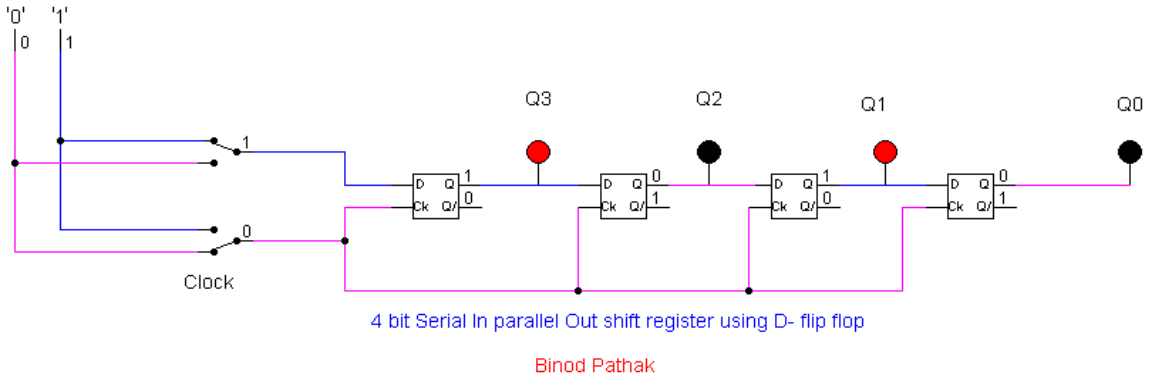
Fundamentals of Computing (4CS015) Workshop: Week 5
Binod Pathak
Group: L4CG5
Email Address: np03cs4a220028@heraldcollege.edu.np

1. Construct 4 bit Serial In parallel Out shift register using D- flip flop. Explain the Working mechanism of the circuit taking Serial input 1010. Also draw the timing diagram according to the given input.

**Answer:**




**Answer:**

| Clock | Input | Q3 | Q2 | Q1 | Q0 |
|---|---|---|---|---|---|
| | Initial | 0 | 0 | 0 | 0 |
| ↑ | 0 | 0 | 0 | 0 | 0 |
| ↑ | 1 | 1 | 0 | 0 | 0 |
| ↑ | 0 | 0 | 1 | 0 | 0 |
| ↑ | 1 | 1 | 0 | 1 | 0 |

**Describe:** The circuit shown in the following diagram outputs parallel data while accepting serial input. The clock values change to 1 and the value is delivered to Q3 when the value 0 is used as input. The clock values then change from 1 to 0 and back to 1 as input 1 is used. Q3's value is then transferred to Q2 and Q3 is then set to 1. After that, input 0 is used, the clock values switch from 1 to 0 to 1 again, Q2's value is transferred to Q1, and Q3's value is determined by input 1's value. The clock values are then altered to 0 and 1, Q2 becomes Q1, Q1 becomes Q0, and Q3 is given the value 1.

**Timing Diagram:**

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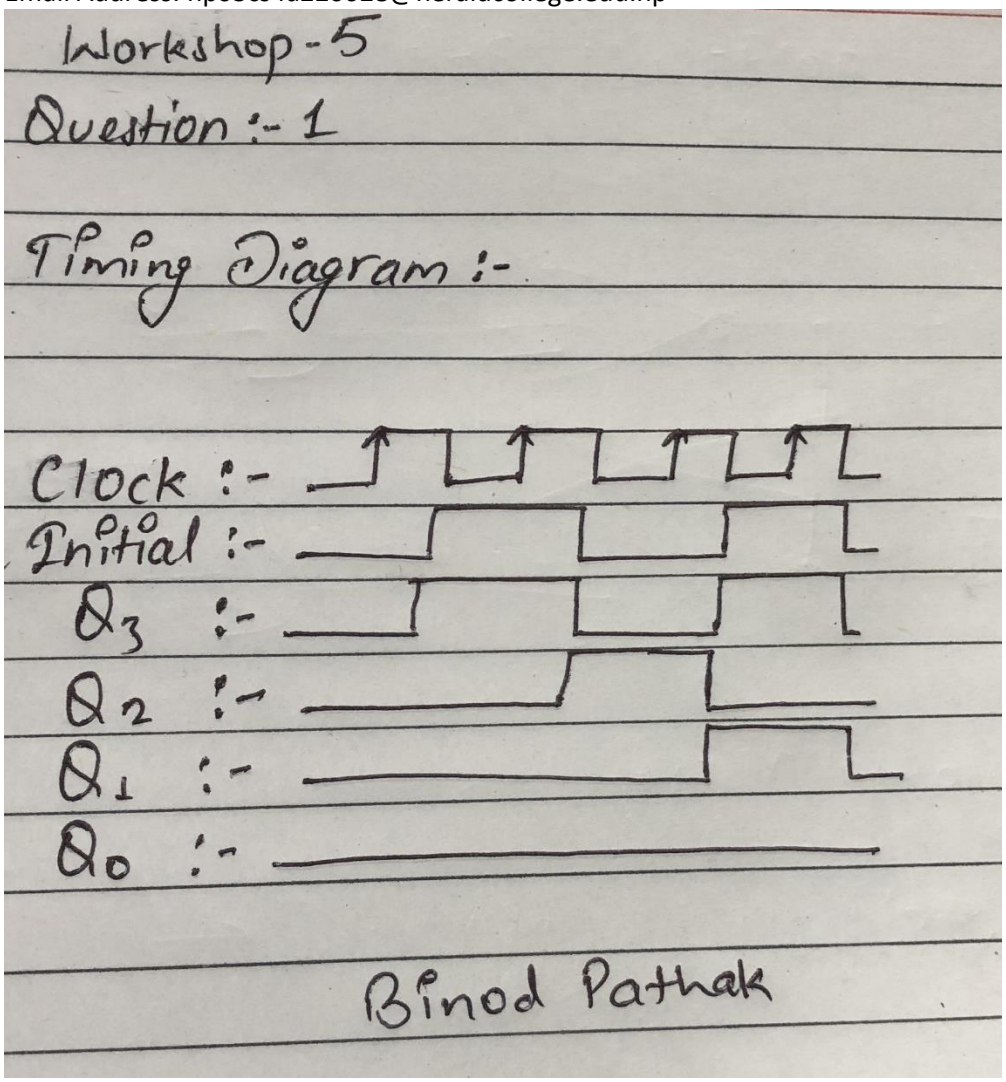


**2.** Design a 3 bit counter using Toggle D-flip flop and draw the timing diagram.

**Answer:**

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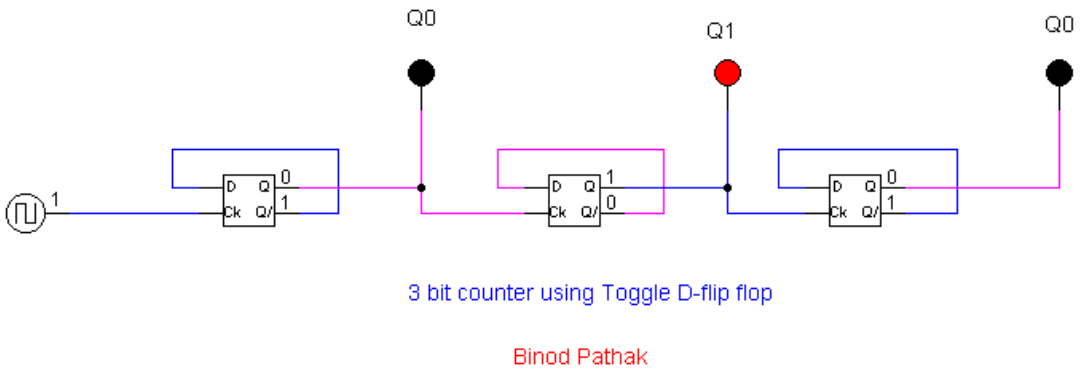


**Table:**

| Clock Transition | Q2 | Q1 | Q0 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 |
| 3 | 0 | 1 | 1 |
| 4 | 1 | 0 | 0 |
| 5 | 1 | 0 | 1 |
| 6 | 1 | 1 | 0 |
| 7 | 1 | 1 | 1 |

**Timing Diagram:**

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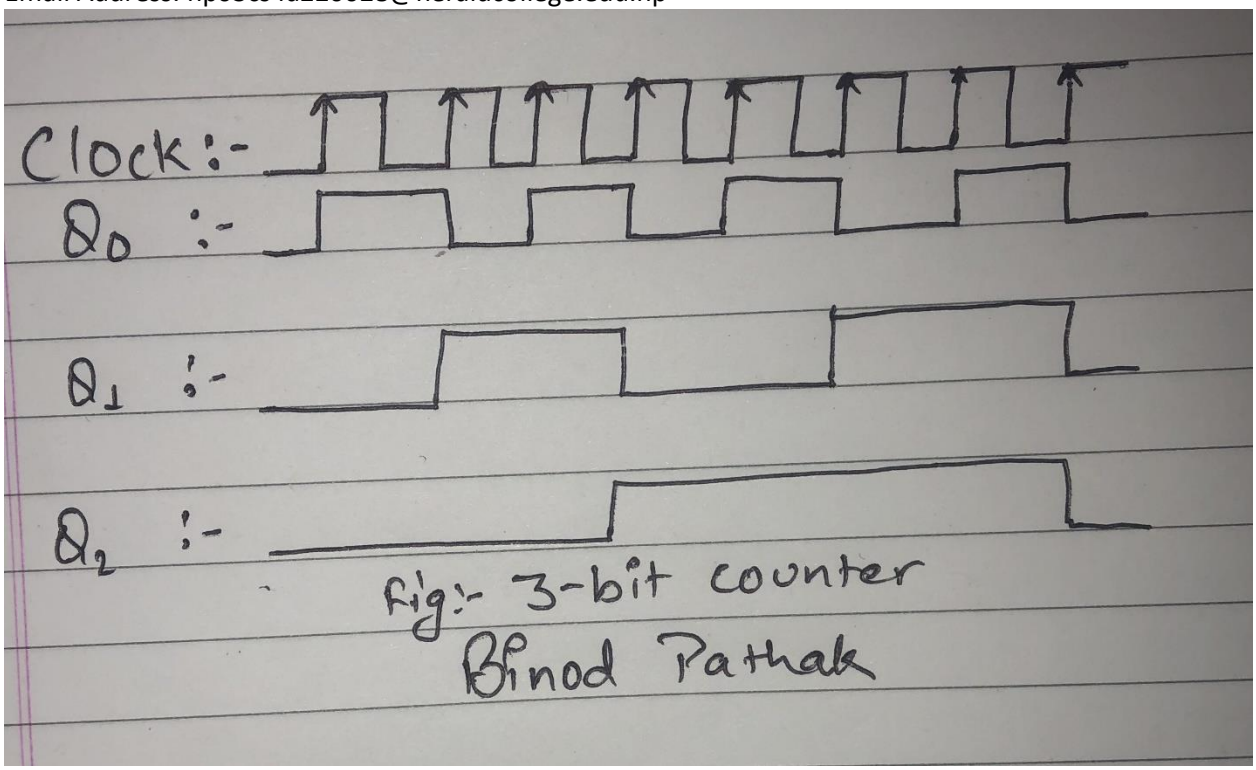
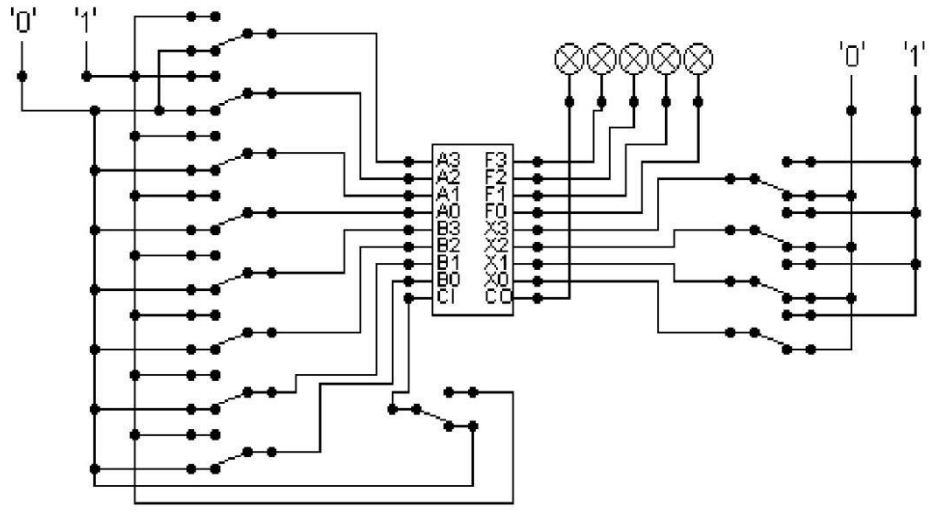



**3.** Load alu.cct file from the logsim folder. The circuit should look like this




The circuit behaves like a simple arithmetic logic unit. The inputs A0-A3 represent a 4 bit binary number. Inputs B0-B3 represent another binary number. A0 and B0 are the least significant bits respectively. The following table details the functions supported by the chip. All other control lines = 0.

| Function | Add | Subtract |
|---|---|---|
| X3-X0 | 1010 | 1011 |

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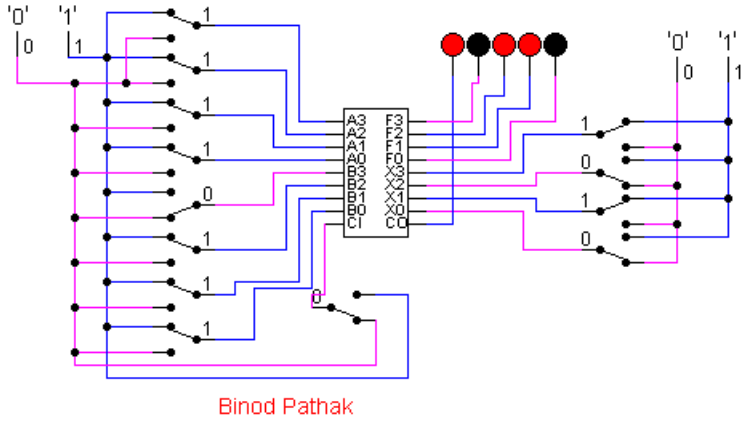
i) Use A= 15 and B = 7

ii) Use A = 13 and B = 9

Write the corresponding result of the operations. Manually provide each operation has provided the correct result.

**Answer:**

i) Use A= 15 and B = 7

| Inputs | Function | Result |
|---|---|---|
| A = 15 = 1111<br>B =7 = 0111 | Add - 1010 | Result = 1011  |

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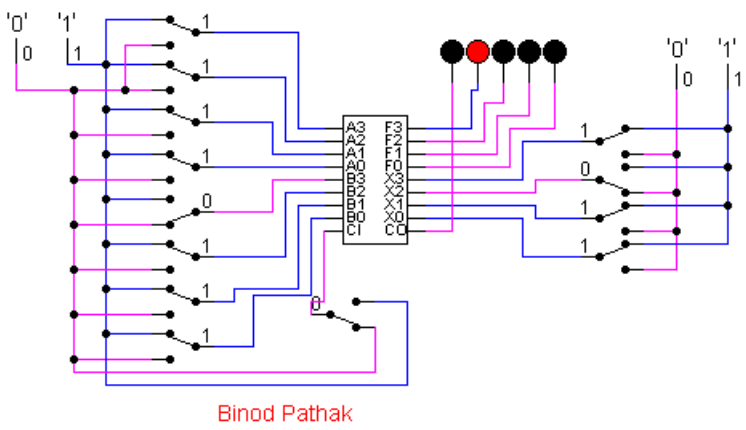
| | | |
|---|---|---|
| A = 15 = 1111<br>B = 7 = 0111 | Subtract - 1011 | Result = 0011   |

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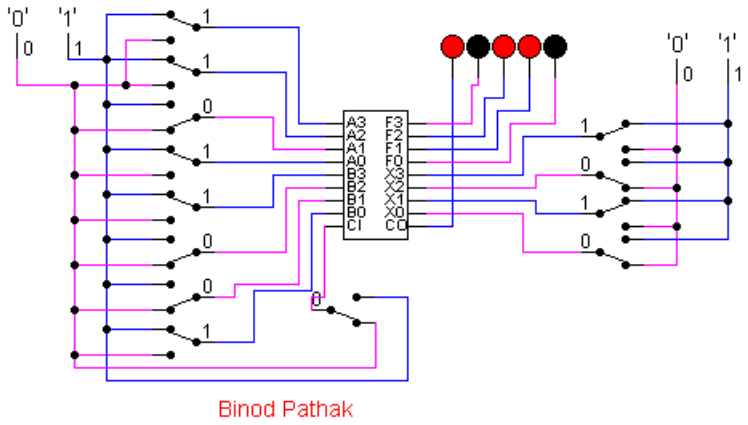
ii) Use A = 13 and B = 9

| Use A = 13 and B = 9Inputs | Function | Result |
|---|---|---|
| A = 13 = 1101 B = 9 = 1001 | Add - 1010 | Sum = 1011<br>Carry = 1<br>  <br> |
| | | |

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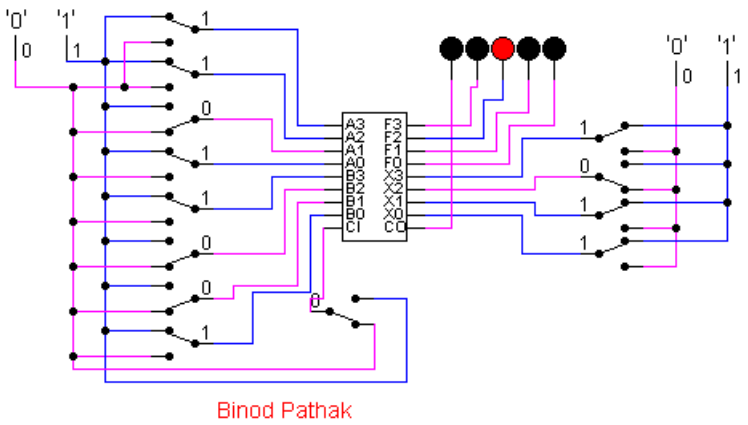
| | | |
|---|---|---|
| A = 15 = 1111<br>B = 7 = 0111 | Subtract - 1011 | Difference = 0001<br>Borrow = 1<br>  <br> |