Software Engineering II

Consider this program over integer variables:

\[
\begin{align*}
\text{k} & := K; \\
\text{x} & := X; \\
\text{z} & := 1; \\
\text{while } k & \neq 0 \text{ do} \\
\text{begin} \\
\text{k} & := k-1; \\
\text{z} & := z \times x \\
\text{end}
\end{align*}
\]

Given that the loop invariant is \(z \times x^k = X^K\), show that executing this program stores the value of \(X^K\) in the variable \(z\). [5 marks]

It is proposed to insert the following code just before the assignment \(k := k-1\):

\[
\begin{align*}
\text{while even(k) do} \\
\text{begin} \\
\text{k} & := k/2; \\
\text{x} & := x \times x \\
\text{end}
\end{align*}
\]

State the loop invariant of this inner loop and show that the modified program still stores the value of \(X^K\) in \(z\). [7 marks]

Briefly describe formal specification languages, top–down design and fault avoidance techniques, indicating their respective roles in a software development project. [8 marks]