System Design

2.3.1.1 The List of Inputs

- “A” is a 16-bit integer that will represent the first integer passed to the functional operator.
- “B” is a 16-bit integer that will represent the second integer passed to the functional operator.
- “Op” is a 4-bit code that will determine the operation applied on the two values A and B.
- “Clock” is a signal that changes between a high and low state.

2.3.1.2 The List of Outputs

- “Result” is a 32-bit integer that will represent the output value of the selected operation on inputs A and B.
- “Error” is a 2-bit code that will determine the presence of an error and its type (overflow or division by 0).

2.3.1.3 The List of Interfaces

- “No-op” is a 32-bit line that contains the output value of the previous clock tick that feeds into multiplexor channel #0
- “Sum” is a 16-bit line that contains the output value from the adder-subtractor module for an addition or subtraction operation that will feed into multiplexor input channel #1 for addition and channel #2 for subtraction (determined by mode).
- “Product” is a 32-bit line that contains the output value from the multiplication module that will feed into multiplexor channel #3.
- “Quotient” is a 16-bit line that contains the output from the division module that will feed into multiplexor channel #4.
- “Remainder” is a 16-bit line that contains the output from the modulo module for a modulo operation that will feed into multiplexor channel #5.
- “Anded” is a 16-bit line that contains the output value of the AND module that will feed into multiplexor channel #6.
- “Nanded” is a 16-bit line that contains the output value of the NAND module that will feed into multiplexor channel #7.
- “Nored” is a 16-bit line that contains the output value of the NOR module that will feed into multiplexor channel #8.

- “Noted” is a 16-bit line that contains the output value of the NOT module that will feed into multiplexor channel #9.
- “Ored” is a 16-bit line that contains the output value of the OR module that will feed into multiplexor channel #10.
- “Xnored” is a 16-bit line that contains the output value of the XNOR module that will feed into multiplexor channel #11.
- “Xored” is a 16-bit line that contains the output value of the XOR module that will feed into multiplexor channel #12.
- “Reset” is a 32-bit line that is composed of all 0 bits that will feed into multiplexor channel #13.
- “Preset” is a 32-bit line that is composed of all 1 bits that will feed into multiplexor channel #14.
- “Mode” is a 1-bit line that determines whether the adder-subtractor does addition or subtraction.
- “Onehot” is a 16-bit one-hot line that contains the channel selection from the 4-bit operational code that will feed into the multiplexor input channels.
- “Mod0Err” is a 2-bit line that contains the error output for the modulus by 0 case which leads from the Modulo module into the Error-Handler module.
- “Div0Err” is a 2-bit line that contains the error output for the division by 0 case which leads from the Divisor module into the Error-Handler module.
- “OFErr” is a 2-bit line that contains the error output for overflow which leads from the Adder-Subtractor module to the Error-Handler module.

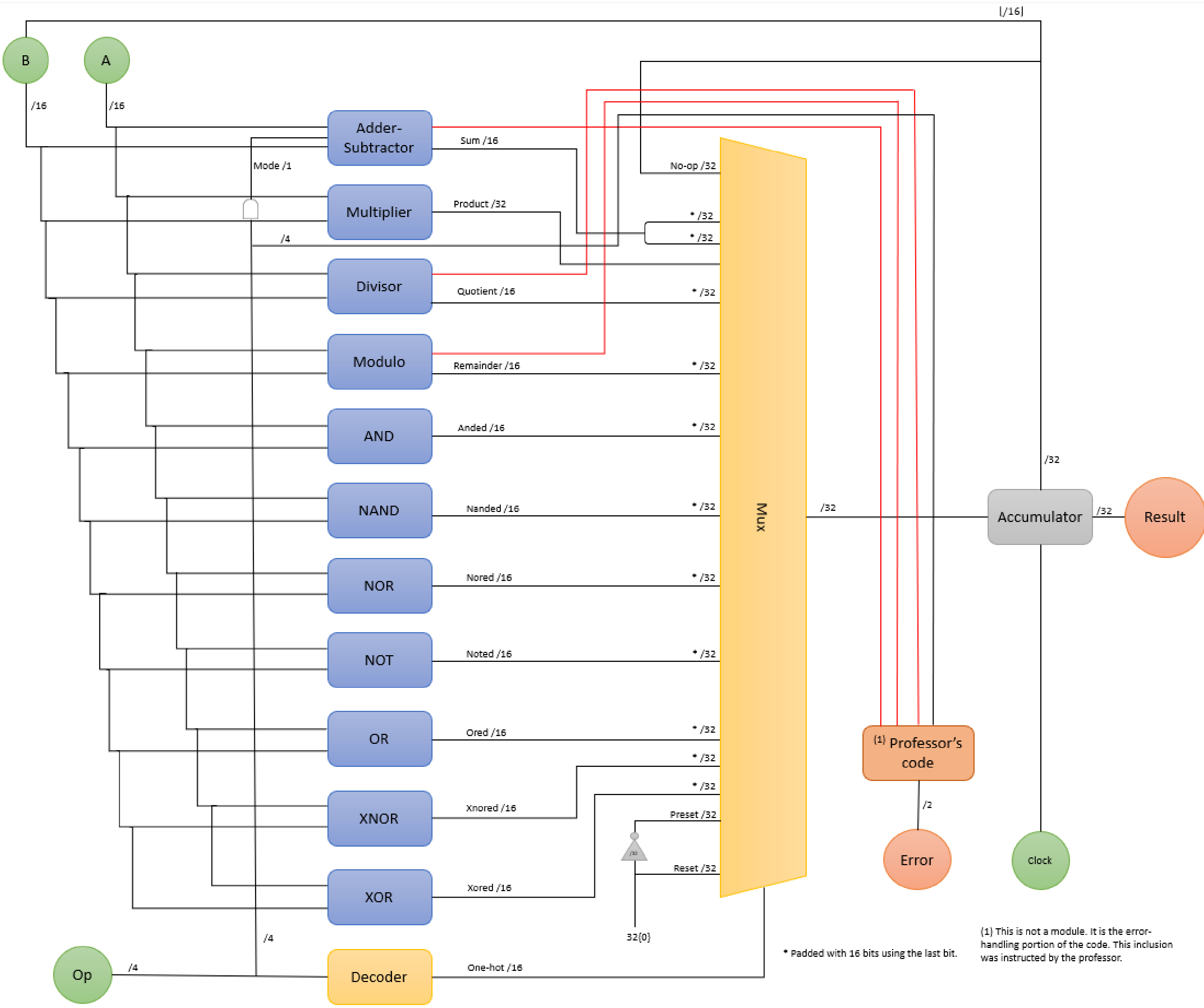
2.3.1.4 The List of Parts

- “AdderSubtractor” is the adder-subtractor component in the ALU that is capable of performing addition and subtraction of 16-bit binary numbers.
- “Multiplier” is the multiplier component in the ALU that is capable of performing multiplication on 16-bit binary numbers.
- “Divider” is the divisor component in the ALU that is capable of performing integer division on 16-bit binary numbers.
- “Modulus” is the modulo component in the ALU that is capable of performing the modulus operation on 16-bit binary numbers (finding the remainder).
- “Mux” is the multiplexor component used in the ALU that handles mutual exclusion among the channels of the ALU.
- “Decoder” is the decoder component used in the ALU that converts the operational code into a one-hot selection for use in the multiplexor.
- “And” is a 16-bit component in the ALU that is capable of performing AND operations on 16-bit binary numbers.

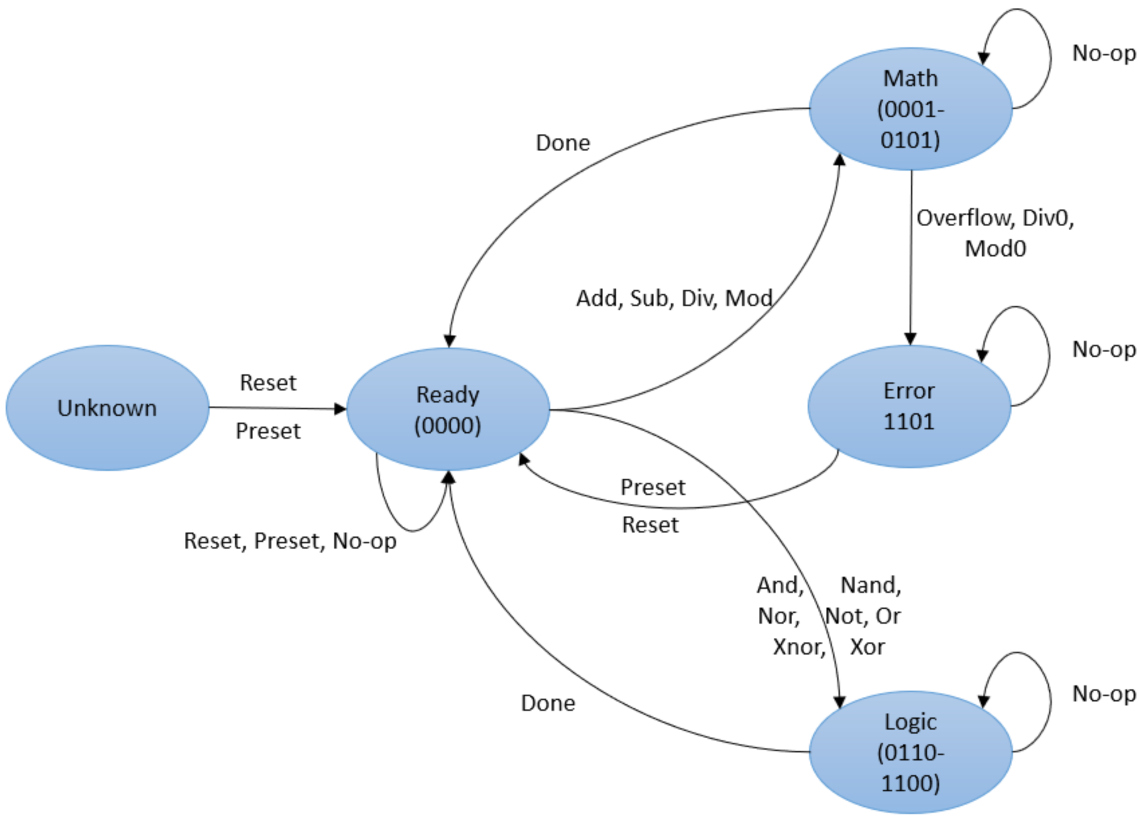
- “Nand” is a 16-bit component in the ALU that is capable of performing NAND operations on 16-bit binary numbers.
- “Nor” is a 16-bit component in the ALU that is capable of performing NOR operations on 16-bit binary numbers.
- “Not” is a 16-bit component in the ALU that is capable of performing NOT operations on 16-bit binary numbers.
- “Or” is a 16-bit component in the ALU that is capable of performing OR operations on 16-bit binary numbers.
- “Xnor” is a 16-bit component in the ALU that is capable of performing XNOR operations on 16-bit binary numbers.
- “Xor” is a 16-bit component in the ALU that is capable of performing XOR operations on 16-bit binary numbers.
- “Accumulator” is a memory register that is identified by a flip-flop with a multi-bit input and multi-bit output bus. It plays an important role in the execution of the instructions by storing an input or output operand.

2.4 The Top-Level Circuit Diagram

Note to grader: zoom in to see the image below in more detail. It will refine the image!



2.5 State Machine



State Table

Current State	Trigger	Next State
Unknown	Reset, Preset	Ready
Ready	Reset, Preset, No-op	Ready
Ready	Add, Sub, Div, Mod	Math
Ready	And, Nor, Xnor, Nand, Not, Or, Xor	Logic
Logic, Math	Done	Ready
Math	OFErr, Div0Err, Mod0Err	Error
Math	No-op	Math
Logic	No-op	Logic
Error	Reset, Preset	Ready
Error	Anything but Reset, Preset	Error

* If it receives a trigger other than those that take it out of its current state, it remains in its current state.