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First Name: Last Name:

Student Number:

University of Toronto
Faculty of Applied Science and Engineering

Lab Test I – March 2004

ECE532S – Digital Hardware

Examiner – Paul Chow

1. There are 6 questions and **6** pages. Do **all** questions. The total number of marks is 50. The duration of the test is 50 minutes.
2. **ALL WORK IS TO BE DONE ON THESE SHEETS!** Use the back of the pages if you need more space. Be sure to indicate clearly if your work continues elsewhere.
3. **No calculators or other computing devices allowed.**
4. Closed book. No aids permitted.

1 [10]	
2 [10]	
3 [12]	
4 [3]	
5 [5]	
6 [10]	
Total [50]	

1. Starting with some short answer questions:

[2 marks]

(a) What is an `elf` file?

[2 marks]

(b) What does the `-g` option do when using the `gcc` compiler and when would you want to use it?

[2 marks]

(c) Where is the stack initialized when you compile and run a C program?

[2 marks]

(d) What does the `gcc nm` command do?

[2 marks]

(e) What is the `pcores` directory used for in the EDK tool flow?

[10 marks] 2. Using a figure, describe how a basic MicroBlaze system is implemented. For each of the following components or functions you must show where (in FPGA, on board, in PC, etc.) and how they are implemented (FPGA logic, external chip, etc.). Also show how all the pieces are connected.

- MicroBlaze processor
- UART
- Ethernet physical layer interface (PHY)
- instruction and data memory using on-chip memory
- Ethernet controller
- instruction and data memory using off-chip memory
- serial port (RS232) physical drivers
- FPGA download functions

3. XMD is the software monitor for MicroBlaze. Part of XMD is implemented on the MicroBlaze processor system and part is implemented on the host PC.

[2 marks] (a) How do the two parts of XMD communicate?

[8 marks] (b) Consider the actions needed to implement the `disassemble` function in the monitor and the related user interface functions. Being curious as to how this command works, you start by executing the following command:

```
(ugsparc100.eecg) size xmdstub.elf  
868 + 148 + 0 = 1016
```

What actions do you think are implemented on the MicroBlaze system and what are implemented on the host PC?

[2 marks] (c) What role does XMD play when using GDB?

[3 marks] 4. Describe how JTAG can be used to test the connectivity on a printed circuit board.

[5 marks] 5. Consider the following C program:

```
int Count = 0;

int main(void)
{
    while(1)
        printf("Count = %d\n",Count++);
}
```

You download the program to your MicroBlaze system and it runs correctly with `Count` starting at 0. Without downloading the program again, you start it running from the beginning of the program and `Count` does not start at 0. What is going on? How would you fix it?

- [10 marks] 6. Demonstrate your understanding of what is going on “under the hood” of the EDK tools, i.e., What is going on under the GUI? You will be graded according to how well you can describe what the tools are doing after you fill in all the forms and push the button to generate a bitstream.