COMP1588 – Computer Systems Architectures Mock Theory Test

You have **110** minutes to answer all questions.

Student Number	
Surname	
Forename	

1. If the CPU's data bus is 7 bits wide
   A) What is the minimum and maximum unsigned integer the machine can store. Show them in decimal and binary format. [/4]
   B) What is the minimum and maximum two's complement number the machine can store. Show them in signed decimal and two's complement representation. [/6]

2. Develop a logic circuit that can be used to check if two 3-bit binary numbers are equal. [/10]

3. Using only Boolean algebra (and not a Karnaugh map or truth table), prove that z = bd+cd [/10]

$$z = \bar{a}.\bar{b}.c.d + \bar{a}.b.\bar{c}.d + \bar{a}.b.c.d + a.\bar{b}.c.d + a.b.\bar{c}.d + a.b.c.d$$

4. This is the Karnaugh map of a logic expression.

cd\ab	**00**	**01**	**11**	**10**
00	1	0	0	1
01	0	1	1	0
11	0	0	0	0
10	1	0	0	1

(1)
(1)

A. Draw the corresponding logic circuit before simplification [/7]
B. Draw the corresponding logic circuit after simplification using the Karnaugh Map [/8]

5. Draw the timing diagram for an SR latch (cross coupled NORS), showing the following event sequence. (S = 1, R = 0), (S = 0, R = 0), (S = 0, R = 0), (S = 0, R = 1). At the initial state of the latch, S+R = 0, Q = 0, Q bar = 1. [/15]

6. A) Draw a flowchart to compute 1+2+3+4+5+ ...+1000 using a loop. [/5]
   B) Draw a flowchart to compute 1+2+3+4+5+ ...+1000 without using any loop.
   (Hint: 1+1000 = 2+999 = 3+998 = ...) [/5]
   C) Draw a flowchart to compute the sum of n numbers without using any loop [/10]

7. Draw a state transition diagram and State Table that reads a string of four characters (‘A’, ‘C’, ‘G’ and ‘T’) and asserts an output if it finds the sequence ‘ATG’.

[/20]

Boolean Algebra rules:

1. **Commutative laws**
   a) $A + B = B + A$ b) $A.B = B.A$

2. **Associative laws**
   a) $A + (B + C) = (A + B) + C$ b) $A.(B.C) = (A.B).C$

3. **Distributive laws**
   a) $A.(B + C) = (A.B) + (A.C)$ b) $A + (B.C) = (A + B).(A + C)$

4. **Tautology laws**
   a) $A.A = A$ b) $A + A = A$

   c) $A + \overline{A} = 1$ d) $\overline{A} . A = 0$

5. **Absorption laws**
   a) $A + (A.B) = A$ b) $A.(A + B) = A$

6. **Common Sense laws**
   a) $0.A = 0$ b) $1 + A = 1$ c) $1.A = A$

   d) $0 + A = A$ e) $\overline{0} = 1$ f) $1 = \overline{0}$

7. **De Morgan's law**

   a) $\overline{A} + \overline{B} = \overline{A.B}$ b) $\overline{A + B} = \overline{A} . \overline{B}$