

Van Dalen Exercise 1.4.1(a-f)

$$1(a) \quad \frac{[\phi]1}{\phi \rightarrow \phi} 1$$

$$1(b) \quad \frac{[\perp]1}{\perp \rightarrow \phi} 1$$

$$1(c) \quad \frac{\frac{[\phi \& - \phi]1}{\phi} \quad \frac{[\phi \& - \phi]1}{-\phi}}{\perp} 1$$

$$1(d) \quad \frac{\frac{[\phi \& - \psi]1}{\phi} \quad \frac{[\phi \& - \psi]1}{-\psi}}{\psi} \quad \frac{\frac{[\phi]2}{-(\phi \& - \psi)} \quad \frac{[-\psi]3}{[-(\phi \& - \psi)]4}}{\frac{\perp}{\psi} 3} 4$$

$$\frac{\frac{\perp}{-(\phi \& - \psi)} 1}{(\phi \rightarrow \psi) \rightarrow -(\phi \& - \psi)} 2 \quad \frac{\perp}{(\phi \rightarrow \psi)} 4$$

$$\frac{(\phi \rightarrow \psi) \rightarrow -(\phi \& - \psi)}{-(\phi \& - \psi) \leftrightarrow (\phi \rightarrow \psi)}$$

$$1(e) \quad \frac{\frac{[(\phi \& \psi)]2}{\phi} \quad \frac{[(\phi \& \psi)]2}{\psi}}{-\psi} \quad \frac{\frac{[-\phi]5}{\psi} \quad \frac{[\phi]6}{\phi \rightarrow -\psi} 6}{\perp} 5 \quad \frac{\frac{[-\psi]4}{\phi \rightarrow -\psi} \quad \frac{[-(\phi \rightarrow -\psi)]3}{[-(\phi \rightarrow -\psi)]3}}{\perp} 4$$

$$\frac{\frac{\perp}{-(\phi \rightarrow -\psi)} 1}{(\phi \& \psi) \rightarrow -(\phi \rightarrow -\psi)} \quad \frac{\frac{\perp}{\phi} 5 \quad \frac{(\phi \& \psi)}{-(\phi \rightarrow -\psi) \rightarrow (\phi \& \psi)} 3}{(\phi \& \psi) \leftrightarrow -(\phi \rightarrow -\psi)}$$

$$1(f) \quad \frac{[\phi]1 \quad [\psi]2}{(\phi \& \psi)} 1$$

$$\frac{\psi \rightarrow (\phi \& \psi)}{(\phi \rightarrow (\psi \rightarrow (\phi \& \psi)))} 2$$