

## De Morgan laws

$$a) \quad \neg(P \wedge Q) \Leftrightarrow (\neg P \vee \neg Q)$$

or else

$$(\neg \neg(P \wedge Q)) \Leftrightarrow \neg(\neg \neg P \vee \neg \neg Q)$$

$$b) \quad \neg(P \vee Q) \Leftrightarrow (\neg P \wedge \neg Q)$$

or

$$P \vee Q \Leftrightarrow \neg(\neg P \wedge \neg Q)$$

Double negation

$$\neg \neg P \Leftrightarrow P$$

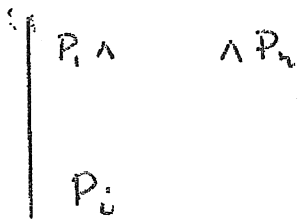
Distributivity laws

$$P \wedge (Q \vee R) \Leftrightarrow (P \wedge Q) \vee (P \wedge R)$$

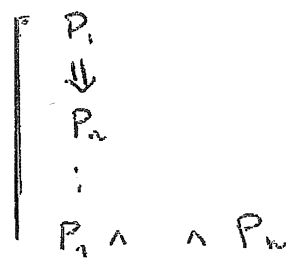
$$P \vee (Q \wedge R) \Leftrightarrow (P \vee Q) \wedge (P \vee R)$$

# Fitch rules

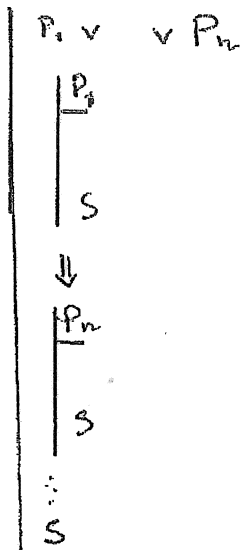
$\wedge$  - Elim



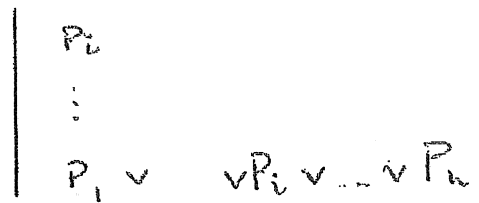
$\wedge$  - Intro



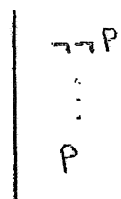
$\vee$  - ~~Intro~~ <sup>Elim</sup>



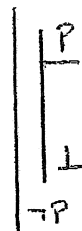
$\vee$  - Intro



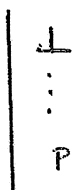
$\neg$  - Elim



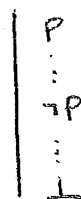
$\neg$  - Intro



$\perp$  - Elim



$\perp$  - Intro



→ Elim

|  
P → Q  
⋮  
P  
⋮  
Q

→ Intro

|  
P  
|  
Q  
P → Q

↔ Elim

|  
P ↔ Q  
⋮  
P  
⋮  
Q

↔ Intro

|  
P  
|  
⋮  
Q  
|  
Q  
|  
⋮  
P  
P ↔ Q

# LOGICAL EQUIVALENCES

Commutativity  
of  $\vee$  and  $\wedge$

$$P \wedge Q \Leftrightarrow Q \wedge P \quad ; \quad P \vee Q \Leftrightarrow Q \vee P$$

Associativity

$$(P \wedge Q) \wedge R \Leftrightarrow P \wedge (Q \wedge R) \quad , \quad P \vee (Q \vee R) \Leftrightarrow (P \vee Q) \vee R$$

Distributivity

$$P \wedge (Q \vee R) \Leftrightarrow (P \wedge Q) \vee (P \wedge R) \quad ; \quad P \vee (Q \wedge R) \Leftrightarrow (P \vee Q) \wedge (P \vee R)$$

Double negation

$$\neg \neg P \Leftrightarrow P$$

Idempotence

$$P \wedge P \Leftrightarrow P$$

De Morgan's

$$\neg (P \wedge Q) \Leftrightarrow \neg P \vee \neg Q \quad ; \quad \neg (P \vee Q) \Leftrightarrow \neg P \wedge \neg Q$$

Absorption

$$P \vee (P \wedge Q) \Leftrightarrow P \quad ; \quad P \wedge (P \vee Q) \Leftrightarrow P$$

Conditional

$$(P \rightarrow Q) \Leftrightarrow \neg P \vee Q \quad ; \quad \neg (P \rightarrow Q) \Leftrightarrow P \wedge \neg Q$$

Identity

$$P \wedge T \Leftrightarrow P \quad ; \quad P \vee \perp \Leftrightarrow P$$

Negation

$$P \vee \neg P \Leftrightarrow T \quad ; \quad P \wedge \neg P \Leftrightarrow \perp$$

Universal  
bound

$$P \vee T \Leftrightarrow T \quad ; \quad P \wedge \perp \Leftrightarrow \perp$$