

50 minutes 3 questions 45 marks

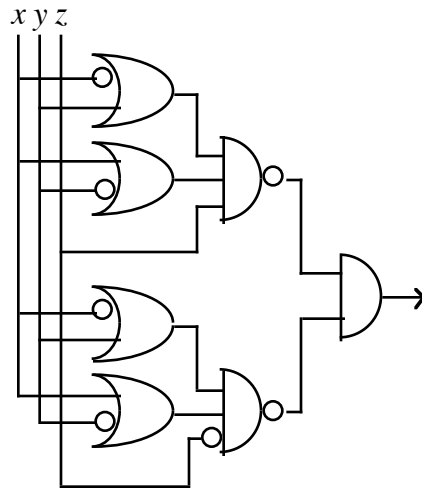
The value of each question is shown in square brackets.

A blank answer is worth about one-third of the marks;

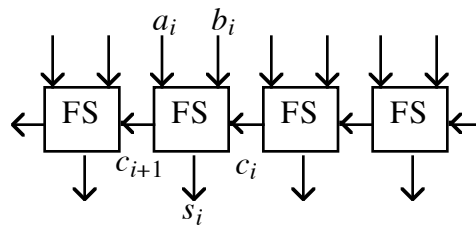
to that, marks will be added for readable, relevant, and correct information, and marks will be subtracted for unreadable, irrelevant, or incorrect information.

One aid sheet is allowed. There are laws on the next two pages.

1[15] Simplify the following circuit.



2[15] A Full Subtractor is a circuit with 3 inputs and 2 outputs. When  $n$  of them are joined together, they perform subtraction on two  $n$ -bit 2's complement numbers, giving a 2's complement answer. Input  $a_i$  is bit  $i$  of the minuend  $A$ ; input  $b_i$  is bit  $i$  of the subtrahend  $B$ , input  $c_i$  comes from the Full Subtractor on the right, output  $c_{i+1}$  goes to the Full Subtractor on the left, and output  $s_i$  is bit  $i$  of the difference  $S = A - B$ .



Design a Full Subtractor using basic gates. What is the value of  $c_0$ ? You can ignore overflow.

3(a)[5] Convert the decimal number 24.6 to binary (ordinary binary, not IEEE).

(b)[5] In base 12 there are 12 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B.

Convert 24.6 from base 12 to (ordinary) decimal.

(c)[5] Convert the decimal number 24.6 to base 12.

End of questions.