Overview of This Course: 4 Main Components

Introduction to VLSI design
- Brief introduction to VLSI design and ASICs vs FPLDs
- Review of combinational and sequential circuits
- Using Altera’s Max-PLUS II for schematic capture, design entry, and simulation

IC technology
- Brief introduction to CMOS
- Comparison of various FPLD families

HDL-based design
- Design using AHDL and VHDL
- Large examples

Projects using schematic capture, AHDL, and VHDL in Altera’s MAX+PLUS II

Logic Synthesis Design Flow

Two alternative design entry methods:
- Manual design and schematic capture — draw and interconnect structural elements (gates, flip-flops, registers, etc.)
  - Sequential or combinational design
  - Manual design with automated bookkeeping
- HDL-based design — describe design in textual form using familiar programming constructs plus some additional ones
  - Decisions regarding flip-flops etc. are made automatically by the CAD tool
  - Semi-automated design

Compilation / Synthesis — produce a flat netlist of gates, optimizing the design to minimize area, speed, power, etc.

Simulation and verification — make sure the design does what you think it does

Logic Synthesis Design Flow (cont.)

Logic Synthesis in a Larger Context

System synthesis — converts a task specification into processors, memories, ASICs, etc. plus software
- Hardware / software codesign
- Tradeoffs between hardware & software

Behavioral (high-level) synthesis — converts an algorithmic description of behavior into registers, adders, ALUs, busses, multiplexors, etc.
- Scheduling breaks design into states
- Data path synthesis produces interconnected set of functional units, registers, etc.

Logic synthesis — converts a structural description into gates and flip-flops
- Designer must specify all states
Integrated Circuits (ICs)

- Integrated Circuit (IC) = “chip”
  - Microprocessor
  - Application-Specific Instruction Set Processor (ASIP)
  - Application-Specific IC (ASIC)

- IC package contains:
  - silicon chip = “die”
  - pins

Figure from Application-Specific Integrated Circuits, Smith, Addison-Wesley, 1997

- Package may have heat sink attached

Some Applications of ICs

- Home
  - Appliances, intercom, telephones, security system, garage door opener, answering machines, fax machines, home computers, TVs, cable TV tuner, VCR, camcorder, video games, cellular phones, sewing machines, cameras, exercise equipment, microwave oven

- Office
  - Telephones, computers, security system, fax machines, copier, printers, pagers

- Automobile
  - Trip computer, air bags, ABS, instrumentation, security system, transmission control, entertainment system, climate control, keyless entry, cellular phone, GPS

List from Hardware/Software Codesign, Giovanni De Micheli, 1996.

Integrated Circuits (ICs)
(cont.)

- A modern digital system is built out of a collection of integrated circuits (ICs), each of which is made up of gates

- ICs are typically classified based on the number of gates they contain
  - SSI (small scale integration) < 10
    - 4 nand gates
    - 4 or gates
    - 4 and gates
  - MSI (medium…) 10-100
    - simple adders, counters
    - multiplexers
    - flip-flops
  - LSI (large…) 100-10,000
    - Interface devices
    - Calculators
    - Digital clocks
    - Simple microprocessors

Integrated Circuits (ICs)
(cont.)

- Classification, cont.
  - VLSI (very large…) >10,000
    - Modern microprocessors
      - 8086 = 29,000
      - i386DX = 275,000
      - i486DX = 1,200,000
      - Pentium = 3,100,000
      - Pentium MMX = 4,500,000
      - Pentium Pro = 5,500,000
      - Pentium II = 7,500,000
      - PA8000 = 3,900,000
      - (Data from "CPU & System Performance Info" at CPU Info Center — http://infopad.eecs.berkeley.edu/cic)
    - Application-specific integrated circuits (ASICs):
      - Dedicated controllers (portable telephone, CD player, auto dashboard)
      - Digital signal processors (image processing, multimedia)
    - Field-programmable logic devices (FPLDs)