Computation Theory

(a) (i) Give a graphical representation of the following register machine program.

\[ \begin{align*}
L0 & : \ Z^+ \rightarrow L1 \\
L1 & : \ L^- \rightarrow L2, L3 \\
L2 & : \ Z^+ \rightarrow L0 \\
L3 & : \ Z^- \rightarrow L4, L5 \\
L4 & : \ L^+ \rightarrow L3 \\
L5 & : \ X^- \rightarrow L1, L6 \\
L6 & : \ \text{HALT}
\end{align*} \]

[3 marks]

(ii) Assuming the contents of register \( Z \) is initially 0, when the program is run starting at instruction \( L0 \) what functions of the initial contents of registers \( X \) and \( L \) are computed in \( X \) and \( L \) when the machine halts? [5 marks]

(b) (i) What is meant by a Turing machine, its configurations, transition relation and the computations it carries out? What does it mean to say that a computation halts? [6 marks]

(ii) Given a Turing machine, is it decidable whether or not for all possible initial configurations the machine will not halt after 100 steps of transition? Justify your answer. [6 marks]