In addition to the below given problem, kindly study the fourth chapter of 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.

- 12) Problem 4.2 (*)
- 13) Problem 4.3.

- (*)
- 14) Let \mathcal{G} denote an interpretation that models a directed graph G. Show that reachability is not expressible in first-order logic: there exists no formula F(x, y) whose only free variables are x and y, such that $\mathcal{G} \models F(x, y)$ iff $\ell(y)$ is reachable from $\ell(x)$ in G. (*)
- 15) Complete the proof of Theorem 4.4.