Prolog for Artificial Intelligence

(a) Give a simple definition of the Prolog predicate \texttt{dfx} that can perform symbolic differentiation with respect to the variable \( x \) of expressions composed of integers (e.g. 0, 1, \ldots), symbolic constants (e.g. \( a, b, \ldots \)), symbolic variables (e.g. \( x, y, \ldots \)) and the operators +, − and *, for addition, subtraction and multiplication. The first argument of \texttt{dfx} is the expression to differentiate and the second argument is the result. Your definition need not perform any simplification of the result. [6 marks]

(b) Trace the execution of the call: \texttt{dfx(x*x-2, R)}. [2 marks]

(c) Now modify your definition so that it simplifies the result by the applications of rewriting rules such as: \( 1\times x \Rightarrow x \) and \( x-0 \Rightarrow x \). [8 marks]

(d) Discuss to what extent, if any, either of your predicates could be used to integrate an expression. [4 marks]