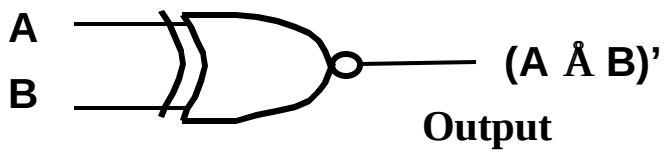
Combinational Comparators

- **Comparing two binary inputs A, B each n bits for equality (i.e A = B) is a common operation in computers.**
- **A single output combinational circuit to accomplish this can be constructed using n 2-input XNOR gates for bit-wise comparison plus one n-input AND gate. The output = 1 if A = B**
- **This can also be done by subtraction (A - B) and checking for a zero result using a single n-input NOR gate.**
- **Example: 1-bit comparator: A, B 1-bit each.**
  - **The 1-bit comparison requires a single XNOR gate**

Truth table:

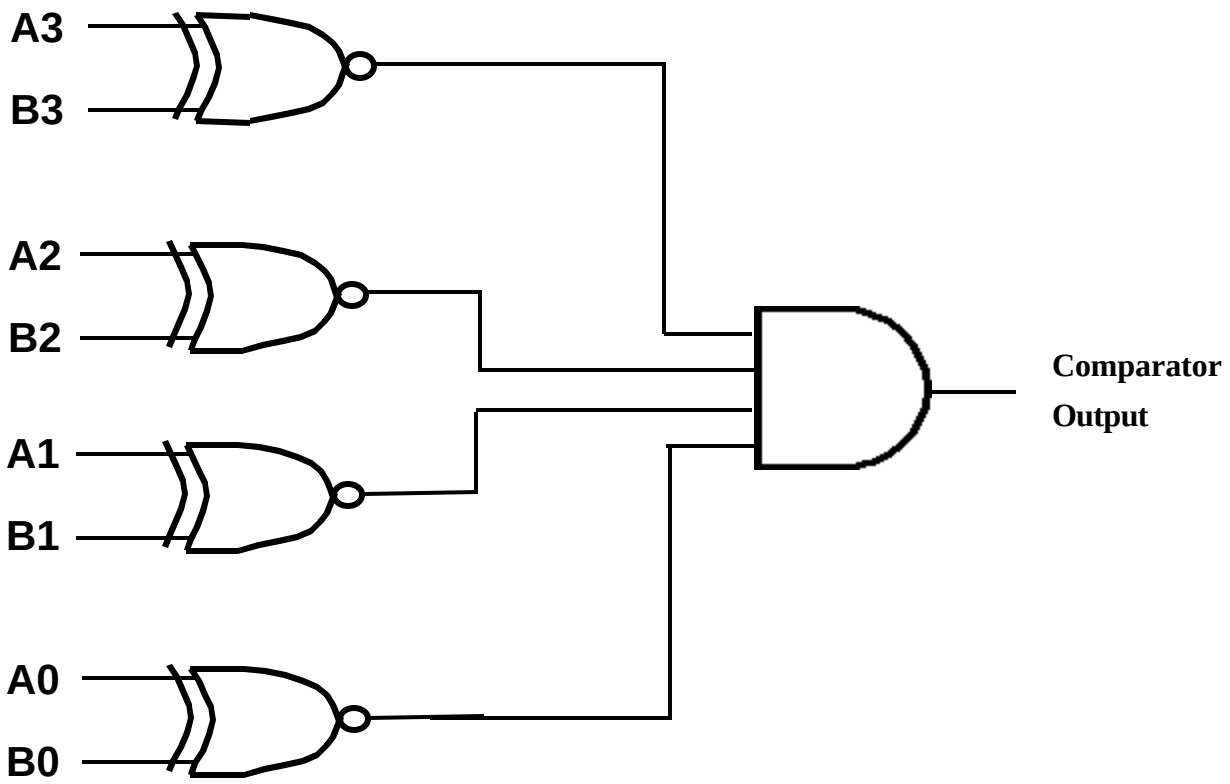
A	B	Output $(A \oplus B)'$
0	0	1
0	1	0
1	0	0
1	1	1



1-bit comparator

Example: 4-bit Comparator

Compares A = A3 A2 A1 A0 with B = B3 B2 B1 B0
Output = 1 if A = B

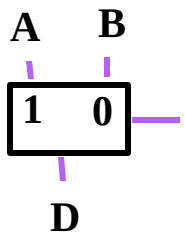


Combinational Shift Circuits

- An n-bit shift circuit (shifter) has a single n-bit data input A, and a single n-bit output R and a number of control inputs to determine the shift amount (0 to n-1).
- Possible shift operations include:
  - Shift left or right:
    - Arithmetic right shift (the sign bit is shifted in),
    - logic shift (0 is shifted in)
    - Rotate left or right.
- Example: Original data input A = 11011
    - Shift left by one : 10110
    - Logic shift right by one: 01101
    - Arithmetic shift right by one: 11101
    - Rotate left by one: 10111
- Combinational shift circuits are usually constructed using a number of levels of multiplexeres.

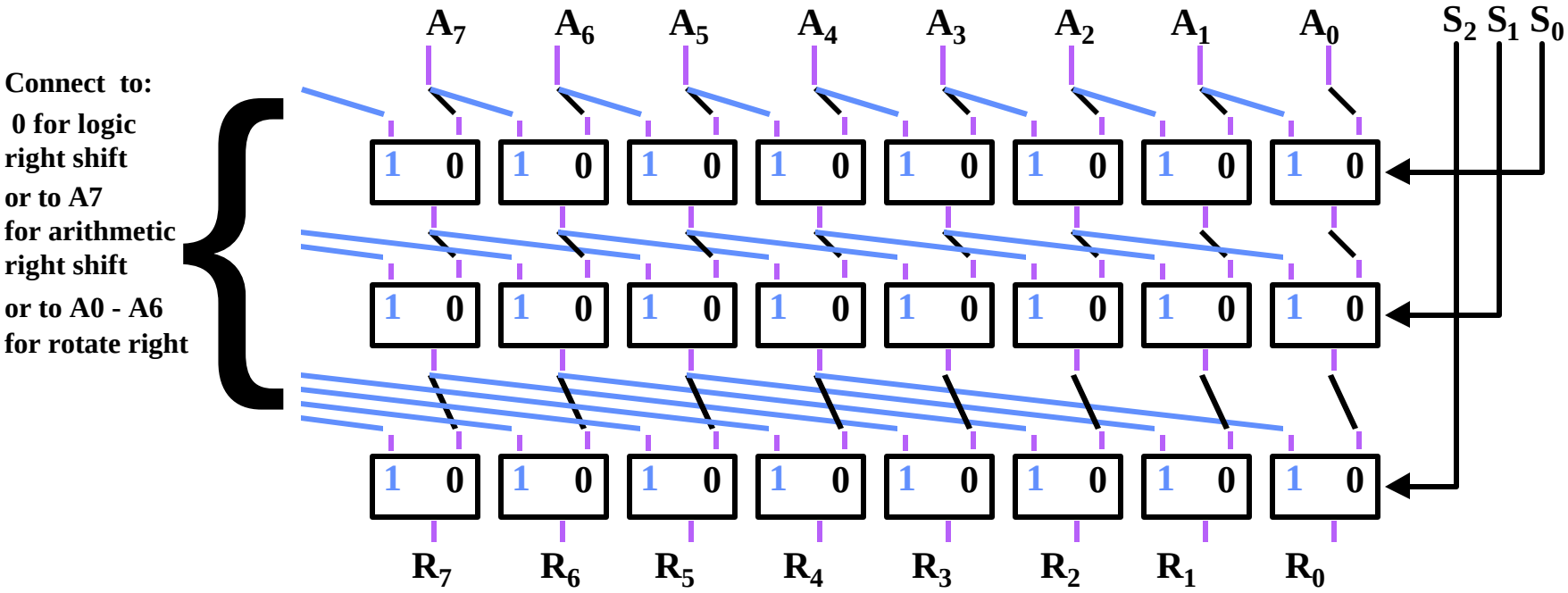
Example: Combinational 8-Bit Right Shifter

Basic Building Block 2-to-1 Mux



Three levels of Muxes used

S_2 S_1 S_0
shift amount from 0 to 7



- **Propagation delay: 2 gate delays per level x 3 levels = 6 gate delays**
- **How many Mux levels for 32-bit shifter? Propagation delay?**