Week03 Logically

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20) p $\leftrightarrow$ q and (p $\bigwedge$ q) $\bigvee$ (!p $\bigwedge$!q) are logically equivalent

p	**q**	**p $\leftrightarrow$ q**	**p $\bigwedge$ q**	**!p $\bigwedge$!q**	**(p $\bigwedge$ q) $\bigvee$ (!p $\bigwedge$)**
0	0	1	0	1	1
0	1	0	0	0	0
1	0	0	0	0	0
1	1	1	1	1	1

21) !(p $\leftrightarrow$ q) and p $\leftrightarrow$!q are logically equivalent

p	**q**	**!p**	**!q**	**!(p $\leftrightarrow$ q)**	**p $\leftrightarrow$!q**
0	0	1	1	0	0
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

22) p $\rightarrow$ q and !q $\rightarrow$!p are logically equivalent

p	**q**	**!p**	**!q**	**p $\rightarrow$ q**	**!q $\rightarrow$!p**
0	0	1	1	1	1
0	1	1	0	1	1
1	0	0	1	0	0
1	1	0	0	1	1

23) !p $\leftrightarrow$ q and p $\leftrightarrow$!q are logically equivalent

p	**q**	**!p**	**!q**	**!p $\leftrightarrow$ q**	**p $\leftrightarrow$!q**
0	0	1	1	0	0
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

24) !(p $\oplus$ q) and p $\leftrightarrow$ q are logically equivalent

$\oplus$ = **xor**

p	**q**	**!(p $\oplus$ q)**	**p $\leftrightarrow$ q**
0	0	1	1
0	1	0	0
1	0	0	0
1	1	1	1

25) $!(p \leftrightarrow q)$ and $!p \leftrightarrow q$ are logically equivalent

p	q	!p	$!(p \leftrightarrow q)$	$!p \leftrightarrow q$
0	0	1	0	0
0	1	1	1	1
1	0	0	1	1
1	1	0	0	0

26) $(p \rightarrow q) \bigwedge (p \rightarrow r)$ and $p \rightarrow (q \bigwedge r)$ are logically equivalent

p	q	r	$p \rightarrow q$	$p \rightarrow r$	$q \bigwedge r$	$(p \rightarrow q) \bigwedge (p \rightarrow r)$	$p \rightarrow (q \bigwedge r)$
0	0	1	1	1	0	1	1
0	1	1	1	1	1	1	1
0	0	0	1	1	0	1	1
0	1	0	1	1	0	1	1
1	0	1	0	1	0	0	0
1	1	1	1	1	1	1	1
1	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0

27) $(\mathbf{p} \to \mathbf{r}) \bigwedge (\mathbf{q} \to \mathbf{r})$ and $(\mathbf{p} \bigvee \mathbf{q}) \to \mathbf{r}$ are logically equivalent

$\mathbf{p}$	$\mathbf{q}$	$\mathbf{r}$	$\mathbf{p} \to \mathbf{r}$	$\mathbf{q} \to \mathbf{r}$	$\mathbf{p} \bigvee \mathbf{q}$	$(\mathbf{p} \to \mathbf{r}) \bigwedge (\mathbf{q} \to \mathbf{r})$	$(\mathbf{p} \bigvee \mathbf{q}) \to \mathbf{r}$
0	0	1	1	1	0	1	1
0	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	0
1	0	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	0	0	0	0	1	0	0
1	1	0	0	0	1	0	0

28) $(\mathbf{p} \to \mathbf{q}) \bigvee (\mathbf{p} \to \mathbf{r})$ and $\mathbf{p} \to (\mathbf{q} \bigvee \mathbf{r})$ are logically equivalent

$\mathbf{p}$	$\mathbf{q}$	$\mathbf{r}$	$\mathbf{p} \to \mathbf{q}$	$\mathbf{p} \to \mathbf{r}$	$\mathbf{q} \bigvee \mathbf{r}$	$(\mathbf{p} \to \mathbf{q}) \bigvee (\mathbf{p} \to \mathbf{r})$	$\mathbf{p} \to (\mathbf{q} \bigvee \mathbf{r})$
0	0	1	0	1	1	1	1
0	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
0	1	0	1	0	1	1	1
1	0	1	0	1	1	1	1
1	1	1	1	1	1	1	1
1	0	0	0	0	0	0	0
1	1	0	1	0	1	1	1

29) $(p \to r) \bigvee (q \to r)$ and $(p \bigwedge q) \to r$ are logically equivalent

p	q	r	$p \to r$	$q \to r$	$p \bigwedge q$	$(p \to r) \bigvee (q \to r)$	$(p \bigwedge q) \to r$
0	0	1	1	1	0	1	1
0	1	1	1	1	0	1	1
0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
1	0	1	1	1	0	1	1
1	1	1	1	1	1	1	1
1	0	0	0	0	0	0	0
1	1	0	0	0	1	0	0

30) $!p \to (q \to r)$ and $q \to (p \bigvee r)$ are logically equivalent

p	q	r	!p	$q \to r$	$p \bigvee r$	$!p \to (q \to r)$	$q \to (p \bigvee r)$
0	0	1	1	1	1	1	1
0	1	1	1	1	1	1	1
0	0	0	1	1	0	1	1
0	1	0	1	0	0	0	0
1	0	1	0	1	1	1	1
1	1	1	0	1	1	1	1
1	0	0	0	1	1	1	1
1	1	0	0	0	1	1	1

31) $p \leftrightarrow q$ and $(p \rightarrow q) \bigwedge (q \rightarrow p)$ are logically equivalent

p	q	$p \rightarrow q$	$q \rightarrow p$	$p \leftrightarrow q$	$(p \rightarrow q) \bigwedge (q \rightarrow p)$
0	0	1	1	1	1
0	1	1	0	0	0
1	0	0	1	0	0
1	1	1	1	1	1

32) $p \leftrightarrow q$ and $!p \leftrightarrow !q$ are logically equivalent

p	q	$!p$	$!q$	$p \leftrightarrow q$	$!p \leftrightarrow !q$
0	0	1	1	1	1
0	1	1	0	0	0
1	0	0	1	0	0
1	1	0	0	1	1