# Conclusion

- What we did the last 10 weeks
- What you should now know
- The relationship of CSE370 to other courses in CSE core requirements
- Follow-on courses
- Evaluation

## What we did . . .

- **Basics of logic design**
  - combinational and sequential circuits
- **Sound design methodologies**
  - finite-state machines and their implementation
- **Modern specification methods**
  - schematics and hardware description languages
- **Modern set of CAD tools**
  - Synario tool suite for digital logic design
- **Differences and similarities in hardware and software design**
  - inherent parallel nature of hardware
  - input/output/state encoding

## You should now . . .

- **Feel confident that you can design a circuit to perform virtually any function**
  - come up with problem specification
  - separation of data path and control concerns
  - consider change to meet criteria of size/cost
- **Have a basic understanding of the hardware costs of a particular function**
  - variable <–> register/memory
  - assignment <–> register load/memory write
  - conditional <–> logic equation
  - program execution <–> sequence of states
  - control flow <–> state machine
- **Have a general understanding of how computers are organized**
  - typical instruction cycle
  - control/data-path/memory
  - finite-state controller

## CSE370's place in CSE core

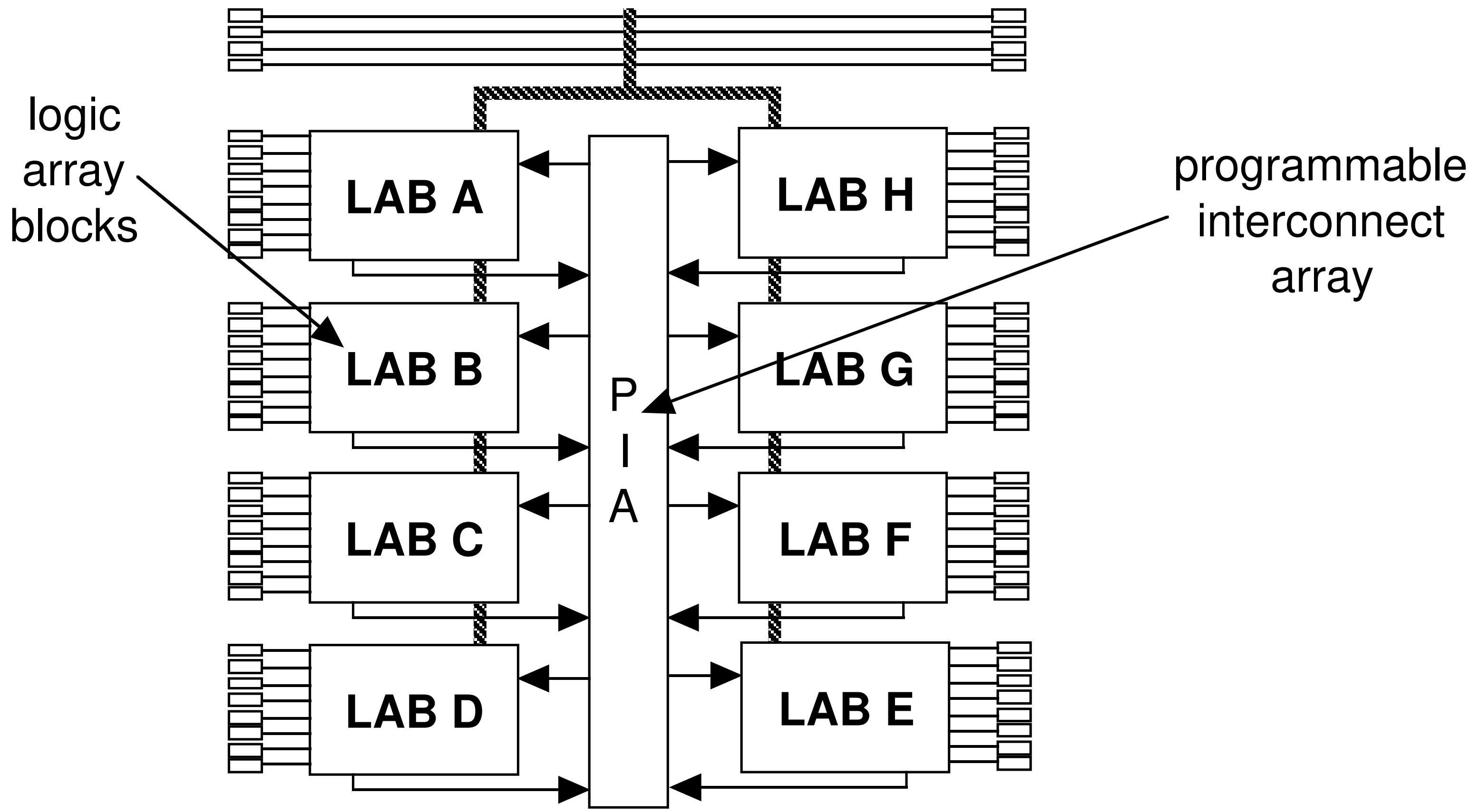
- **CSE321 – Discrete Mathematics**
  - basic mathematics used in computing
- **CSE322 – Introduction to Formal Methods in Computer Science**
  - finite automata, languages, computability
- **CSE326 – Data Structures**
  - fundamental elements of data organization and interaction with algorithms
- **CSE341 – Programming Languages**
  - survey of different languages and their motivation/advantages/disadvantages
- **CSE370 – Introduction to Digital Logic**
  - the best of the bunch
- **CSE378 – Machine Organization and Assembly Language**
  - basic architecture and mapping of software to machine instructions

## Courses that have CSE370 as a pre-requisite

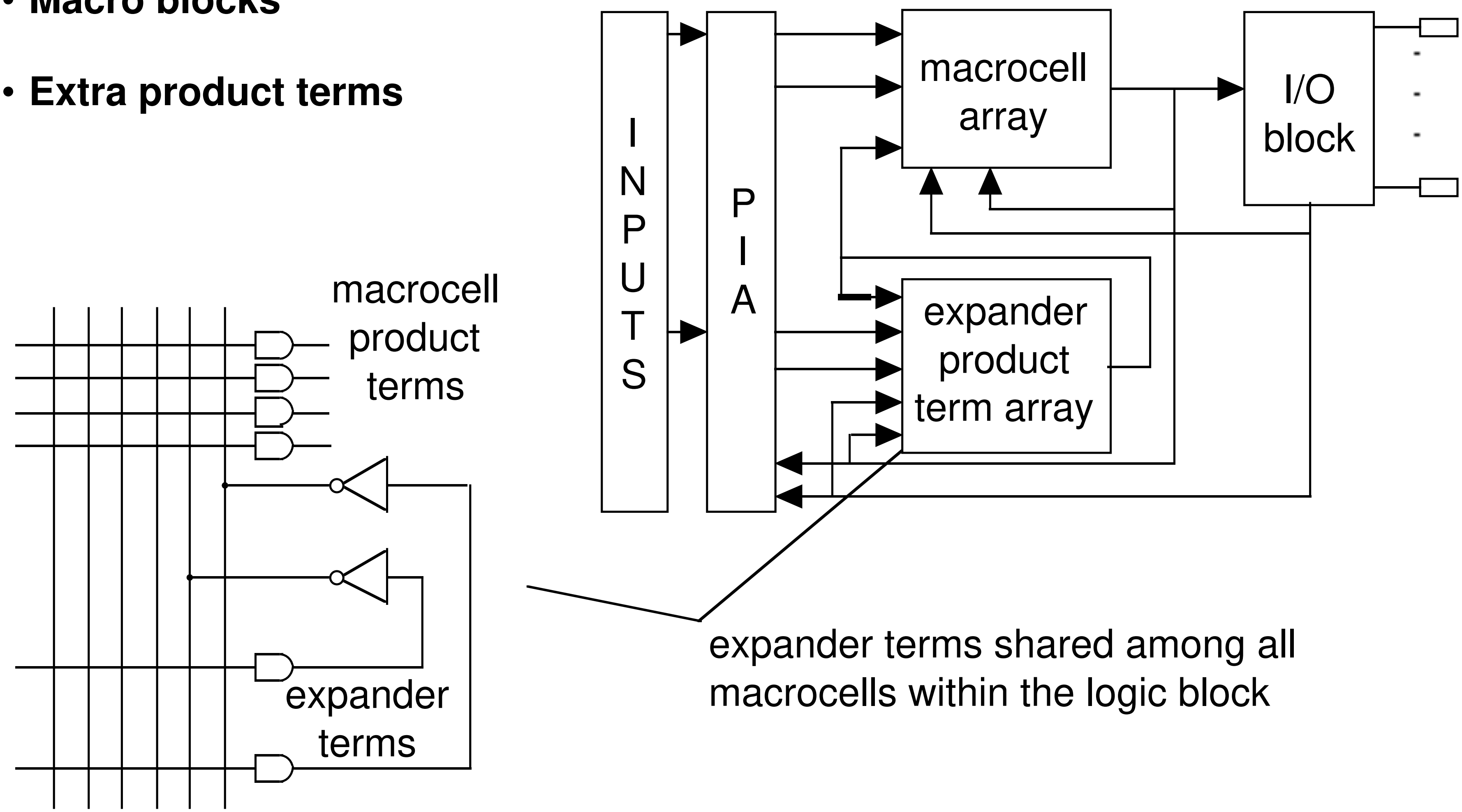
- **CSE467 – Advanced Digital Design**
  - construction and debugging techniques, design labs
  - complex PLDs, field-programmable gate arrays (FPGAs)
  - behavioral synthesis and underlying algorithms
- **CSE471 – Computer Design**
  - high-level simulation of processor architecture (in Verilog)
  - architecture tradeoffs and evaluation
- **CSE477 – Digital System Design**
  - embedded processors
  - large team design project
- **CSE468 – VLSI Design**
  - elective
  - custom and semi-custom chip design

## Complex PLDs (CPLDs)

- Multiple PLDs in one package
- Programmable interconnect

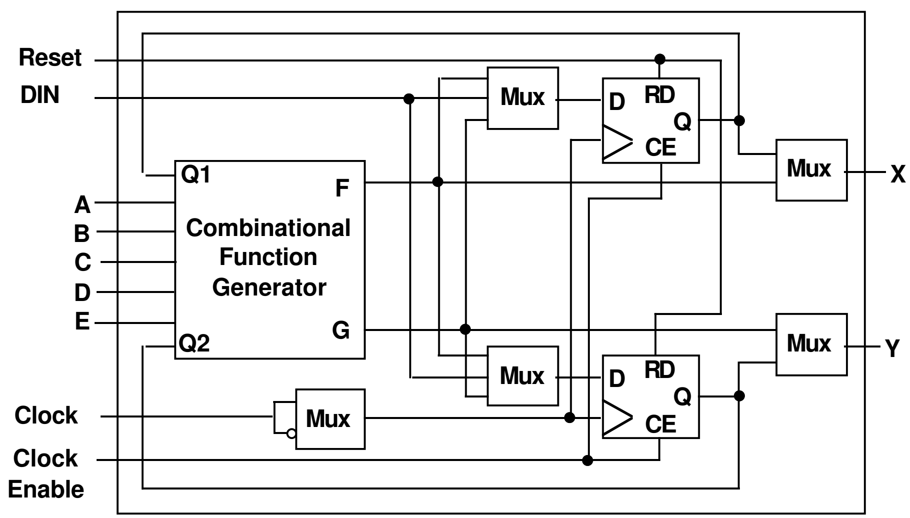


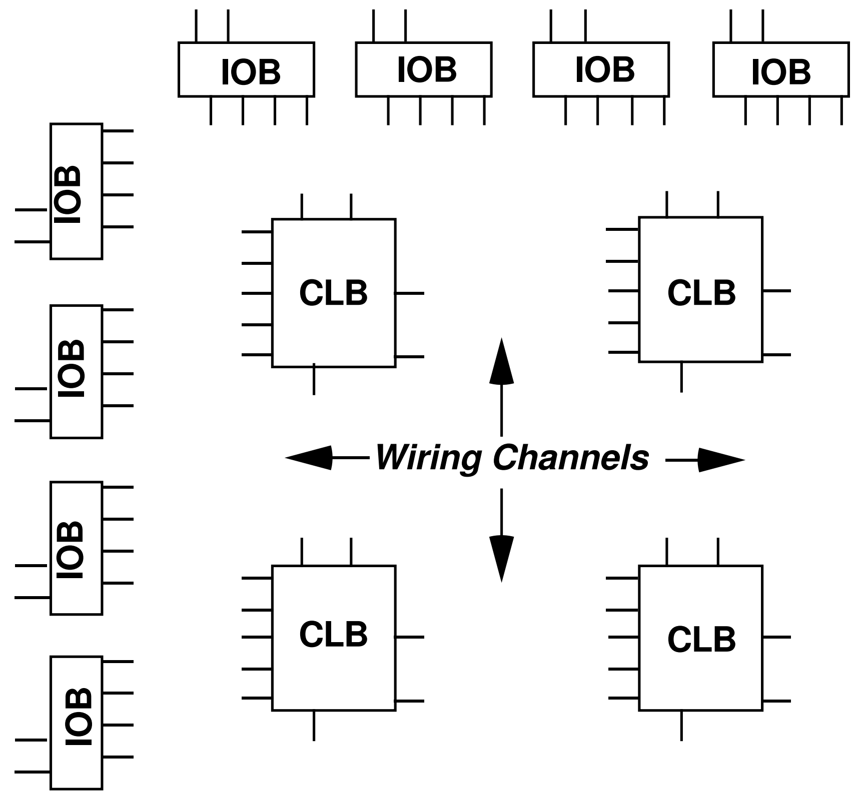
- **Macro blocks**
- **Extra product terms**



# Field-programmable Gate Arrays (FPGAs)

- **Array of logic cells implemented as lookup tables – <u>any</u> function of 5 inputs**
- **Programmable interconnect**
  - different length wires connecting cells
- **Programmable I/O cells**



## Embedded processors

- **Ever faster processor**
  - software doing the job hardware used to do
- **Specialized I/O capabilities**
  - controllability and observability of individual wires (I/O ports)
- **Timer and communication co-processors**
  - serial line interface
  - timers
  - input capture (record time of event)
  - output compare (generate at a specified time)

## Summary

- **What the entire course was about**
  - converting solutions to problems into combinational and sequential networks effectively organizing the design hierarchically
  - doing so with a modern set of design tools that lets us handle large designs effectively
  - taking advantage of optimization opportunities (dont' care, encodings, etc.)
  - appreciating the inherent parallel nature of hardware

- **That took ten weeks**
  - but there is a lot more to it
  - this was just the beginning
  - hope to see you in 467 or 477 or 468 or . . .

## Evaluation

- **These really do matter**
  - department takes them very seriously
  - crucial feedback for instructor
- **Take the time and fill it out completely**
  - additional questions can be answered on back of form
  - yellow sheets are the most valuable – write down your thoughts

# THE END