Engr354: Digital Logic

Chapter 1: Design Concepts

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Overall Logic Design Process

• Digital hardware systems;
• Digital hardware implementation methods;
  – Standard chips;
  – Programmable logic devices (PLD’s);
  – Application Specific Integrated Circuits (ASIC’s);
  – Fully custom IC’s;
  – VHDL.
• Design process.
A Digital Hardware System

Printed Circuit Boards
Design Abstraction

AMD’s Barcelona Multicore Chip
- Four out-of-order cores on one chip
- 1.9 GHz clock rate
- 65nm technology
- Three levels of caches
A Silicon Wafer

ITRS Roadmap

Table 1.1  A sample of the International Technology Roadmap for Semiconductors.

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Technology feature size</td>
<td>78 nm</td>
</tr>
<tr>
<td>Transistors per cm²</td>
<td>283 M</td>
</tr>
<tr>
<td>Transistors per chip</td>
<td>2,430 M</td>
</tr>
</tbody>
</table>
Standard Chips

- Realize common logic functions;
- Usually less than 100 transistors;
- Common ones will be found in your lab kits;
- You will use them in some homework assignments;
- Not used much today as they occupy too much space on printed circuit boards (PCB’s).
Standard Chips

Programmable Logic Devices (PLD’s)

- Realize much more complicated logic circuits than a standard chip;
- Often reprogrammable;
- Field-programmable gate arrays (FPGA) will soon use more than 100 million transistors;
- Widely used today.
Field Programmable Gate Array (FPGA)

- Group of 8 logic cells
- Memory block
- Interconnection wires

Custom Designed Chips

- PLD’s are not very efficient so they may not meet performance or cost objectives;
- May need to design a **custom** or **semi-custom chip** (ASIC);
- Advantage - optimized for a given task;
- Disadvantage: more complex design and manufacturing process, more design time;
- Fluke microprocessor.
Custom Designed Chips

VHDL – A Structured Programming Language

```vhdl
library IEEE;
use IEEE.std_logic_1164.all;

entity Vchapmux is
  port ( A, B, S: in STD_LOGIC;
         Z: out STD_LOGIC );
end Vchapmux;

architecture Vchapmux_arch of Vchapmux is
begin
  Z <= A when S = '0' else B;
end Vchapmux_arch;
```
Summary

- Digital hardware systems;
- Digital hardware implementation methods;
  - Standard chips;
  - Programmable logic devices (PLA's);
  - Application Specific Integrated Circuits (ASIC’s);
  - Fully custom IC’s;
  - VHDL.
- Design Process.