

Assignment #3

CIS 427/527

Group 2

January 25, 2016

1

Show that the following propositions are derivable:

(a) $\varphi \rightarrow \varphi$

$$\frac{[\varphi]^1}{\varphi \rightarrow \varphi} \rightarrow I^1$$

(b) $\perp \rightarrow \varphi$

$$\frac{\frac{[\perp]^1}{\varphi} \perp E}{\perp \rightarrow \varphi} \rightarrow I^1$$

(c) $\neg(\varphi \wedge \neg\varphi)$

$$\frac{\frac{[\varphi \wedge \neg\varphi]_1}{\varphi} \wedge E \quad \frac{[\varphi \wedge \neg\varphi]_1}{\neg\varphi} \wedge E}{\frac{\perp}{\neg(\varphi \wedge \neg\varphi)} \rightarrow RAA^1} E$$

(d) $(\varphi \rightarrow \psi) \leftrightarrow \neg(\varphi \wedge \neg\psi)$

Incomplete

$$\frac{\frac{\perp}{\neg(\varphi \wedge \neg\psi)} RAA \quad \frac{\varphi \rightarrow \psi}{\neg(\varphi \wedge \neg\psi) \rightarrow (\varphi \rightarrow \psi)} \rightarrow I}{(\varphi \rightarrow \psi) \leftrightarrow \neg(\varphi \wedge \neg\psi) \rightarrow I} \rightarrow I$$

(e) $(\varphi \wedge \psi) \leftrightarrow \neg(\varphi \rightarrow \neg\psi)$

Incomplete

$$\frac{\frac{\frac{\perp}{\neg\psi} \rightarrow I}{\varphi \rightarrow \neg\psi} \rightarrow I \quad \frac{\frac{[\varphi]_4 \quad [\neg\varphi]_3}{\frac{\perp}{\varphi \rightarrow \neg\psi} \rightarrow I^4} \quad \frac{\frac{\perp}{\neg\neg\varphi} \rightarrow I^3}{\varphi} \quad \frac{\frac{[\varphi]_2 \quad [\neg\psi]_1}{\varphi \rightarrow \neg\psi} \rightarrow I}{\frac{\perp}{\neg\neg\psi} \rightarrow I^1}}{\frac{(\varphi \wedge \psi) \rightarrow \neg(\varphi \rightarrow \neg\psi) \rightarrow I \quad \frac{\varphi \wedge \psi}{\neg(\varphi \rightarrow \neg\psi) \rightarrow (\varphi \wedge \psi)} \rightarrow I^2} \rightarrow I} \rightarrow I$$

(f) $\varphi \rightarrow (\psi \rightarrow (\varphi \wedge \psi))$

$$\frac{\frac{[\varphi]^1 \quad [\psi]^2}{\varphi \wedge \psi} \wedge I \quad \frac{\varphi \wedge \psi}{\psi \rightarrow (\varphi \wedge \psi)} \rightarrow I^2}{\varphi \rightarrow (\psi \rightarrow (\varphi \wedge \psi)) \rightarrow I^1} \rightarrow I^1$$

2

Show that the following propositions are derivable:

(a) $(\varphi \rightarrow \neg\varphi) \rightarrow \neg\varphi$

$$\frac{\frac{\frac{[\varphi \rightarrow \neg\varphi]_1}{\neg\varphi \wedge \varphi} E}{\perp} RAA_2}{(\varphi \rightarrow \neg\varphi) \rightarrow \neg\varphi} \rightarrow I_1$$

(b) $[\varphi \rightarrow (\psi \rightarrow \sigma)] \leftrightarrow [\psi \rightarrow (\varphi \rightarrow \sigma)]$

(c) $(\varphi \rightarrow \psi) \wedge (\varphi \rightarrow \neg\psi) \rightarrow \neg\varphi$

(d) $(\varphi \rightarrow \psi) \rightarrow [(\varphi \rightarrow (\psi \rightarrow \sigma)) \rightarrow (\varphi \rightarrow \sigma)]$

$$\frac{\frac{[\varphi \rightarrow \psi]_1}{\psi} \rightarrow E \quad \frac{[\varphi]_2}{\psi \rightarrow \sigma} \rightarrow E}{\frac{\sigma}{\varphi \rightarrow \sigma} \rightarrow I_2} \rightarrow E$$

$$\frac{(\varphi \rightarrow (\psi \rightarrow \sigma)) \rightarrow (\varphi \rightarrow \sigma)}{(\varphi \rightarrow \psi) \rightarrow [(\varphi \rightarrow (\psi \rightarrow \sigma)) \rightarrow (\varphi \rightarrow \sigma)]} \rightarrow I_3$$

3

Show:

(a) $\varphi \vdash \neg(\neg\varphi \wedge \psi)$

(b) $\neg(\varphi \wedge \neg\psi), \varphi \vdash \psi$

(c) $\neg\varphi \vdash (\varphi \rightarrow \psi) \leftrightarrow \neg\varphi$

(d) $\vdash \varphi \Rightarrow \vdash \psi \rightarrow \varphi$

(e) $\neg\varphi \vdash \varphi \rightarrow \psi$