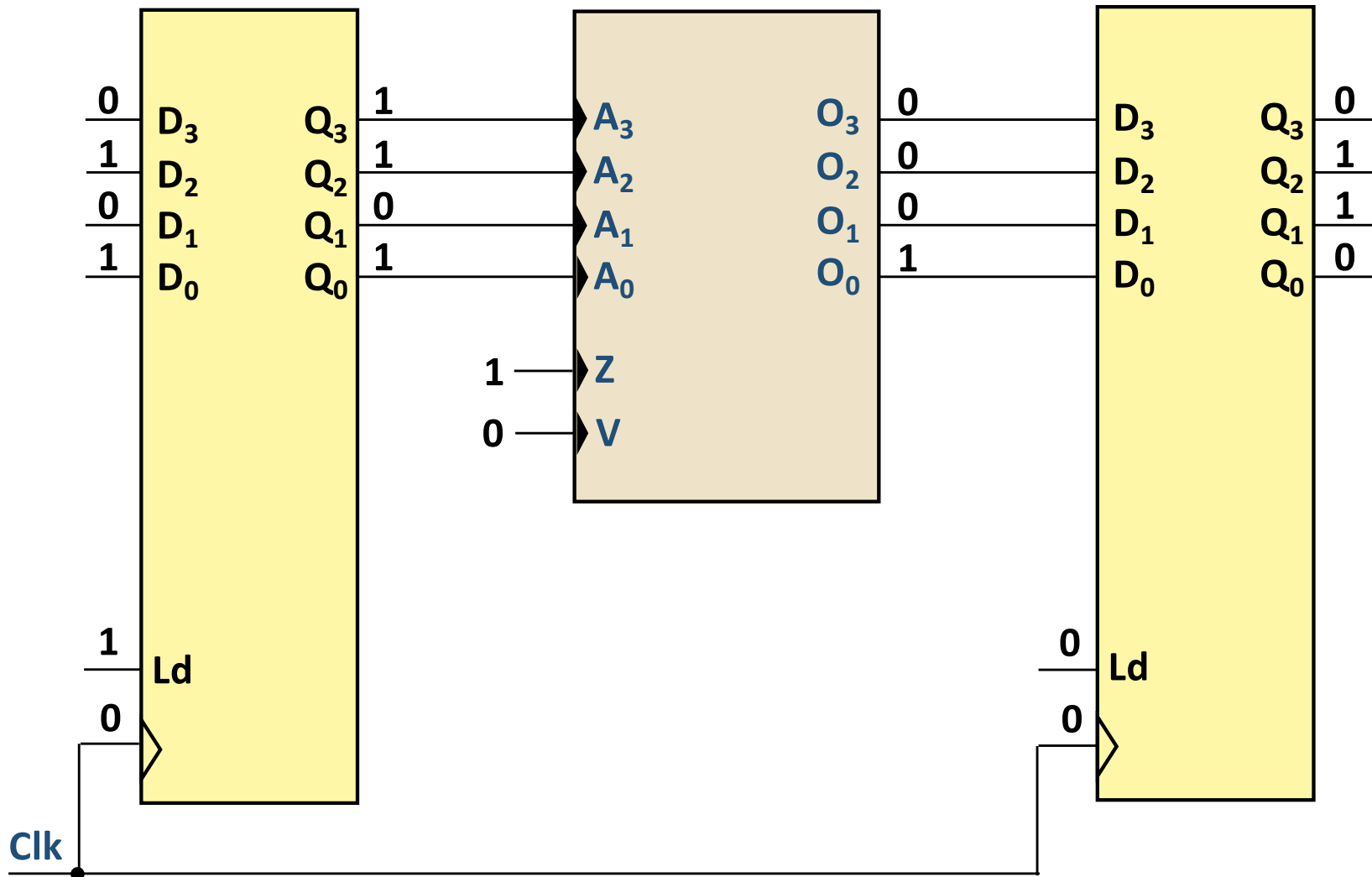
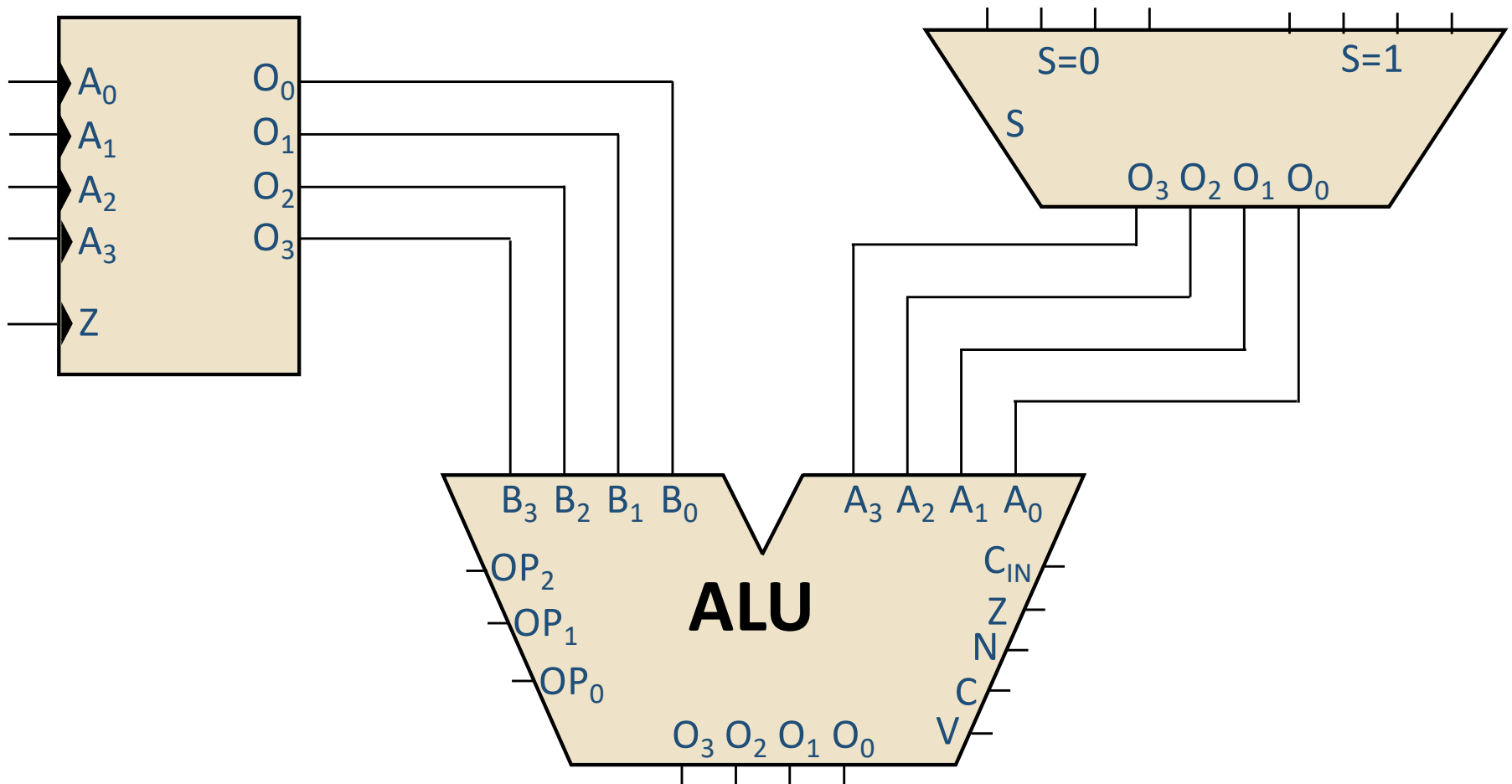


Digital Circuits Fundamental



Logic Boxes

(Combinational Logic Circuits)

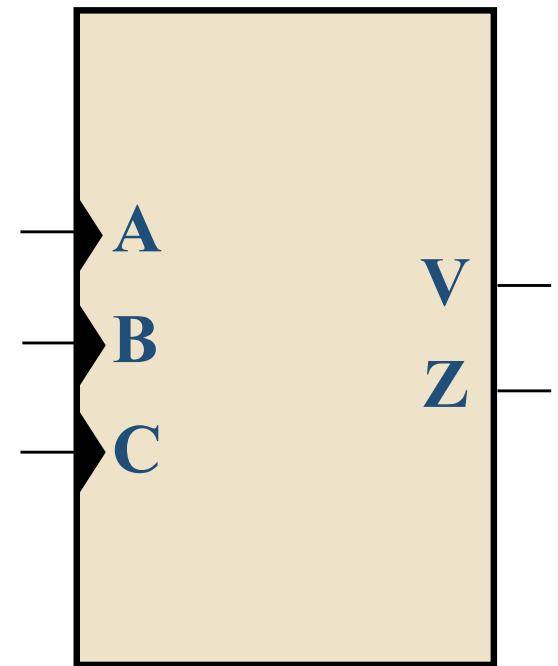


On this Lesson

- Characteristics of logic boxes
- Graphical representation of logic boxes
- Truth tables
- Output time delays
- Basic operation of Arithmetic Logic Units (ALU)
- Basic operation of multiplexers

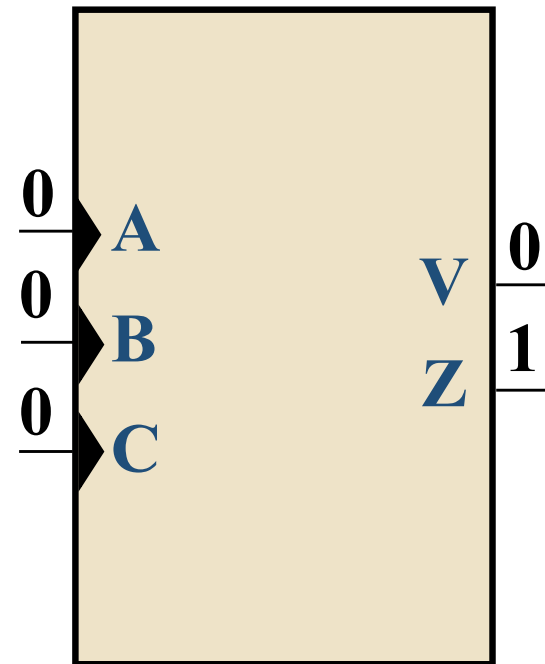
Logic Boxes: Combinational Logic Circuits

- Have binary input and output signals
 - *Inputs*
 - logic 0 or 1
 - independent of outputs
 - *Outputs*
 - logic 0 or 1
 - boolean functions of some or all the inputs
- A change on an input signal may cause a change on output signals
- Output changes take place a time delay after a change in an input signal
- Do not store information (An external source must maintain the values of the inputs for the outputs to maintain their values.)

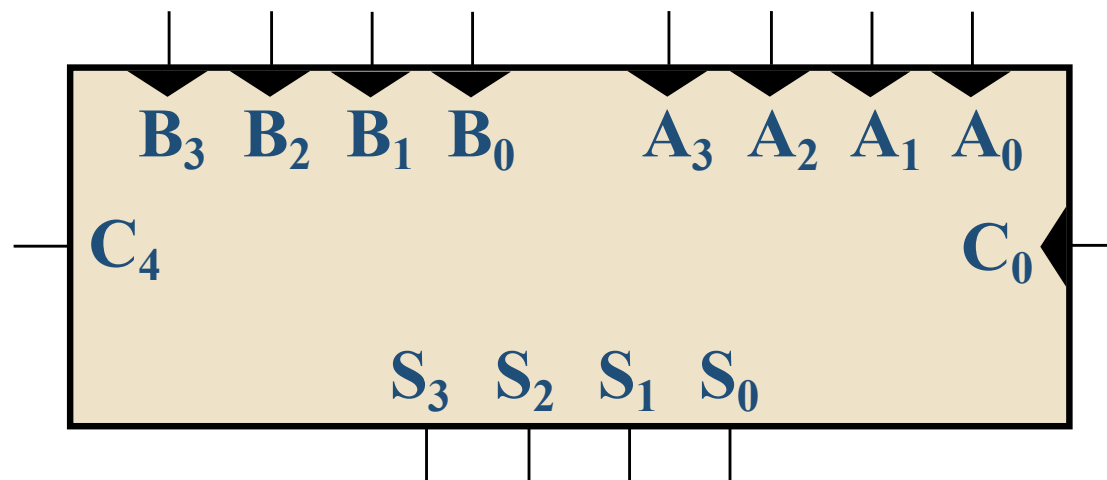


Truth Tables

A	B	C	V	Z
0	0	0	0	1
0	0	1	1	1
0	1	0	1	0
0	1	1	1	0
1	0	0	0	1
1	0	1	1	1
1	1	0	0	0
1	1	1	0	1



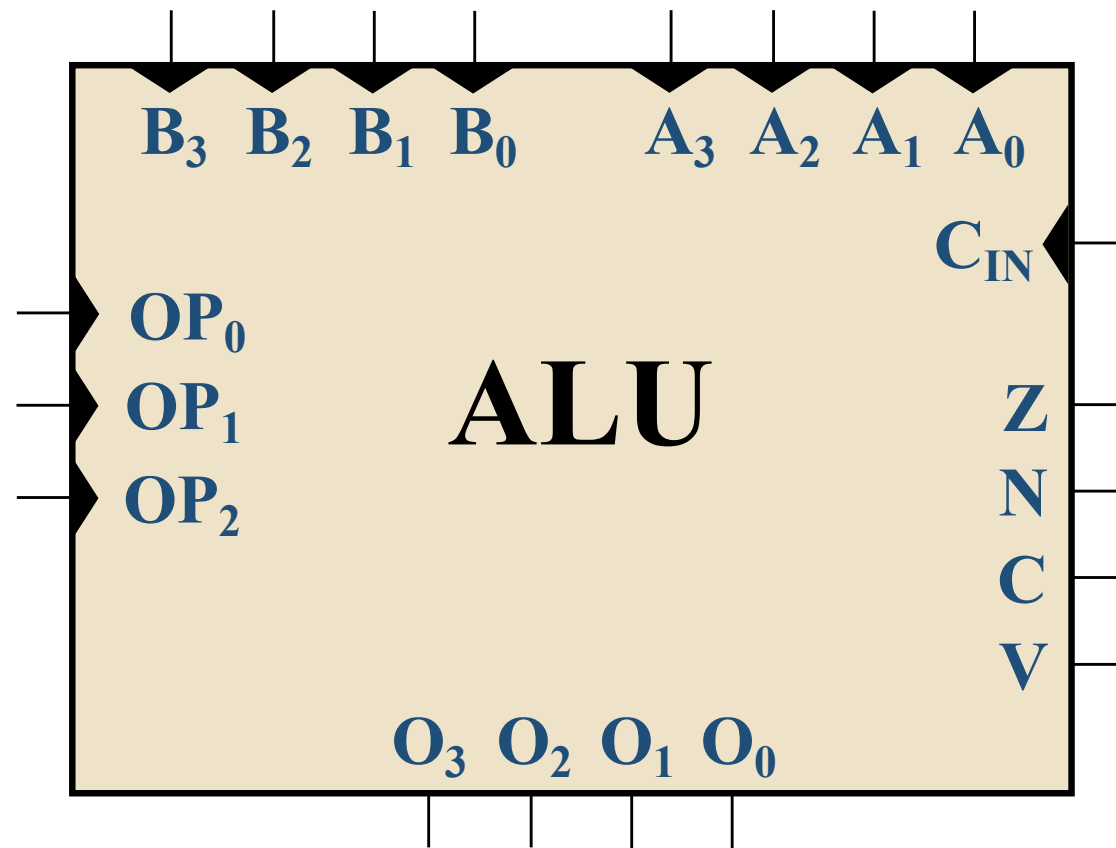
4-bit Adder



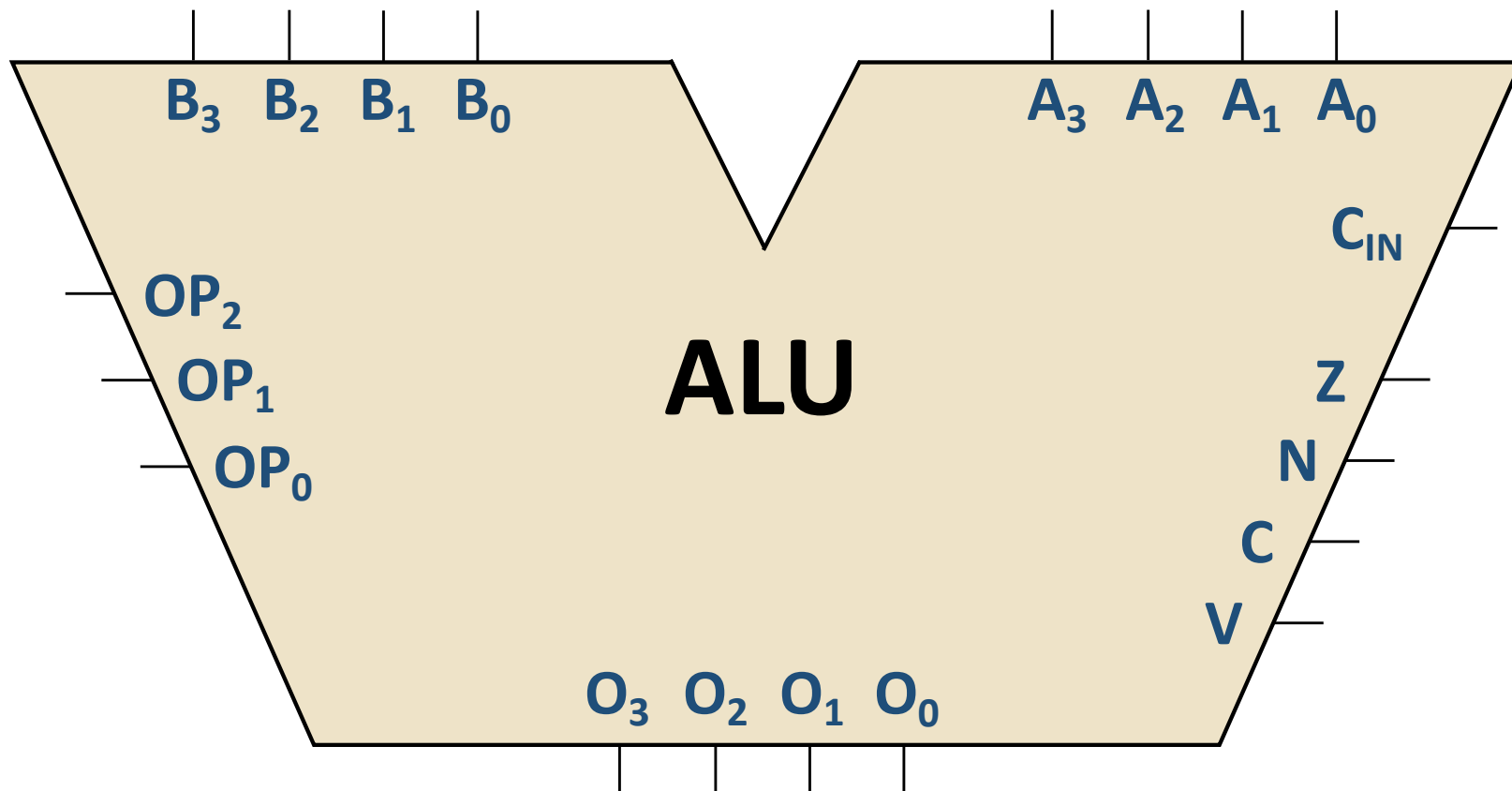
$$\mathbf{A + B + C_0 = C_4|S}$$

Arithmetic Logic Unit (ALU)

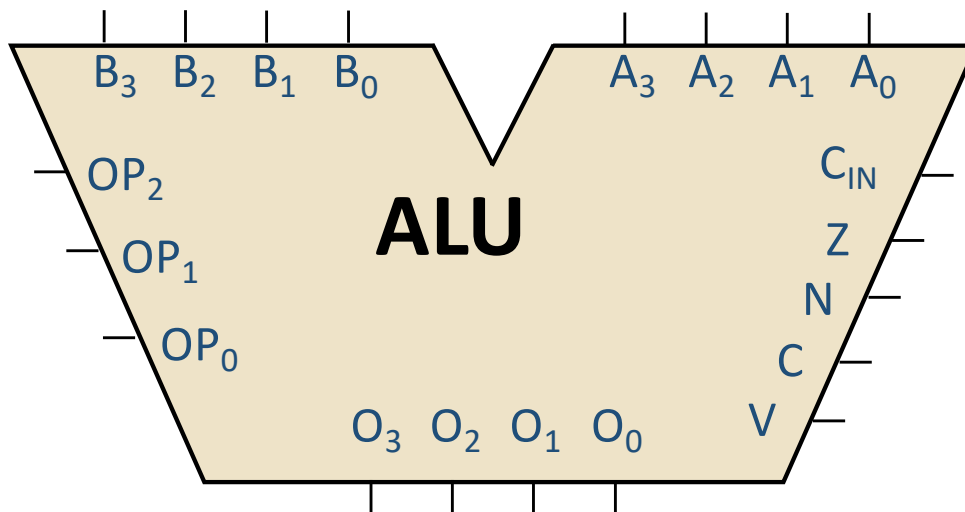
i



Block Diagram View of ALU

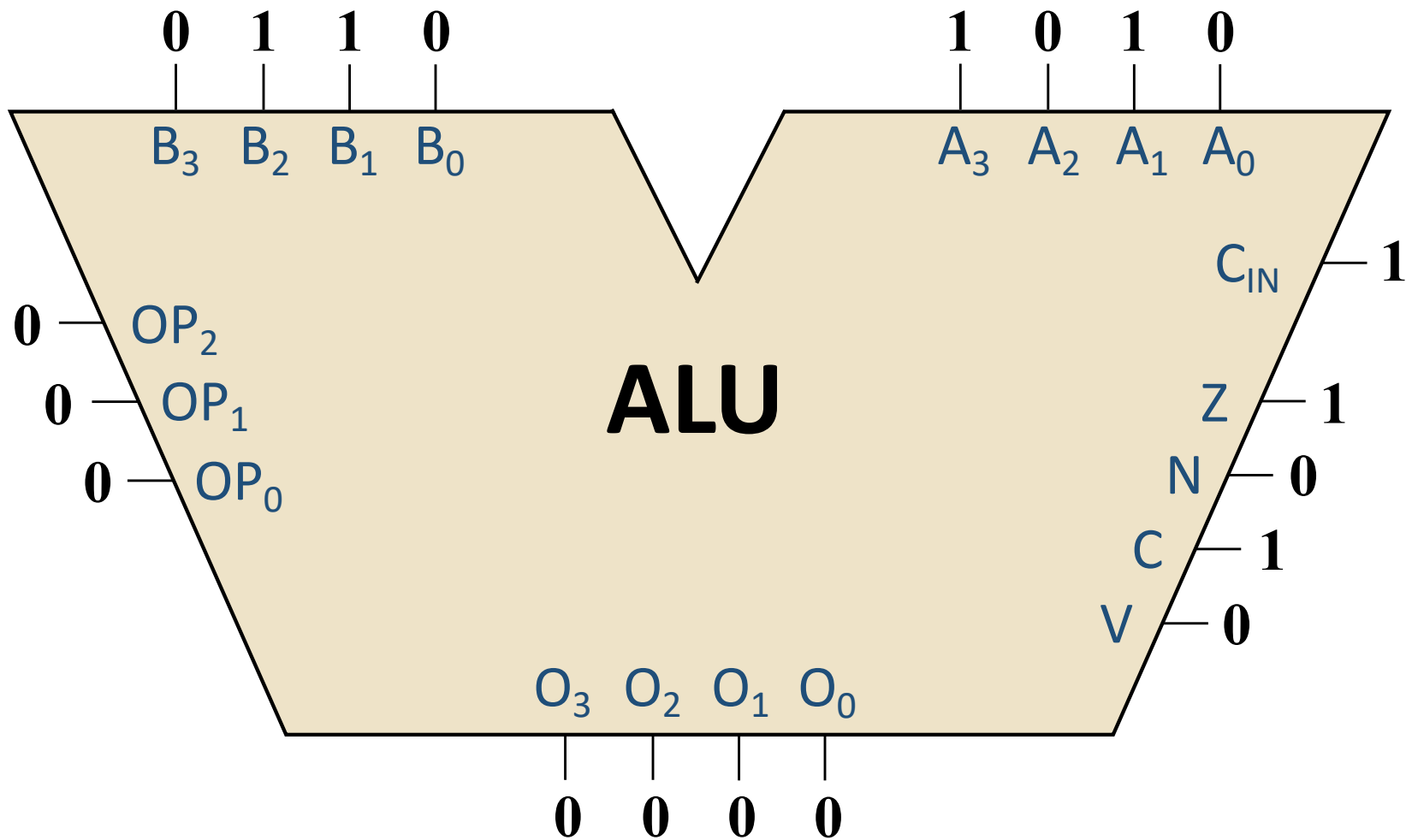


Arithmetic Logic Unit (ALU)

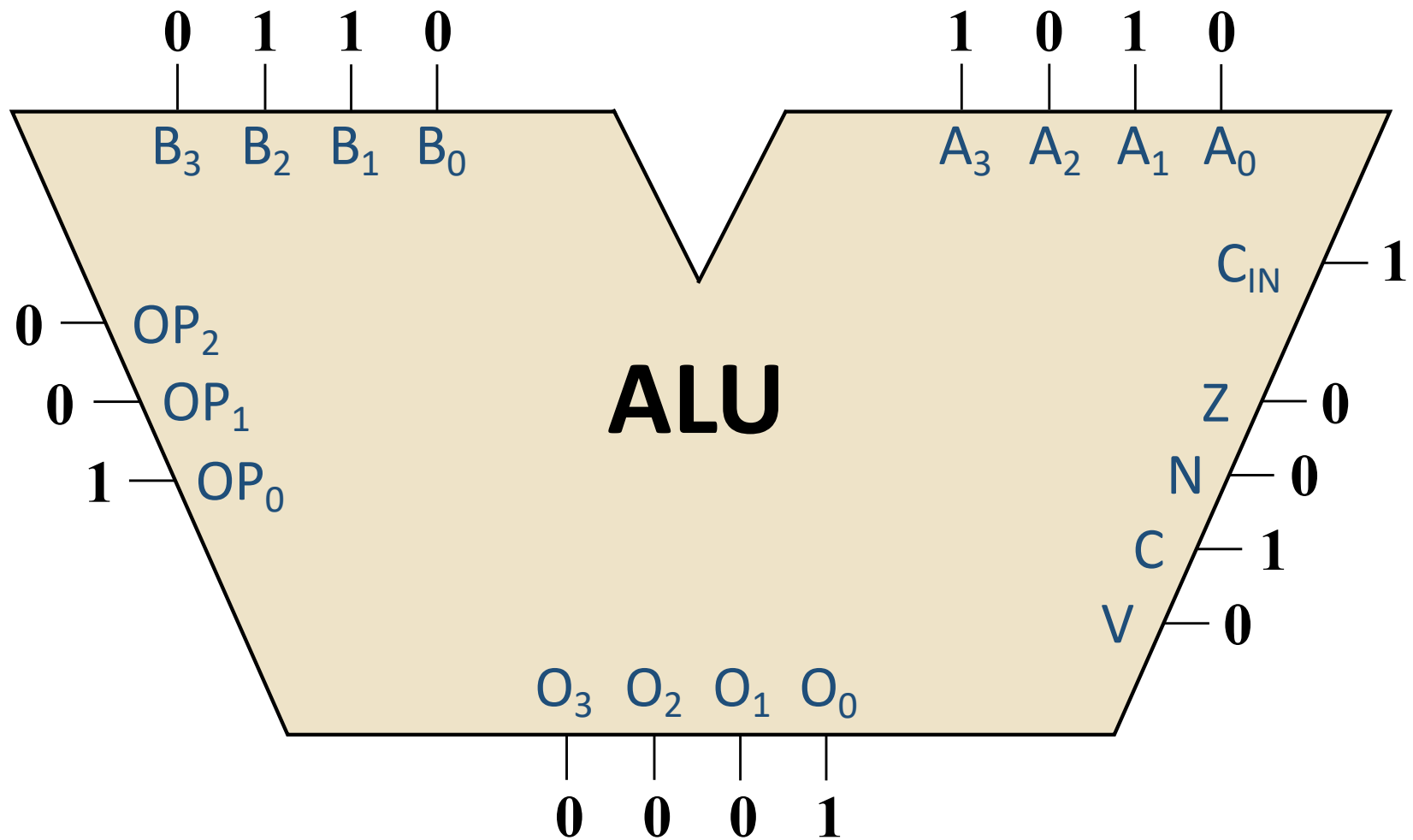


OP_2	OP_1	OP_0	Operation
0	0	0	$A + B$
0	0	1	$A + B + C_{IN}$
0	1	0	$A - B$
0	1	1	A and B
1	0	0	A or B
1	0	1	A
1	1	0	LSR A
1	1	1	LSL A

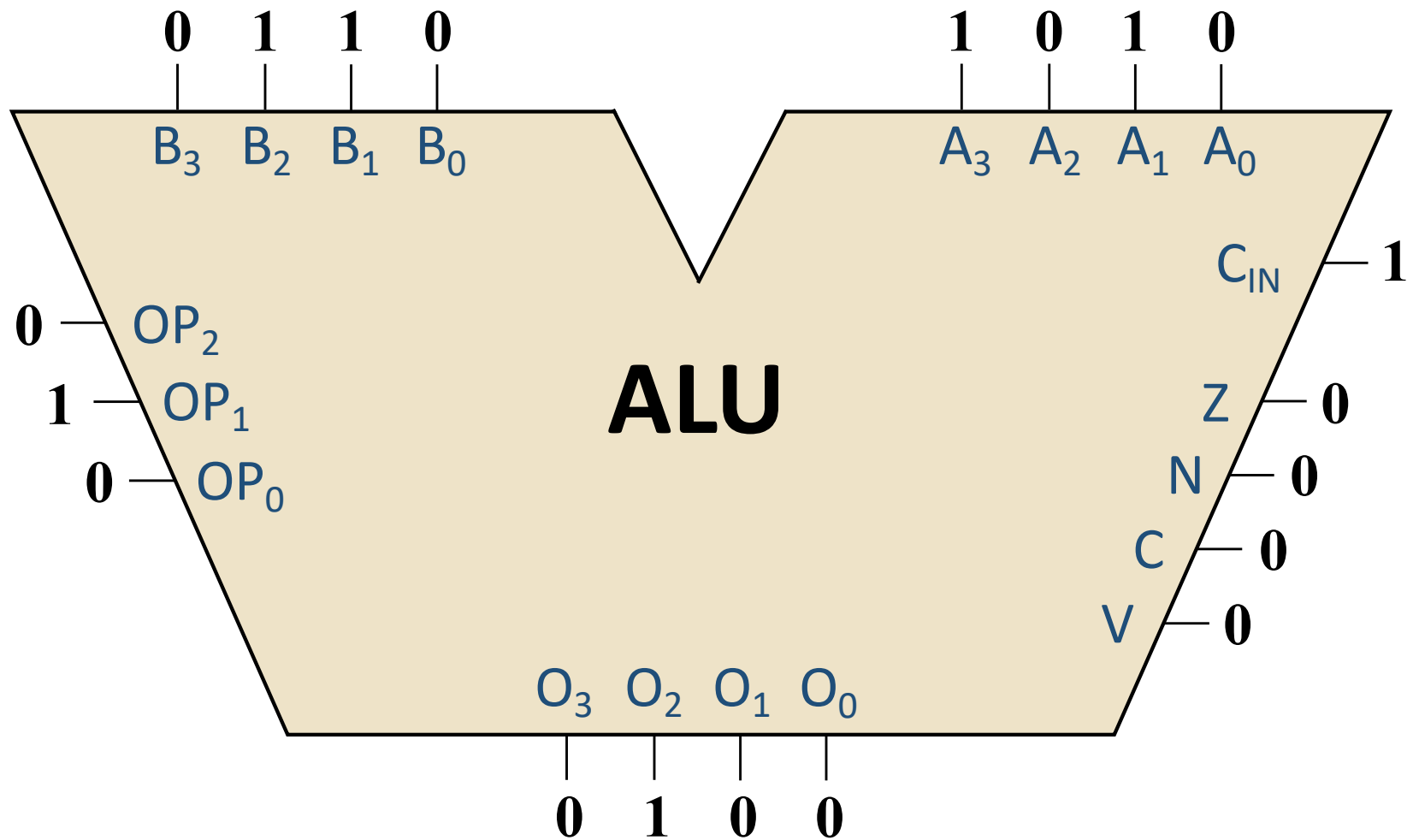
A + B



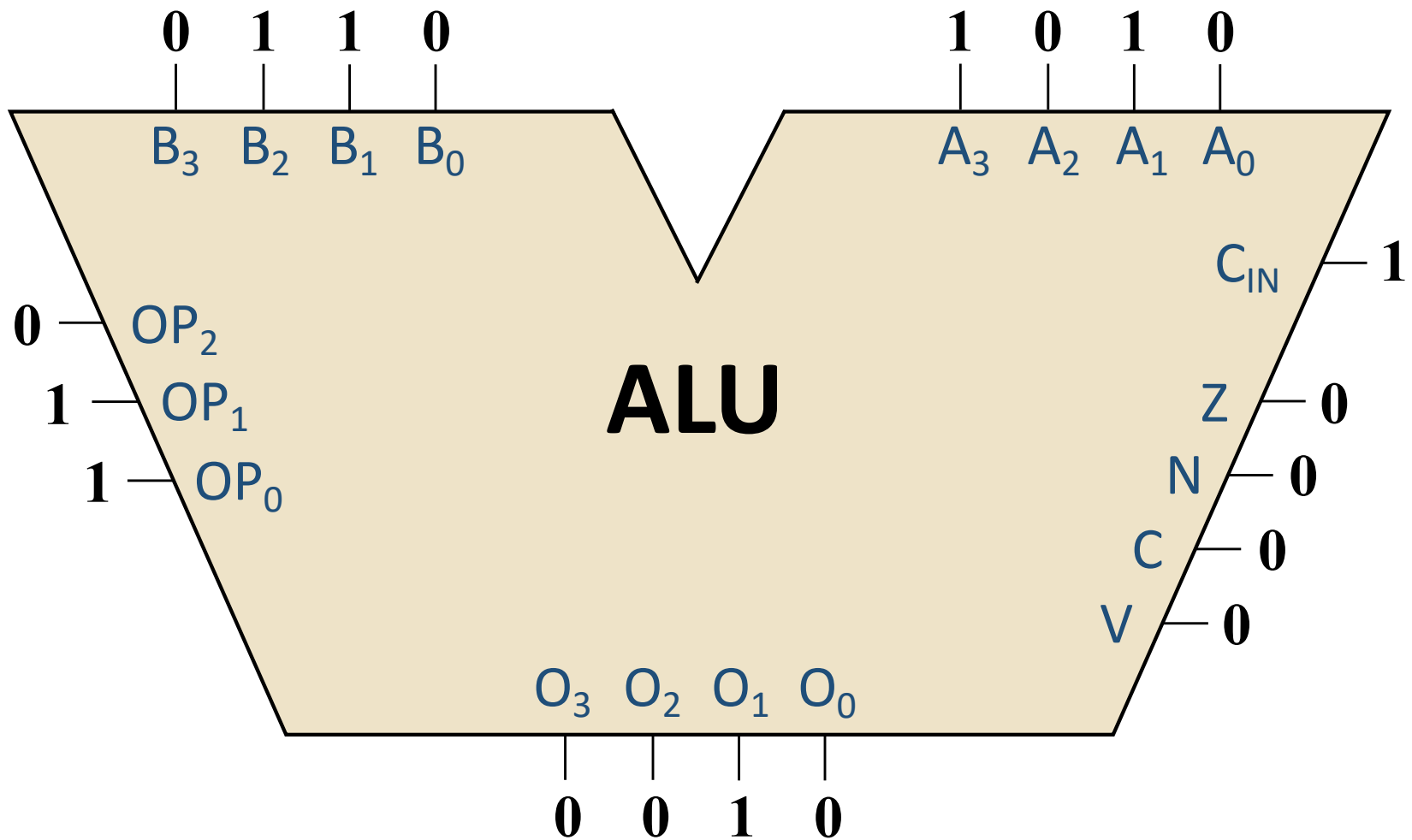
$$A + B + C_{IN}$$



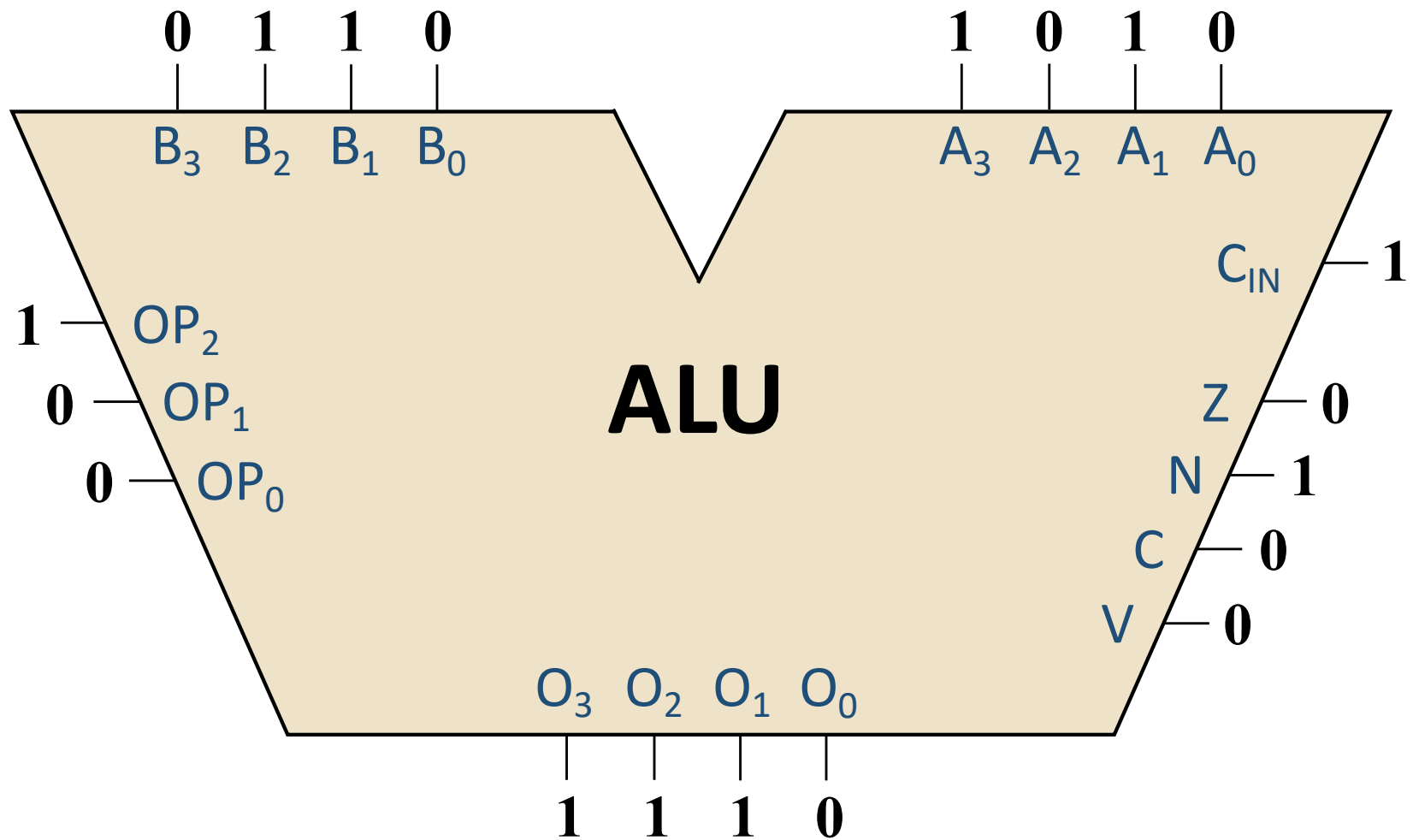
A - B



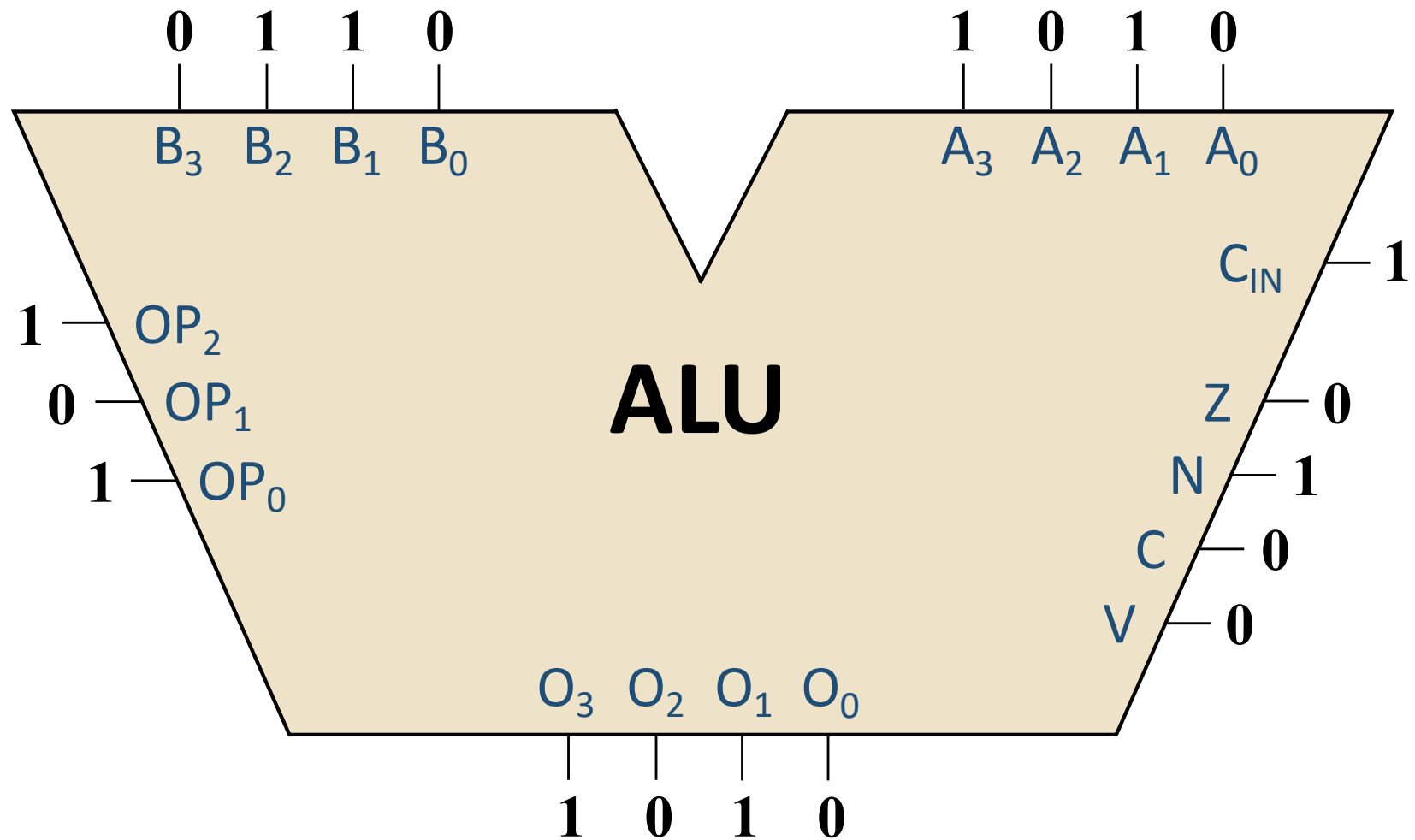
A and B



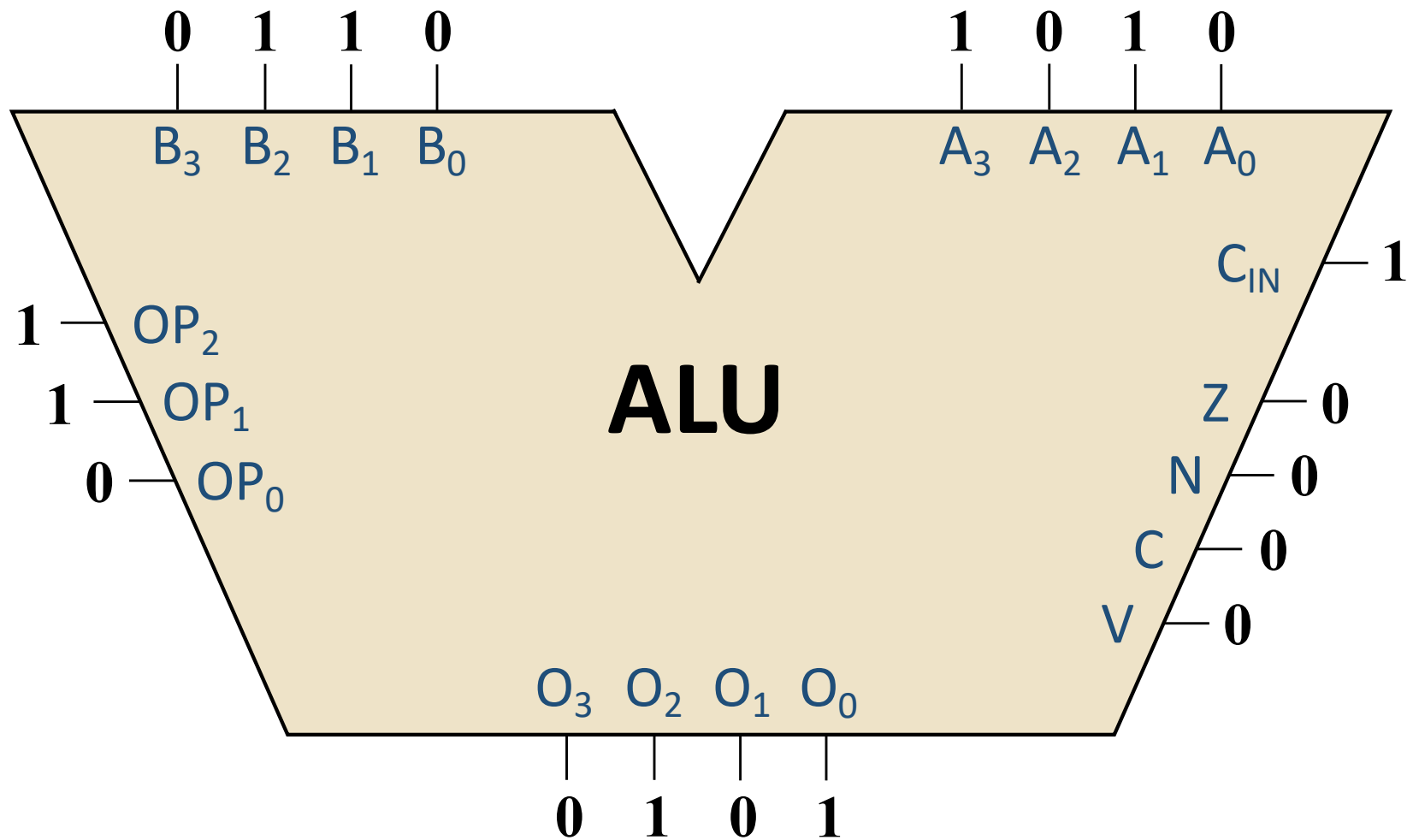
A or B



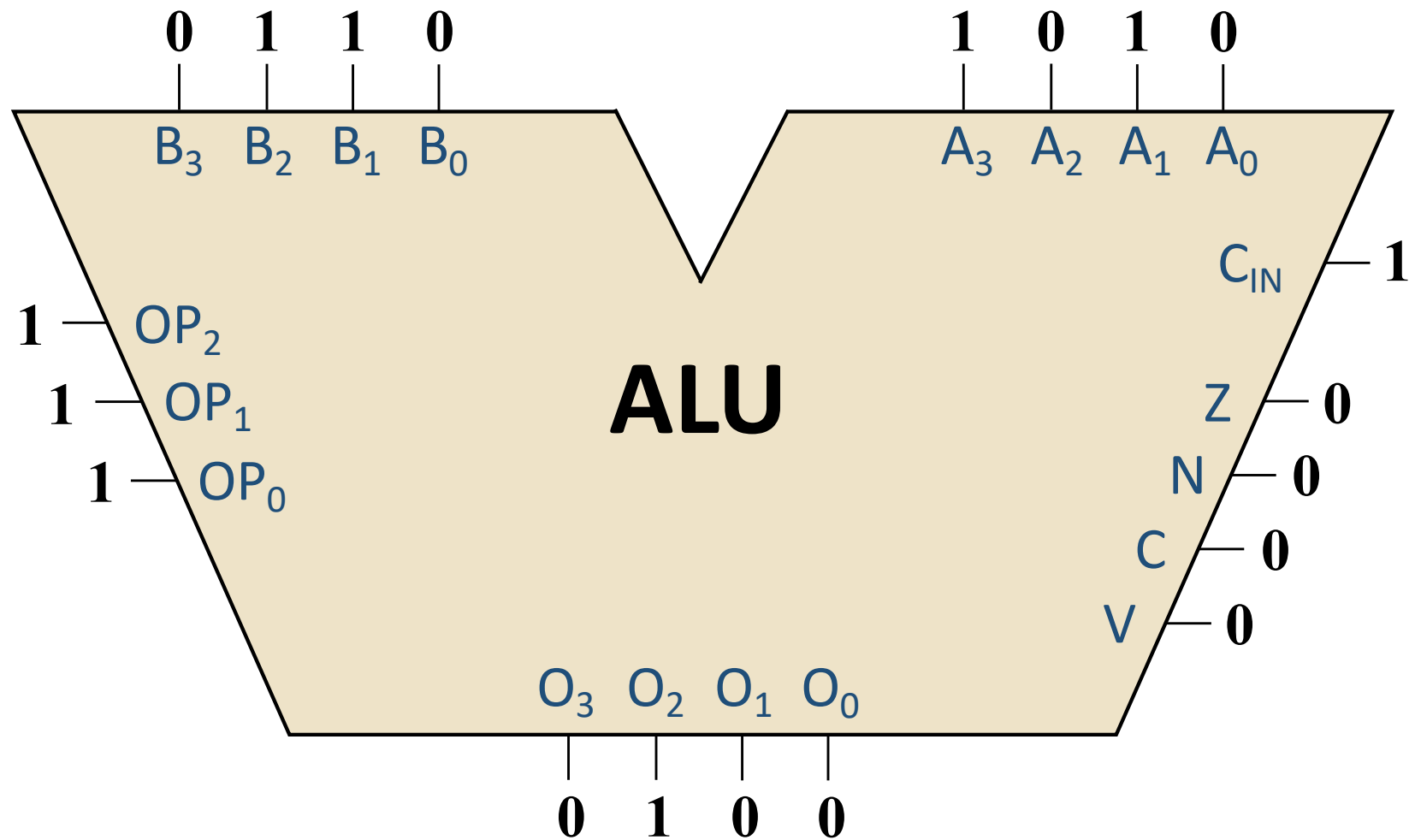
A



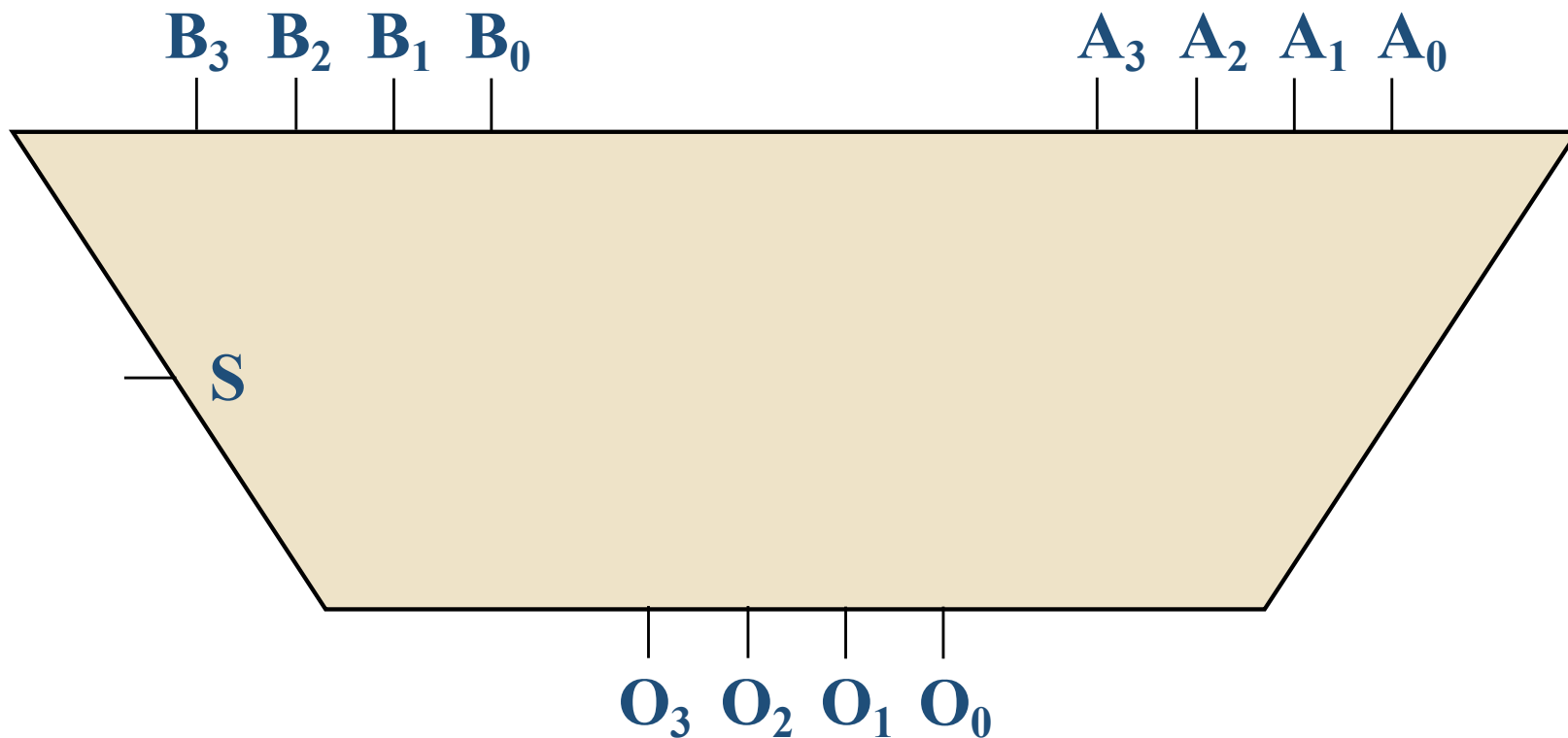
LSR A



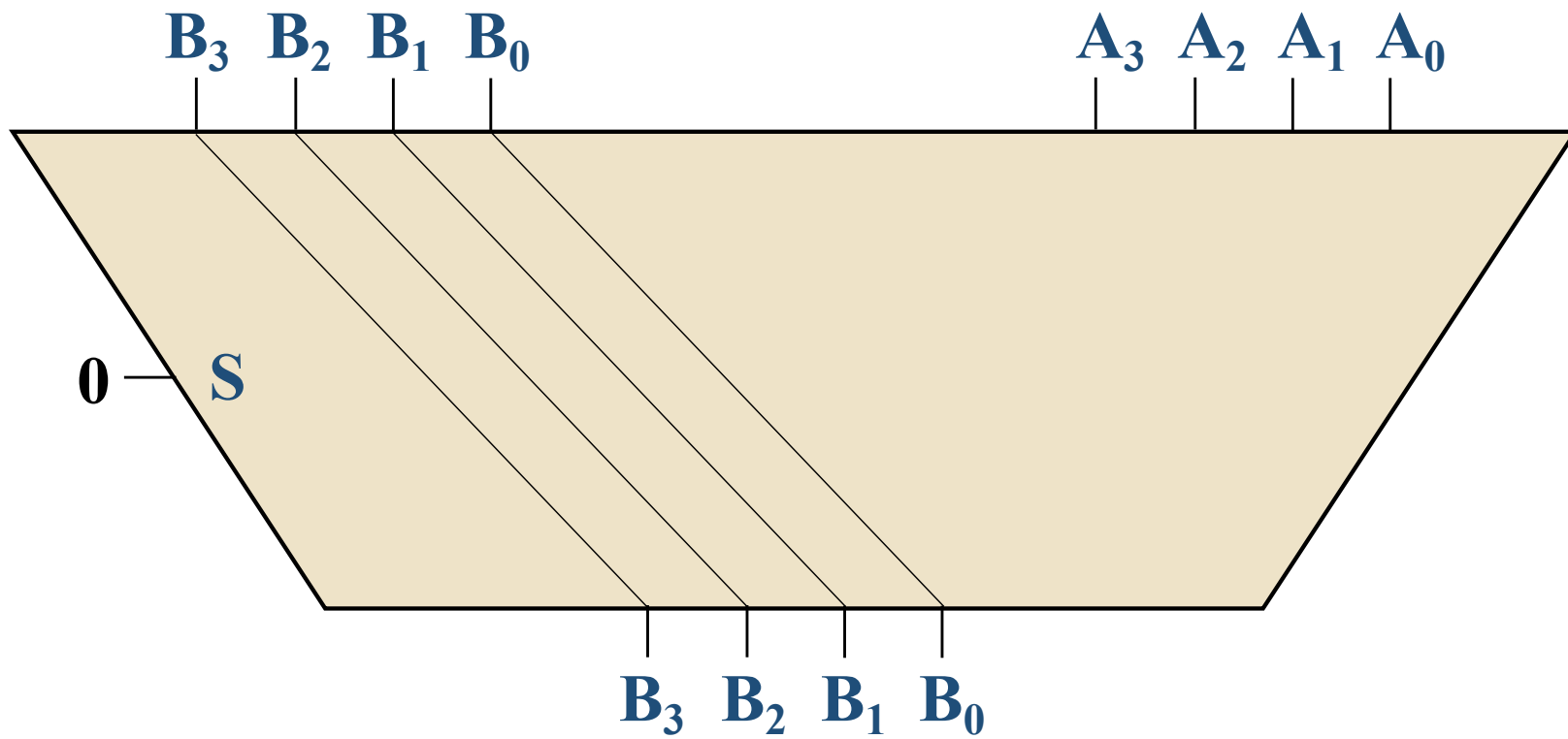
LSL A



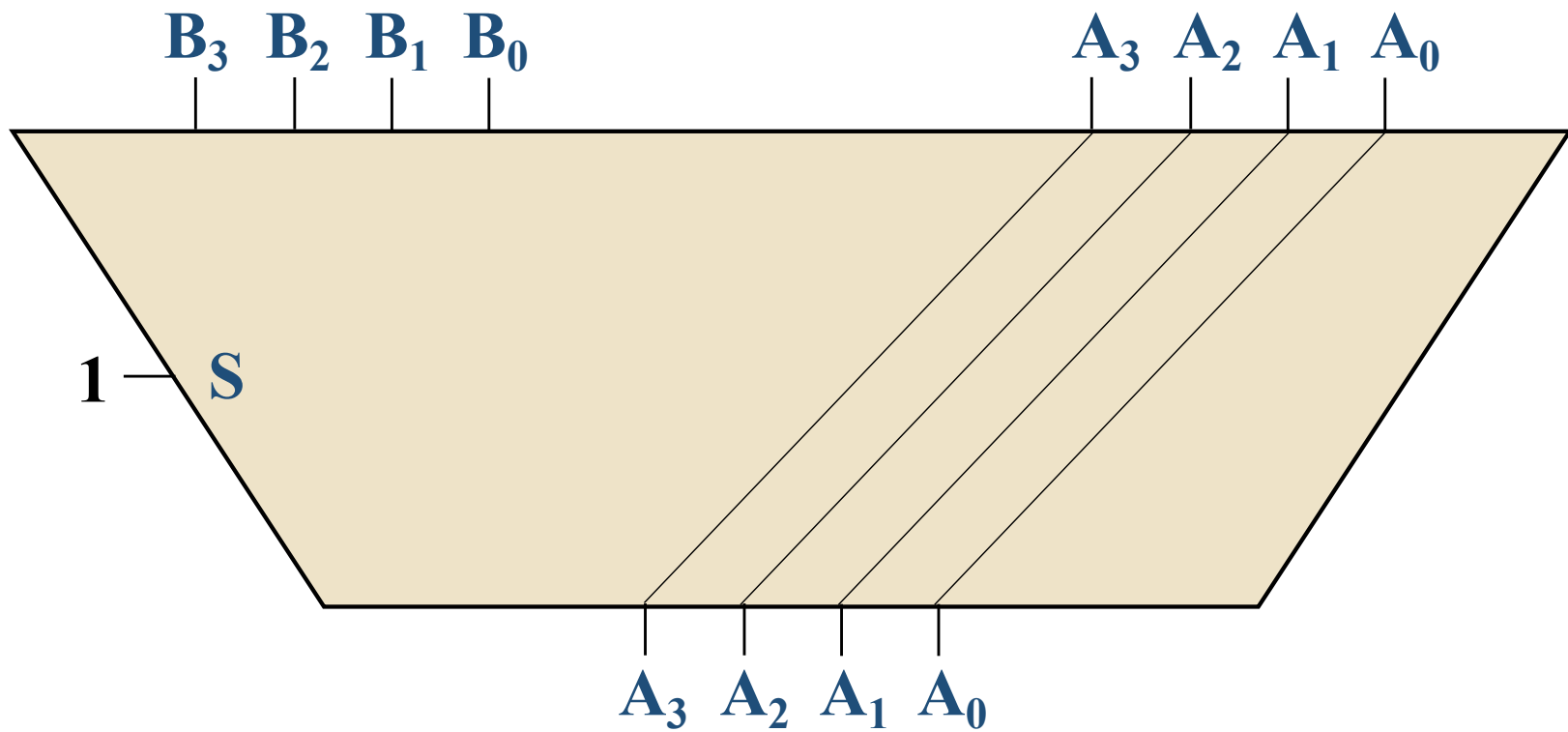
Two-Input Data Selector (Multiplexer)



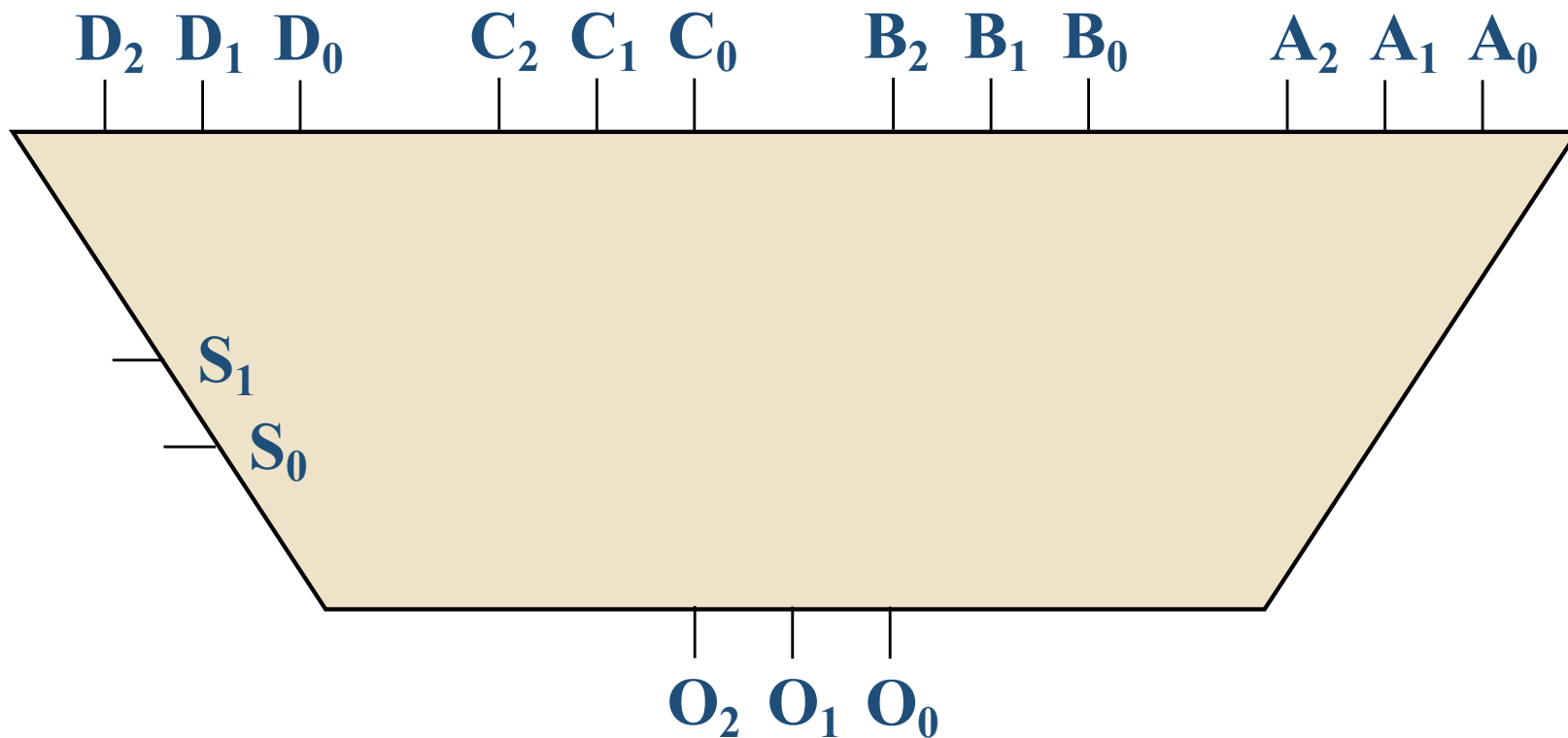
$$S = 0$$



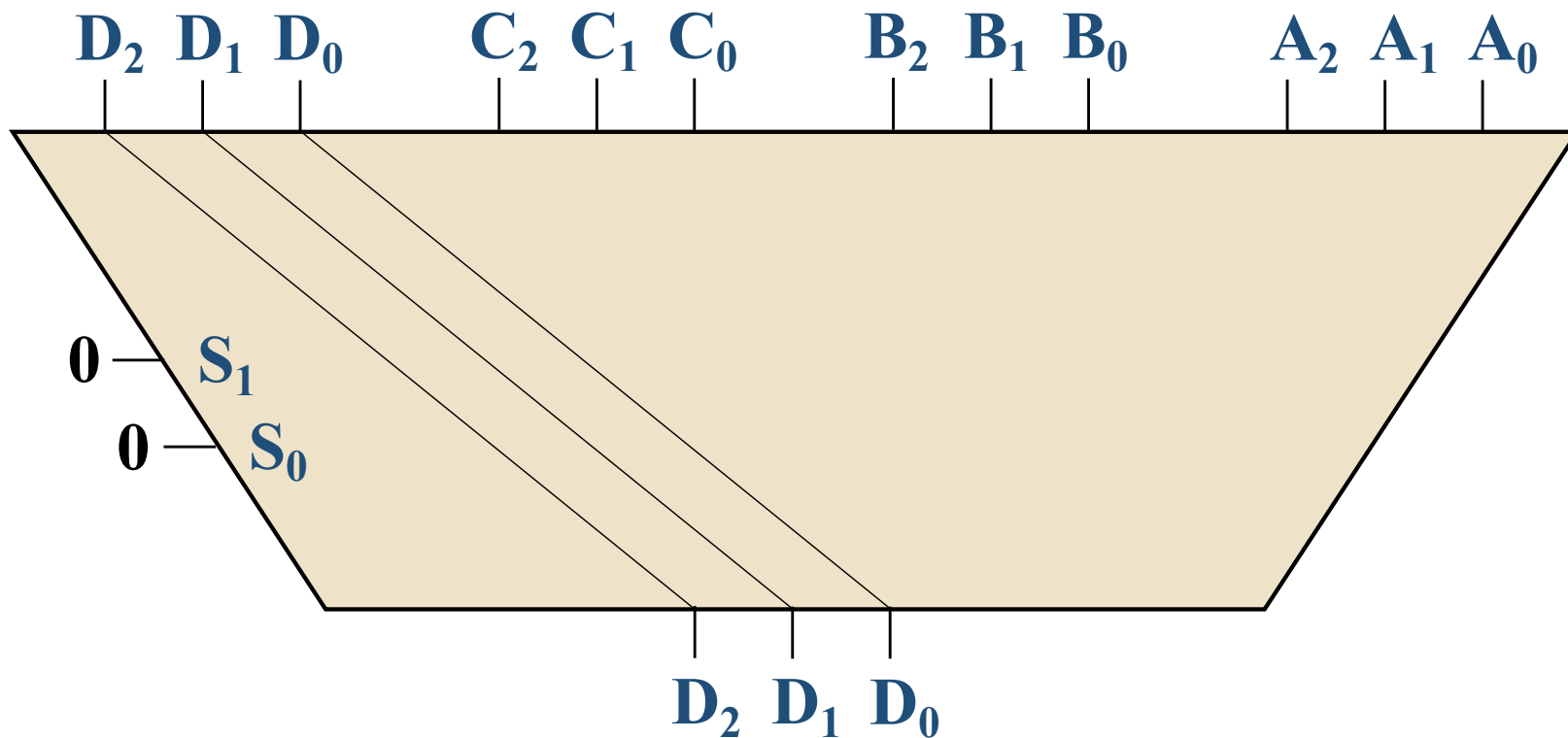
$$S = 1$$



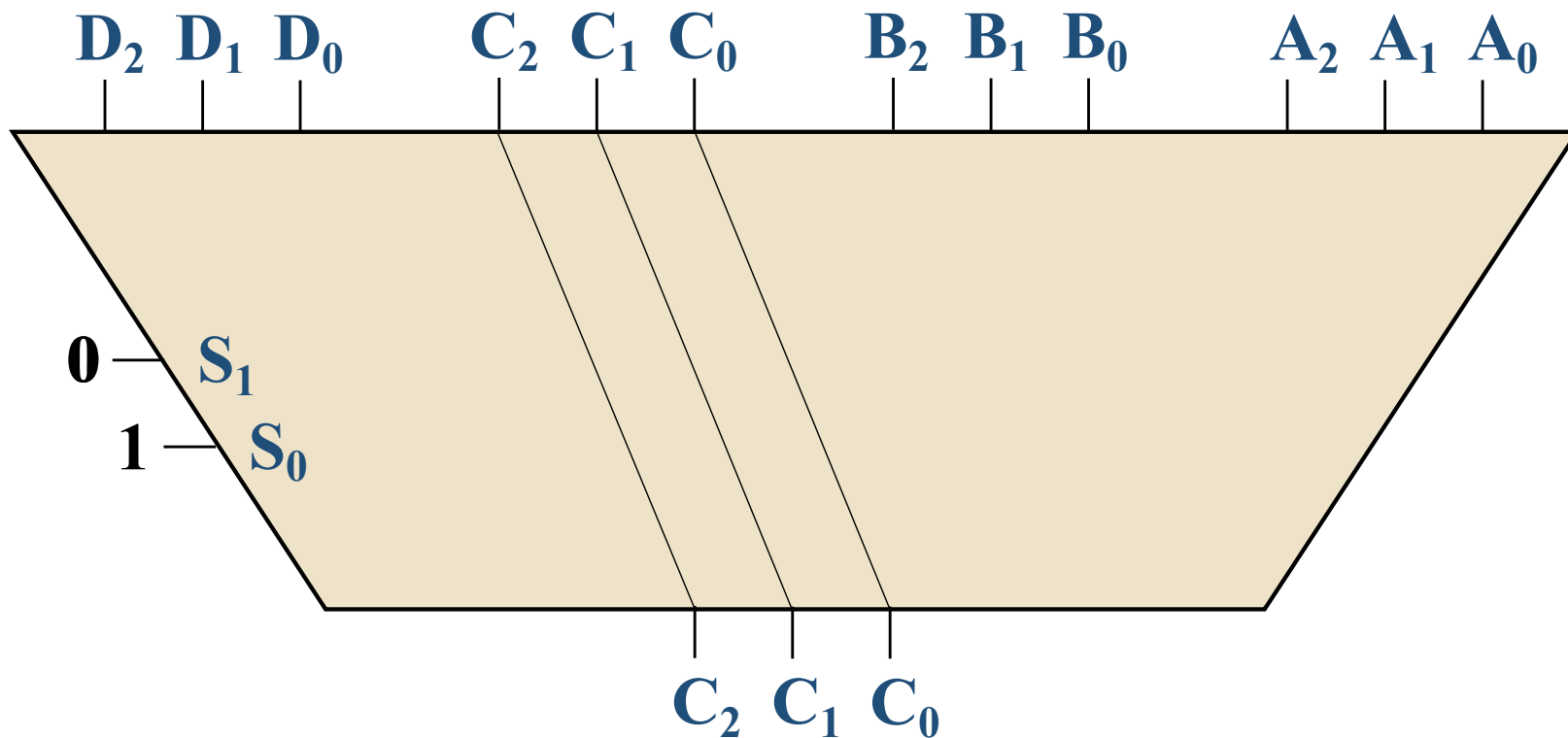
Four-input Multiplexer



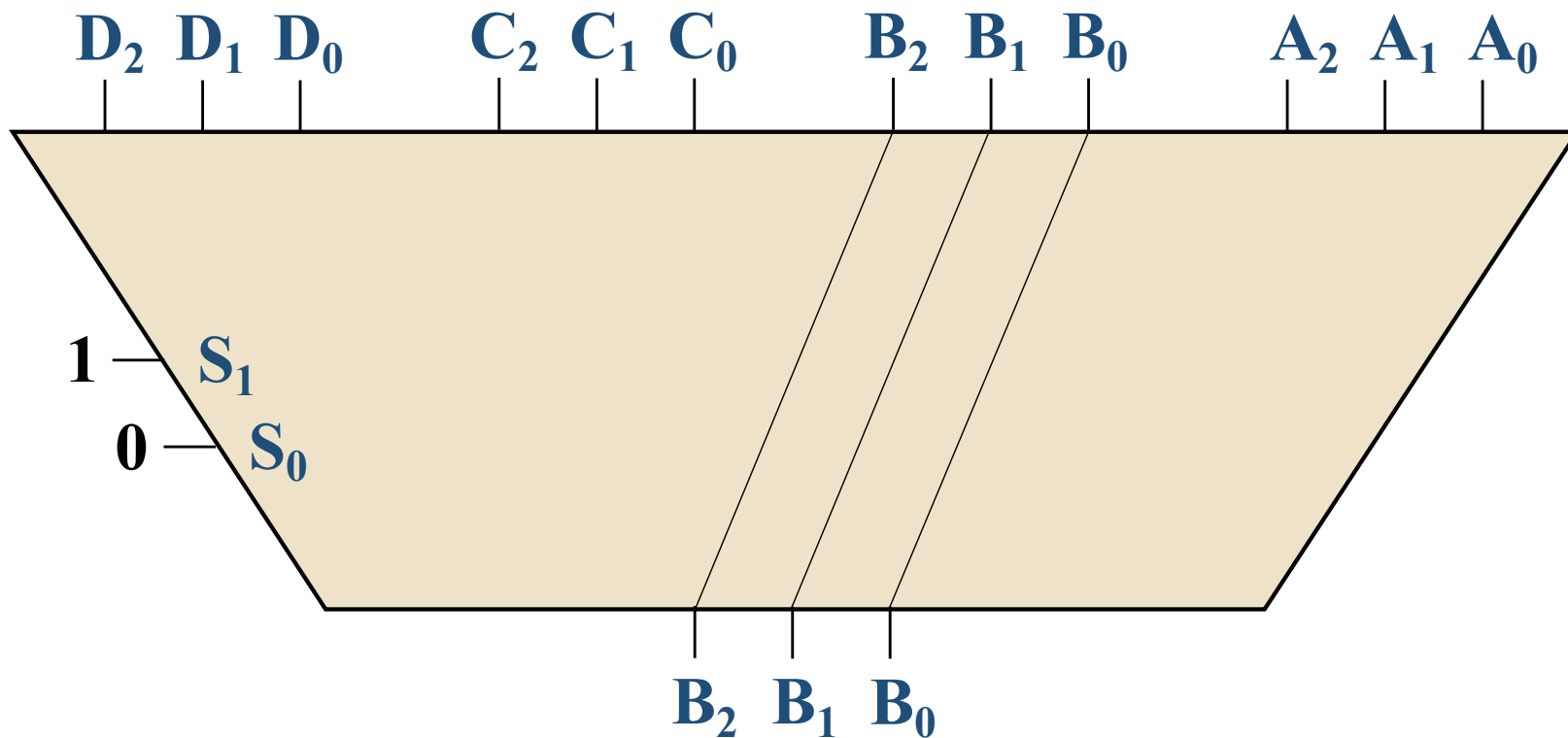
Four-input Multiplexer



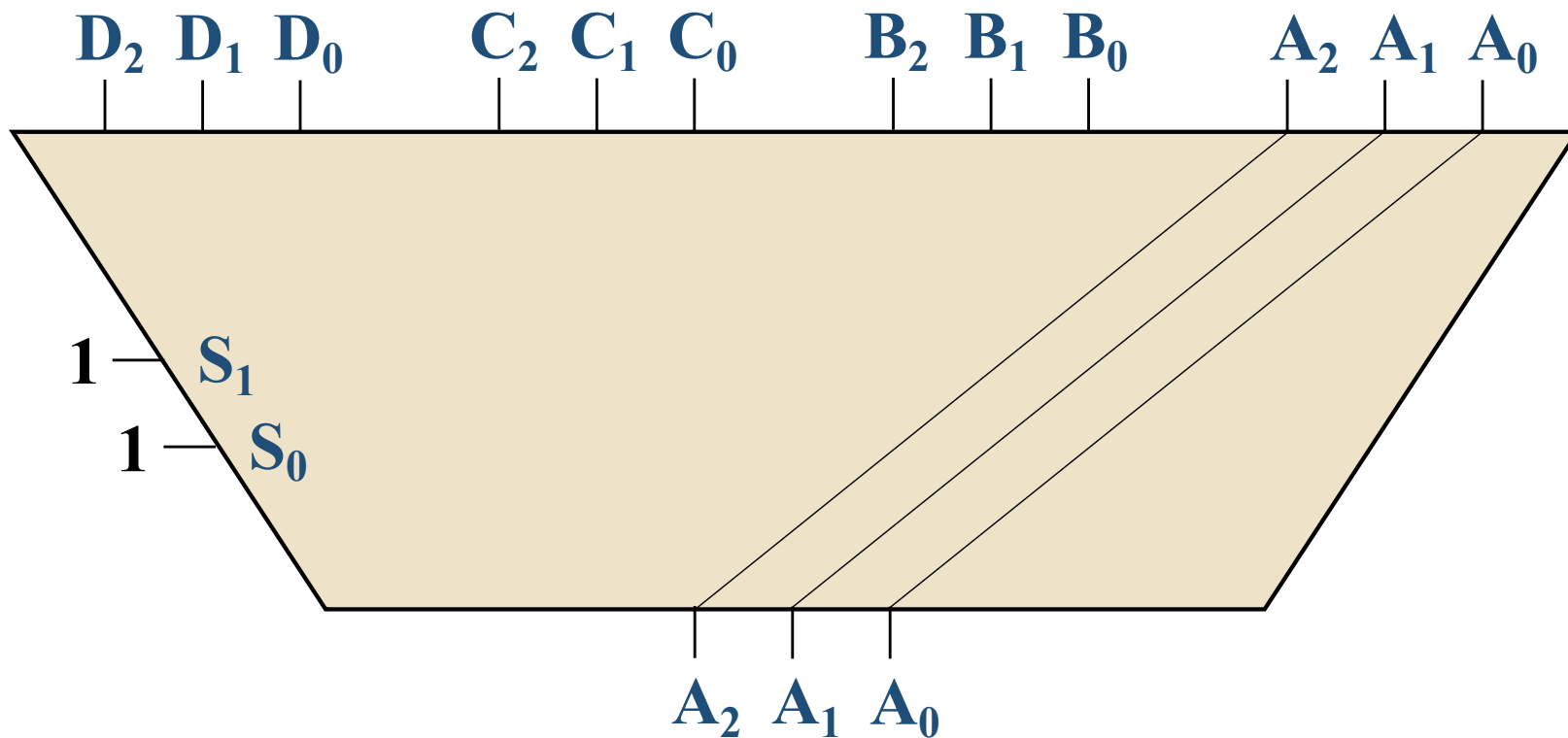
Four-input Multiplexer



Four-input Multiplexer



Four-input Multiplexer



n -to- 2^n Binary Decoder

Binary Decoder	
D ₃	O ₀
D ₂	O ₁
D ₁	O ₂
D ₀	O ₃
E	O ₄
	O ₅
	O ₆
	O ₇
	O ₈
	O ₉
	O ₁₀
	O ₁₁
	O ₁₂
	O ₁₃
	O ₁₄
	O ₁₅

[illegible]

Lesson Outcomes

- Know the basic operation of combinational logic circuits.
- Understand boolean functions through truth tables.
- Understand the effect of time delays of logic boxes.
- Understand the basic operation of ALUs, multiplexers and binary decoders.