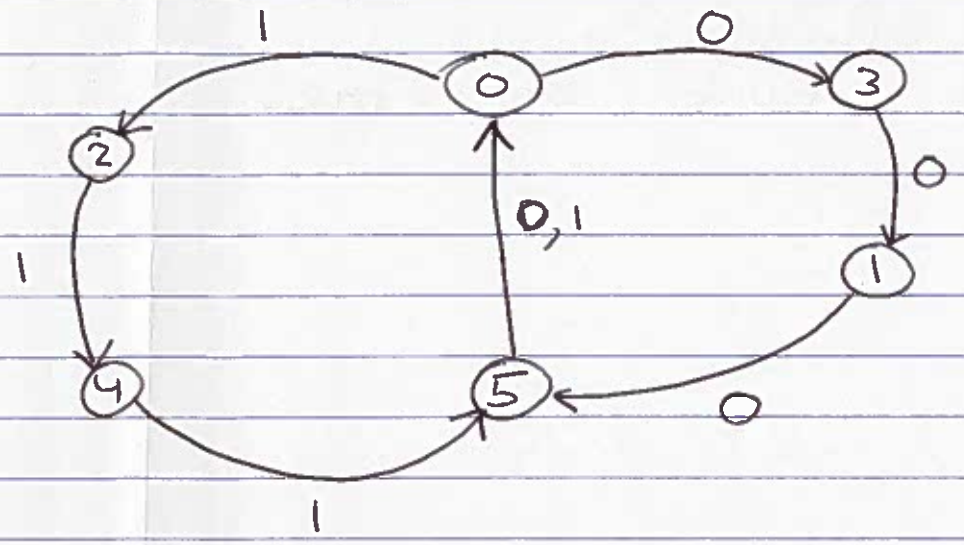
1 a)



b)

input	TS	Q2	Q1	Q0	NS	D2	D1	D0
0	0	0	0	0	3	0	1	1
0	1	0	0	1	5	1	0	1
0	2	0	1	0	X	x	x	x
0	3	0	1	1	1	0	0	1
0	4	1	0	0	X	x	x	x
0	5	1	0	1	0	0	0	0
0	X	x	x	x	x	x	x	x
0	X	x	x	x	x	x	x	x
1	0	0	0	0	2	0	1	0
1	1	0	0	1	X	x	x	x
1	2	0	1	0	4	1	0	0
1	3	0	1	1	X	x	x	x
↓	5							
1	X	x	x	x	x	x	x	x
1	X	x	x	x	x	x	x	x
1	4	1	0	0	5	1	0	1
1	5	1	0	1	0	0	0	0
1	x	x	x	x	x	x	x	x
1	x	x	x	x	x	x	x	x

c) D0:

IQ2 \ Q1Q0	00	01	11	10
00	1	1	1	x
01	x	0	x	x
11	1	0	x	x
10	0	x	x	0

$(I' \cdot Q2') + (Q1' \cdot Q0' \cdot Q2)$

D1:

	00	01	11	10
00	1	0	0	x
01	x	0	x	x
11	0	0	x	x
10	1	x	x	0

$(Q1' \cdot Q0' \cdot Q2')$

D2:

	00	01	11	10
00	0	1	0	x
01	x	0	x	x
11	1	0	x	x
10	0	x	x	1

$(Q1 \cdot Q0') + (Q0' \cdot Q2) + (Q2' \cdot Q1' \cdot Q0)$

d)

I	Q2	Q1	Q0	D2	D1	D0	Next State
0	0	1	0	1	0	1	5
0	1	0	0	1	0	1	5
0	1	1	1	0	0	0	0
0	1	1	0	1	0	0	4
1	1	1	1	0	0	0	0
1	1	1	0	1	0	0	4
1	0	0	1	1	0	0	4
1	0	1	1	0	0	0	0

Does not cause any issues.

e) States are assigned such that number is in binary. LSB indicates whether odd or even

$O_1 = D0$

$O_2 = D0'$

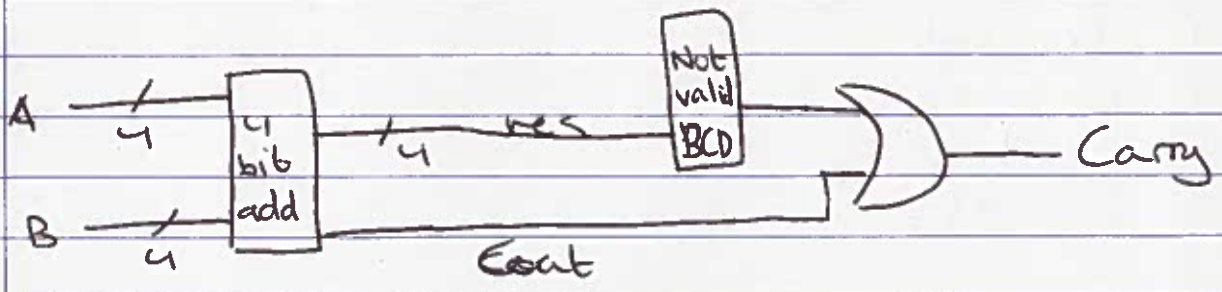
2a)

b_3b_2 \ b_1b_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

$$(b_3 \cdot b_2) + (b_3 \cdot b_1)$$

$$= b_3 \cdot (b_1 + b_2)$$

b) Any results between 10 & 15 inclusive the binary carry is different from the BCD carry.



c) $4 + 9 = 13$

$$\begin{array}{r} 0100 \\ 1001 + \\ \hline 1101 \end{array}$$ in binary

0001 0011 in BCD

$3 + 8 = 11$

$$\begin{array}{r} 0011 \\ 1000 + \\ \hline 1011 \end{array}$$ in binary

0001 0001 in BCD

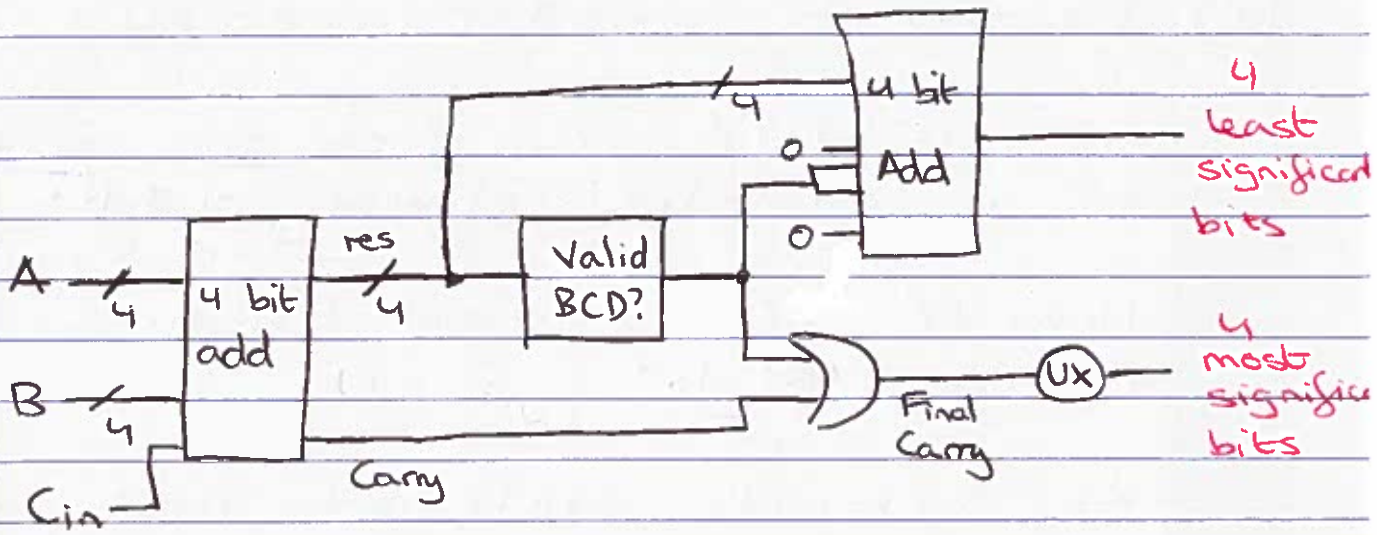
$3 + 9 = 12$

$$\begin{array}{r} 0011 \\ 1001 \\ \hline 1100 \end{array}$$ in binary

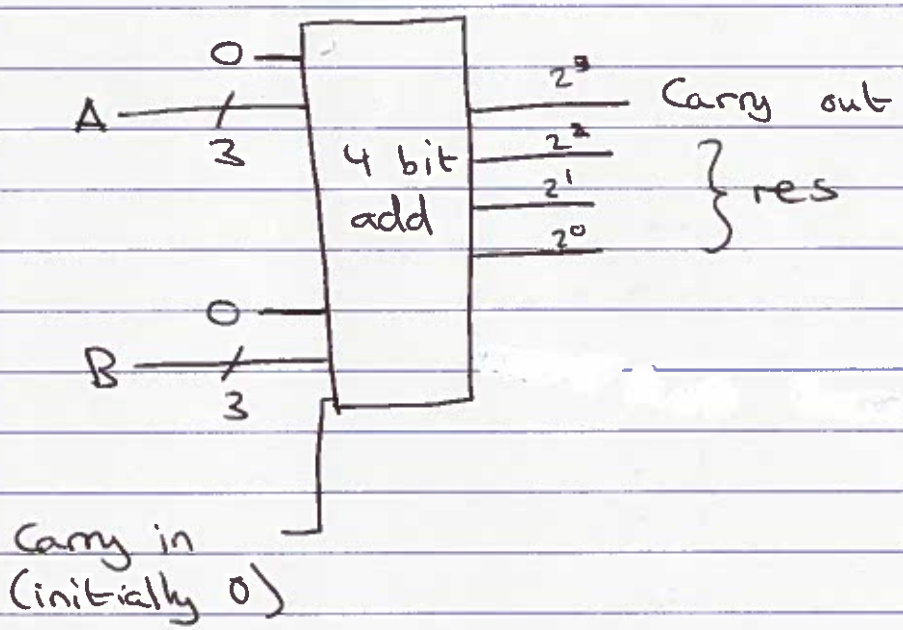
0001 0010 in BCD

Add 0110 to the result if ~~carry is~~ not a valid BCD

d)


A
4
B
4
Cin
4 bit
add
res
4
Carry
Valid
BCD?
4
0
0
4 bit
Add
Final
Carry
Ux
4
least
significant
bits
4
most
significant
bits

e)


0
A
3
0
B
3
4 bit
add
2^3
2^2
2^1
2^0
Carry out
res
Carry in
(initially 0)