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]