2005 Paper 7 Question 9

Types

(*a*) State the *value-restricted* typing rule for let-expressions in ML. [5 marks]

(*b*) Which of the following typing judgements are provable in the ML type system with the value-restricted rule for let-expressions? Justify your answer in each case, stating any other of the ML typing rules that you use. For part (*iii*) you must decide whether or not there is a type scheme σ that makes the typing provable.

(*i*) $\{\,\} \vdash$ let $r = $ ref $\lambda x(x)$ in $(!r)(r := \lambda y(\text{true})) : unit$ [5 marks]

(*ii*) $\{\,\} \vdash$ let $r = $ ref $\lambda x(x)$ in $(!r)(r := \lambda y(())) : unit$ [3 marks]

(*iii*) $\{\,\} \vdash$ let $f = \lambda x(\text{ref } x)$ in $f\,f : \sigma$ [3 marks]

(*iv*) $\{x : \alpha\} \vdash \lambda f(f\,x) : \forall \beta((\alpha \to \beta) \to \beta)$ (where α and β are distinct type variables) [2 marks]

(*v*) $\{x : \beta\} \vdash \lambda f(f\,x) : \forall \beta((\beta \to \beta) \to \beta)$ [2 marks]