UNIVERSITY OF DUBLIN

XCS1BA41

TRINITY COLLEGE

FACULTY OF ENGINEERING, MATHEMATICS AND SCIENCE

SCHOOL OF COMPUTER SCIENCE AND STATISTICS

Junior Freshman Computer Science
1BA4 Digital Logic Design

Trinity Term 2008

1BA4 Exam

Tuesday 3rd June, 2008 **Goldsmith Hall** 14:00–17:00

Dr.B.A.Coghlan

Attempt FOUR questions

Materials:
Log tables are available from the invigilators, if required.

Non-programmable calculators are permitted for this examination—please indicate the make and model of your calculator on each answer book used.

1. Using only Huntington's Postulates and theorems, solve the following problems:

(a) Prove the *Absorption Theorem*, i.e.: $J + JK = J$ [7 marks]

(b) Simplify:

$$F = A'B'C'D' + A'B'C'D + A'B'CD + A'B'CD' + A'BC'D + ABC'D + BC'$$ [6 marks]

(c) Simplify: $F = AB'C + A'BC' + BC$ [6 marks]

(d) Simplify: $F = (A + B' + C)' + (B + C')' + (A + C)'$ [6 marks]

2. Simplify the following equation using the Quine-McCluskey method:

$$F = \Sigma(3, 5, 6, 7, 8, 11, 13, 14)$$ [25 marks]

3. Use J-K flip-flops to design the logic for a 4-bit synchronous bidirectional sequencer that steps upwards through the Fibionacci Series when its input $UP = 1$, and steps downwards through the series when $UP = 0$, stopping at the highest and lowest number in the series respectively. Verify that the sequencer is self-starting. Remember that the Fibionacci Series comprises those positive integers $1, 2, ...$ that are the sum of the previous two members of the series. [25 marks]

4. Assuming the following specification for an asynchronous sequential logic machine:

IF $(x = 1)$ AND $(y = 0)$
  THEN $Q = 0$
ELSEIF $(x = 1)$ AND $(y = 1)$
  THEN $Q = \overline{Q_{last}}$
ELSE
  $Q = \overline{Y}$
ENDIF

(a) Derive the draft transition table. [5 marks]

(b) Expand the draft transition table to form a total transition table. [10 marks]

(c) Convert the total transition table into a primitive flow table. [10 marks]

present state	present inputs 00	01	11	10
a	(a), 0	(a), 1	b , X	d , X
b	a , X	(b), 0	(b), 0	c , X
c	a , X	a , X	d , X	(c), 0
d	a , X	a , X	(d), 1	(d), 1

Figure 1: Flow Table

5. Find a race-free state assignment for an asynchronous sequential machine that has the flow table of Figure 1. *Hints:* Transition diagrams and Gray-coded cycle lengths. [25 marks]

6. Assume N is a 2bit unsigned integer count input, and Y is a 3bit unsigned integer output. Completely design an algorithmic state machine to perform the following algorithm:

```
        R0 := N;  Y := 0              ; input N and initialise result
Loop:   Y := Y + R0;  R0 := R0 - 1    ; accumulate result and decrement count
        If (R0 <> 0) GoTo Loop        ; loop until R0=0
```

Assume that apart from basic logic you also have a supply of 2-bit full adder/subtractors and 2:1 multiplexers. [25 marks]