

Mock exam questions for the course
Computer-Supported Modeling and Reasoning

1. Prove $A \wedge B \wedge C \rightarrow A \wedge C$ using natural deduction.
2. If p is a binary predicate symbol and c is a nullary function symbol, then what kind of expression is $p(p(c, c), c)$?
3. What is a first-order *theory*?
4. β -reduce $(\lambda xy. y)((\lambda x. xx)(\lambda x. xx))$.
5. How does one represent $(\neg a \rightarrow b) \wedge a$ in the typed λ -calculus?
6. What does `back()`; do?
7. The metalogic \mathcal{M} only has very few logical symbols. Nevertheless we can represent proofs from propositional logic, say, in \mathcal{M} , although propositional logic has more logical symbols. How is this done?
8. HOL also has only very few logical symbols in its basic version. Nevertheless, in the end we can do proofs involving more logical symbols. How? Compare with \mathcal{M} .
9. How is the rule *FalseE*:

$$\frac{False}{P} \text{ FalseE}$$

derived in HOL?

10. What is a *constant definition* in the sense of a conservative extension?
11. The definition of *lfp* (least fixpoint), is it a *constant definition*, or is it recursive? Give the definition.
12. Describe the principle of Noetherian induction.
13. In order to axiomatize the natural numbers, we must force the existence of an infinite set, using a HOL axiom. How is this done?
14. What is a *datatype*?
15. The abstract syntax of IMP is based on the following type declarations:

```
types
  loc
  val = nat (*or whatever*)
  state = loc => val
  aexp = state => val
  bexp = state => bool
```

Explain!

16. Does it make sense to require that an AVL tree is always “perfectly balanced”? If not, what is it that we do require?