**CS1005 Logic & Computation  
Lab sheet 1: Turing Machines Answers**

1. Write down the binary numbers corresponding to decimal 1 to 20 inclusive.

1 = 1

2 = 10

3 = 11

4 = 100

5 = 101

6 = 110

7 = 111

8 = 1000

9 = 1001

10 = 1010

11 = 1011

12 = 1100

13 = 1101

14 = 1110

15 = 1111

16 = 10000

17 = 10001

18 = 10010

19 = 10011

1. = 10100
2. Do the following additions in binary notation **without translating into decimal**. Show your working [i.e. the ‘carries’]:
   * + - 0+1 = 1
       - 1+1 = 10 (1 carried from 20 column)
       - 11+1 = 100 (1 carried from 20 and 21 columns)
       - 101+1 = 110 (1 carried from 20 column)
       - 111+1 = 1000 (1 carried from 20 , 21 and 22 columns)
       - 11+10 = 101 (1 carried from 21 columns)
       - 100+101 = 1001 (1 carried from 22 column)
3. \*100\* = \*101\* (rows 1, 2, 9, 10, 11) \*010\* = \*011\* (rows 1, 2, 10, 9, 11)
4. \*111\* = \*1000\* (rows 1, 3, 6, 6, 5, 9, 9, 9, 11)
5. \*101\* = \*110\* (rows 1, 3, 5, 9, 11) \*001\* = \*010\* (rows 1, 3, 5, 9, 11)
6. \*100\* would remain \*100\* \*010\* would remain \*010\*

\*111\* would still change to \*1000\*

\*101\* would still change to \*110\* \*001\* would still change to \*010\*

The ones that would still change do so because row 2 is not used

1. If you have time, in your own words, think of one good reason why state analysis is so important in computing today.

Without state analysis there would be no way to complete calculations