

Now refer to the document “Quantum circuits, registers and the language QUANT”, pages 12–17. In fact, for Problem 2, you can focus just on pages 15–17 and the language QCIRC.

**Problem 2. [3 marks]**

Write a Context-Free Grammar for the language QCIRC over the ten-symbol alphabet  $\{I, H, X, Z, \text{CNOT}, \text{TOF}, *, \otimes, (, )\}$ . It can be typed or hand-written, but must be in PDF format and saved as a file `prob2.pdf`.

$S \rightarrow Q$  ( where ‘Q’ is a quantum circuit expression)

$Q \rightarrow I$

$Q \rightarrow H$

$Q \rightarrow X$

$Q \rightarrow Z$

$Q \rightarrow \text{CNOT}$

$Q \rightarrow \text{TOF}$

$Q \rightarrow (Q)$

$Q \rightarrow Q * Q$  (matrix multiplication)

$Q \rightarrow Q(x)Q$  (kronecker product)