x^2 + 7x - 10$$

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Hint: The following instructions may be used.

add	lw	sll
addi	mfhi	sra
addiu	mflo	srl
addu	mult	sub
and	multu	subu
andi	nor	sw
div	or	xor
divu	ori	xori

[20 marks]

(b) List five properties of the first general purpose electronic digital computer ENIAC (Electronic Numerical Integrator And Computer).

[5 marks]

Question 3

(a) Evaluate the following in two's compliment:

(i) 111000 - 110011

(ii) -6 + 13

[6 marks]

(b) Using Booth's multiplication algorithm, multiply 5 (multiplicand) by -6 (multiplier), where each number is represented using 4 bits.

[10 marks]

(c) Express the following numbers in IEEE standard 754 32-bit floating-point format:

(i) -6

(ii) 384

(iii) -1/32

[9 marks]

Question 4

(a) Explain briefly, the seven levels of RAID

[7 marks]

(b) Define the following terms briefly.

(i) High-level language

(ii) Assembly language

(iii) Machine language

(iv) Moore's law

(v) Reduced Instruction Set Architecture (RISC)

[10 marks]

(c) Explain the two main types of memory errors. With a block diagram, how can error correcting code function work.

[8 marks]

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