14 Types (AMP)

(a) Give the Mini-ML typing rule for expressions of the form \texttt{let} \( x = M_1 \) \texttt{in} \( M_2 \).
How and why is this rule modified in the full ML language? [5 marks]

(b) Given a Mini-ML typing problem \( \Gamma \vdash M : ? \), define what is a solution for it and what it means for a solution to be principal. [3 marks]

Do the following Mini-ML typing problems have solutions? Justify your answer in each case.

\( (i) \quad f : \forall \{\} (\alpha \to \beta) \vdash (f \texttt{true}) f : ? \) \quad [3 marks]

\( (ii) \quad f : \forall \{\beta\} (\alpha \to \beta) \vdash (f \texttt{true}) f : ? \) \quad [4 marks]

\( (iii) \quad f : \forall \{\} (\alpha \to \beta) \vdash \texttt{let} f = \lambda x (\lambda y) \texttt{in} (f \texttt{true}) f : ? \) \quad [5 marks]