# FINAL EXAM
FIRST SEMESTER SESSION 2011/2012

<table>
<thead>
<tr>
<th>COURSE CODE / NAME</th>
<th>STIK2023/ COMPUTER ARCHITECTURE AND ORGANIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>12 JANUARY 2012 (THURSDAY)</td>
</tr>
<tr>
<td>TIME</td>
<td>8.30 P.M – 11.00 A.M (2 ½ HOURS)</td>
</tr>
<tr>
<td>VENUE</td>
<td>DMS</td>
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</table>

**INSTRUCTION:**

1. Answer ALL of the questions in this booklet only.
2. You are allowed to use scientific calculator.
3. This booklet contains **FOURTEEN (14)** questions in **NINE (9)** pages (not including this page)

<table>
<thead>
<tr>
<th>MATRIC NO :</th>
<th>[With word]</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>[With number]</td>
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<table>
<thead>
<tr>
<th>IDENTIFICATION CARD NO. :</th>
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<th>LECTURER :</th>
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<table>
<thead>
<tr>
<th>GROUP :</th>
<th>TABLE NO. :</th>
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DO NOT OPEN THIS EXAMINATION PAPER UNTIL INSTRUCTED

CONFIDENTIAL
STIK 2023 Computer System Architecture

INSTRUCTION: Answer all of the questions in this booklet only. Make sure to write your answers clearly with visible and readable writing.

1. The following questions are related to introduction to computer architecture:
   a. What is the main difference between the von Neumann architecture and the bus model architecture?

   (3 Marks)

   b. The introduction of new technology in second generation marked great achievement that enables integrated circuit to be possible. Describe what technology that allows for such advancement.

   (2 Marks)

2. Find value for the following base conversion and show how your work.
   a. 53.375 to base 2

   (3 Marks)
b. 198 in base 8

3 Marks

c. 100,1011 to base 8

3 Marks

3. Convert the following numbers as indicated.

a. \( 110101_2 \) to unsigned base 10.

3 Marks

b. \((-29)_{10}\) to two's complement (use 8 bits in the result).

3 Marks
c. \((61543)_8\) to unsigned base 16 (use four base 16 digits in the result). (3 Marks)

d. \((37)_{10}\) to unsigned base 3 (use four base 3 digits in the result). (3 Marks)

4. Show the results of adding/subtracting the following pairs of six-bit (i.e. one sign bit and five data bits) two's complement numbers and indicate whether or not overflow/underflow occurs for each case:

\[
\begin{array}{ccccccc}
1 & 0 & 1 & 0 & 1 & 1 & \\
+ & 1 & 0 & 0 & 1 & 0 & 1 \\
\hline
1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]

\[
\begin{array}{ccccccc}
1 & 1 & 1 & 1 & 1 & 1 & \\
+ & 0 & 0 & 0 & 1 & 1 & 1 \\
\hline
1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]

\[
\begin{array}{cccccc}
1 & 1 & 1 & 1 & 1 & 0 \\
- & 1 & 0 & 0 & 1 & 0 & 1 \\
\hline
\end{array}
\]

\[
\begin{array}{cccccc}
1 & 0 & 0 & 0 & 0 & 1 \\
- & 0 & 1 & 1 & 1 & 0 & 1 \\
\hline
\end{array}
\]
5. Represent \((107.875)_{10}\) in the IEEE-754 single precision floating point representation which has a sign bit, an eight-bit excess 127 exponent, and a normalized 23-bit significand in base 2 with a hidden 1 to the left of the radix point. Truncate the fraction if necessary by chopping bits as necessary. Show your work.

(8 Marks)

6. The following questions are dealing with digital logic design.

a. Derive function \(x\) represented by the following circuit. The prime symbol (') has the same meaning as overbar.

(3 Marks)
b. Design a circuit that implements function \( p \) below using AND, OR, and NOT gates. Do not change the form of the equation. The circuit should implement this function exactly.

\[
f(i_0, i_1, i_2) = i_2(i_0i_1 + \overline{i_0i_1})
\]

(8 Marks)

7. Design a binary-to-Gray code converter using an 8-to-1 MUX, a 4-to-1 MUX, and a 16-to-1 MUX. Use the truth table shown below (use the block diagram as representation of MUX):

<table>
<thead>
<tr>
<th>( x_2 )</th>
<th>( x_1 )</th>
<th>( x_0 )</th>
<th>( z_2 )</th>
<th>( z_1 )</th>
<th>( z_0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>0</td>
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</tbody>
</table>

(8 Marks)
STIK 2023 Computer System Architecture

8. Which of the following operations does function baz in the ARC program shown below carry out? The parameters A and B are passed to the function and returned from it are passed via the stack. B is closer to the stack pointer than A. Circle one of these operations: (4 Marks)

(A) min( A , B )  (B) max( A , B )  (C) addcc( A , B )  (D) subcc( A , B )

(E) ( A := B ) \( \text{--- in this case, the result is a boolean, indicated by a nonzero result.} \)

```
baz:    ld   %sp, 4, %r1
        ld   %sp, 0, %r2
        orncc %r2, %r0, %r3
        addcc %r3, 1, %r3
        addcc %r1, %r3, %r4
        bneg  foo
        st   %r2, 4, %sp
        ba   DONE

foo:    st   %r1, 4, %sp
        addcc %r14, 4, %r14

DONE:   jmpl  %r15, 4, %r0
```
10. Given an architecture that implements the following instructions:

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Operand(s)</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUSH</td>
<td>arg</td>
<td>Push contents of memory location arg onto stack</td>
</tr>
<tr>
<td>POP</td>
<td>arg</td>
<td>Pop stack into memory location arg</td>
</tr>
<tr>
<td>BA</td>
<td>label</td>
<td>Branch to label</td>
</tr>
<tr>
<td>ADD</td>
<td>arg1, arg2, arg3</td>
<td>arg3 ← arg1 + arg2</td>
</tr>
</tbody>
</table>

What is the result of executing the following program? Describe the final value of variable A, B and the stack.

```
PUSH A
ADD A, 1, A
PUSH A
ADD A, 1, A
PUSH A
POP B
ADD B, -1, B
POP B
ADD B, -1, B
POP B
```

(6 Marks)

11. The following questions are related to memory:

   a. A cache has a 95% hit ratio, an access time of 100ns on a cache hit, and an access time of 800ns on a cache miss. Compute the effective access time.

   (3 Marks)
b. A computer has 16 pages of virtual address space but only 4 page frames. Initially the memory is empty. A program references the virtual pages in the order: 0 2 4 5 2 4 3 1 1 2 10. Which references cause a page fault with the LRU page replacement policy?

(5 Marks)

c. When running a particular program with $N$ memory accesses, a computer with a cache and paged virtual memory generates a total of $M$ cache misses and $F$ page faults. $T_1$ is the time for a cache hit; $T_2$ is the time for a main memory hit; and $T_3$ is the time to load a page into main memory from the disk. What is the overall effective access time for the system?

(3 Marks)

12. A hard magnetic disk with a single platter rotates once every 16 ms. There are 8 sectors on each of 1000 tracks. An interleave factor of 1:2 is used. What is the fastest possible time to copy a track from the top side of the platter to the corresponding track on the bottom side of the platter? Assume that the sectors must be read in numerical order starting from 0, that the top and bottom tracks must be mirror images, that any number of sectors can be read from the top track before writing them to the bottom track, and that simultaneous reading and writing is not allowed (even on different tracks.)

(8 Marks)
13. Using the page table shown below, translate virtual address 2050 into a physical address, and translate physical address 25 into a virtual address. Address length is 16 bits, page size is 2048 words. Physical memory has 4 page frames.

<table>
<thead>
<tr>
<th>Page</th>
<th>Present (1-in/0-out)</th>
<th>Page Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>

... (8 Marks)

14. How the DNA computing differ from traditional silicon computing. (2 Marks)