CPEG 422/622
EMBEDDED SYSTEMS DESIGN

Chengmo Yang

chengmo@udel.edu

Evans 201C

LECTURE 12
MIDTERM REVIEW

TOPICS STUDIED

- FPGA
- VHDL
- Adder
- Multiplier
- Floating Point Number

FPGA TOPICS

- FPGA vs. ASIC, pros and cons
- FPGA structure
  - CLB, SB, CB, look-up tables
- Vivado Steps
  - Simulation
  - Synthesis, implementation (mapping, placement, routing), bitstream generation
  - Constraint files
- Timing
  - Path types, critical path, negative slack

VHDL TOPICS

- Design structure
  - Library, entity, architecture
- Declaration
  - Component, Signals,…
- Behavior description
  - Signal assignment, process, if-then-else, case…
- Combinational vs. sequential circuits
  - Concurrent vs. sequential statements
  - Signal assignments inside vs outside process
  - Signal vs. variables
- Testbench vs. synthesizable code
  - Wait, assert, report, loop
- Waveforms
  - Draw waveforms based on signal assignments and vise versa
  - Debugging

ADDER

- Single-bit
  - Half adder, full adder
- Multi-bit
  - Carry ripple, carry-look-ahead
  - Recursive equations of CLA
  - Hierarchical design
  - Timing of 2-level CLA adder, critical path
- Signed vs unsigned number
  - 2's complement subtraction
  - Overflow conditions

MULTIPLIER

- Basic algorithm for unsigned numbers
  - Performs an addition for every "1" in the multiplier
- Booth's algorithm for 2's complement numbers
  - Checks 2 bits of the multiplier at a time, performs a subtraction for every "10" in the multiplier, and an addition for every "01" in the multiplier
  - Step-by-step view of the algorithm
- Implementation
  - Need three n–bit registers and an n-bit adder when multiplying two n-bit numbers
  - Know how to connect the different components
  - Determine the control signals of different components at the top-level

FLOATING POINT NUMBERS

- IEEE 754 representation
  - Sign, exponent, fraction, bias
  - Normalized vs. denormalized values
  - Smallest and largest values
- The non-even gap between adjacent numbers
- Conversion between integer and FP numbers
- FP addition/subtraction, multiplication/division