In addition to the below given problems, kindly study Chapters 6 and 7 in the lecture notes. Referenced problems can also be found there. In the lecture only marked problems will be discussed; for solutions to the other problems please contact Georg Moser.

21) Problem 6.3

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- 22) Problem 6.4
- 23) Problem 6.5
- 24) Give a type system for the restriction of the  $\lambda$ -calculus, where all variables occur exactly once in the body of a term. More precisely we have the following terms: (i) variables x, (ii) abstractions  $\lambda x.M$ , and (iii) applications MN. For (ii) we have the constraint that  $x \in \mathsf{FV}(M)$ , and for (iii) that  $\mathsf{FV}(M) \cap \mathsf{FV}(N) = \emptyset$ . Furthermore, we define  $\mathsf{FV}(x) := \{x\}$ ,  $\mathsf{FV}(\lambda x.M) := \mathsf{FV}(M) - \{x\}$ , and  $\mathsf{FV}(MN) := \mathsf{FV}(M) \cup \mathsf{FV}(N)$ .

*Hint*: Look-up linear logic

25) Consider the restriction of the  $\lambda$ -calculus defined in Exercise 24. Prove strong normalisation of the calculus. (Hence also for the corresponding logic.) (\*)