Review Problem 46

For a stereo, design a crossover box to deal with swapped speaker cables using only muxes.
Shift Register

Register that shifts the binary values in one or both directions.
Shift register can be used for serial transfer

- Serial: one bit transferred at a time
- Parallel: all bits transferred at the same time

2 modes of communication: Parallel vs. Serial

Transfer of Data
Shift Register w/Parallel Load

<table>
<thead>
<tr>
<th>Action</th>
<th>Shift Load</th>
<th>Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>old = 0</td>
<td>0</td>
<td>1</td>
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</tbody>
</table>

Legend:
- Clk: Clock
- Dff: D Flip-Flop
- P3, P2, P1: Parallel Load

Diagram shows a shift register with parallel load connections.
**Conversion between Parallel & Serial**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>00</th>
<th>01</th>
<th>02</th>
<th>03</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP - Sender</td>
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<tr>
<td>OP - Receiver</td>
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- **Parallel to Serial**: 00, 01, 02, 03
- **Serial to Parallel**: Manual conversion steps (diagram showing parallel inputs leading to serial output)
3-bit binary up-counter state diagram:

- **Binary value decreases by 1**
- **Down Counter**: Binary value decreases by 1
- **Up Counter**: Binary value increases by 1
- n-bit Binary Counter: counts from 0 to \(2^n - 1\) in binary

A reg. that goes through a specific state sequence

Counters