**Question 1**

N = $N\_{3} N\_{2} N\_{1} N\_{0}$

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | $$N\_{3}$$ | $$N\_{2}$$ | $$N\_{1}$$ | $$N\_{0}$$ |  |  |
|  |  |  |  | $$N\_{3}$$ | $$N\_{2}$$ | $$N\_{1}$$ | $$N\_{0}$$ |  |  |
|  |  |  |  | $$N\_{0}N\_{3}$$ | $$N\_{0}N\_{2}$$ | $$N\_{0}N\_{1}$$ | $$N\_{0}N\_{0}$$ |  |  |
|  |  |  | $$N\_{1}N\_{3}$$ | $$N\_{1}N\_{2}$$ | $$N\_{1}N\_{1}$$ | $$N\_{1}N\_{0}$$ |  |  |  |
|  |  | $$N\_{2}N\_{3}$$ | $$N\_{2}N\_{2}$$ | $$N\_{2}N\_{1}$$ | $$N\_{2}N\_{0}$$ |  |  |  |  |
|  | $$N\_{3}N\_{3}$$ | $$N\_{3}N\_{2}$$ | $$N\_{3}N\_{1}$$ | $$N\_{3}N\_{0}$$ |  |  |  |  |  |
|  | $$N\_{3}N\_{2}$$ | $$N\_{1}N\_{3}$$ | $$N\_{0}N\_{3}$$ | $$N\_{0}N\_{2}$$ | $$N\_{1}N\_{0}$$ | 0 | $$N\_{0}$$ | 0 | $$\leftarrow 2N^{2}$$ |
|  | $$N\_{3}$$ |  | $$N\_{2}N\_{1}$$ |  | $$N\_{1}$$ |  |  |  |  |
|  |  |  | $$N\_{2}$$ |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | 1 | $$\leftarrow +1$$ |
|  | $$N\_{3}N\_{2}$$ | $$N\_{1}N\_{3}$$ | $$N\_{0}N\_{3}$$ | $$N\_{0}N\_{2}$$ | $$N\_{1}N\_{0}$$ | 0 | $$N\_{0}$$ | 1 |  |
|  | $$N\_{3}$$ |  | $$N\_{2}N\_{1}$$ |  | $$N\_{1}$$ |  |  |  |  |
|  |  |  | $$N\_{2}$$ |  |  |  |  | $$m\_{i} m\_{j}$$ |  |

****

$$N\_{2}N\_{1}$$

$$N\_{0}N\_{3}$$

$$N\_{0}N\_{2}$$

$$1$$

$$N\_{0}$$

$$0$$

$$N\_{1}$$

$$N\_{1}N\_{0}$$

FA

HA

HA

$$N\_{3}$$

$$N\_{1}N\_{3}$$

HA

FA

FA

$$N\_{3}N\_{2}$$

$$N\_{2}$$

$$P\_{0}$$

$$P\_{8}$$

$$P\_{7}$$

$$P\_{6}$$

$$P\_{4}$$

$$P\_{5}$$

$$P\_{3}$$

$$P\_{2}$$

$$P\_{1}$$

N = $1011\_{2}=11$

$$2N^{2}+1=243$$

$$1$$

$$0$$

1

$$0$$

$$1$$

$$1$$

$$0$$

1

FA

HA

HA

0

$$1$$

$$0$$

$$1$$

HA

FA

FA

$$1$$

$$0$$

$$1$$

$$1$$

$$1$$

$$1$$

$$0$$

$$0$$

$$1$$

$$128+64+32+16+2+1=243$$

**Question 2**

This implementation can be done in several ways, in terms of how to divide the 8-bit. Below we give implementation by using two 4-bit Carry Skip Adder.

$$C\_{1}$$

$$C\_{in}$$



$$B\_{0}-B\_{3}$$

$$A\_{0}-A\_{3}$$

$$P\_{2}$$

$$P\_{1}$$

$$S\_{7}$$

$$S\_{6}$$

$$S\_{5}$$

$$S\_{0}$$

$$S\_{1}$$

$$S\_{2}$$

$$S\_{3}$$

$$S\_{4}$$

$$P\_{2}$$

$$P\_{1}$$

$$C\_{out}$$

$$P\_{7}$$

$$P\_{6}$$

$$P\_{0}$$

$$P\_{1}$$

$$P\_{2}$$

$$P\_{3}$$

$$P\_{4}$$

$$P\_{5}$$

$$C\_{in}$$

$$Critical path Carry Skip=8\*τ\_{FA}+2\*τ\_{AND}+2\*τ\_{MUX} =8\*3τ\_{gate}+2τ\_{gate}+3\*2τ\_{gate}=32τ\_{gate}$$

$$Critical path Carry Ripple=8\*τ\_{FA} =8\*3τ\_{gate}=24τ\_{gate}$$

$$Area of Carry Skip=8\*A\_{FA}+2 A\_{AND}+2 A\_{MUX} =8\*5A\_{gate}+2A\_{gate}+2\*3A\_{gate}=48A\_{gate}$$

$$Area of Carry Ripple=8\*A\_{FA}=8\*5A\_{gate}=40A\_{gate}$$



$$Delay=3τ\_{gate}$$

$$Area=5A\_{gate}$$



$$Delay=3τ\_{gate}$$

$$Area=4A\_{gate}$$

Neglect inverter

**Question 3**

|  |  |  |
| --- | --- | --- |
| Present State |  | Next State |
| $$y\_{3}$$ | $$y\_{2}$$ | $$y\_{1}$$ |  | $$y\_{3}^{+}$$ | $$y\_{2}^{+}$$ | $$y\_{1}^{+}$$ |
| 0 | 0 | 0 |  | 0 | 0 | 0 |
| 0 | 0 | 1 |  | 0 | 0 | 0 |
| 0 | 1 | 0 |  | 0 | 0 | 1 |
| 0 | 1 | 1 |  | 0 | 0 | 1 |
| 1 | 0 | 0 |  | 0 | 1 | 0 |
| 1 | 0 | 1 |  | 0 | 1 | 0 |
| 1 | 1 | 0 |  | 0 | 1 | 1 |
| 1 | 1 | 1 |  | 0 | 1 | 1 |



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $y\_{3}$ $y\_{2}y\_{1}$ | 00 | 01 | 11 | 10 |
|  0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 |

$$y\_{1}^{+}=y\_{2}=D\_{1}$$

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $y\_{3}$ $y\_{2}y\_{1}$ | 00 | 01 | 11 | 10 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

$$y\_{2}^{+}=y\_{3}=D\_{2}$$

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $y\_{3}$ $y\_{2}y\_{1}$ | 00 | 01 | 11 | 10 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |

$$y\_{3}^{+}=0=D\_{3}$$

Using D Flip Flop:

$$y\_{3}^{+}=0=D\_{3}$$

$$y\_{2}^{+}=y\_{3}=D\_{2}$$

$$y\_{1}^{+}=y\_{2}=D\_{1}$$

CLK

$$y\_{1}$$

$$y\_{2}$$

$$y\_{3}$$

0

$$D\_{1}$$

$$D\_{2}$$

$$D\_{3}$$