# Student Information

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# Answer 1

Table 1: Truth Table for $(\neg q \land (p \to q)) \to \neg p$

| $p$ | $q$ | $\neg q$ | $p \to q$ | $\neg q \land (p \to q)$ | $\neg p$ | $(\neg q \land (p \to q)) \to \neg p$ |
|---|---|---|---|---|---|---|
| T | T | F | T | F | F | T |
| T | F | T | F | F | F | T |
| F | T | F | T | F | T | T |
| F | F | T | T | T | T | T |

Table 2: Truth Table for $((p \lor q) \land (\neg p \lor r)) \to (q \lor r)$

| $p$ | $q$ | $r$ | $p \lor q$ | $\neg p$ | $\neg p \lor r$ | $(p \lor q) \land (\neg p \lor r)$ | $q \lor r$ | $((p \lor q) \land (\neg p \lor r)) \to (q \lor r)$ |
|---|---|---|---|---|---|---|---|---|
| T | T | T | T | F | T | T | T | T |
| T | T | F | T | F | F | F | T | T |
| T | F | T | T | F | T | T | T | T |
| T | F | F | T | F | F | F | F | T |
| F | T | T | T | T | T | T | T | T |
| F | T | F | T | T | T | T | T | T |
| F | F | T | F | T | T | F | T | T |
| F | F | F | F | T | T | F | F | T |

# Answer 2

$(p \to q) \lor (p \to r) \equiv (\neg p \lor q) \lor (p \to r)$ from Table 7 K.Rosen page 28.
$(\neg p \lor q) \lor (p \to r) \equiv (\neg p \lor q) \lor (\neg p \lor r)$ from Table 7 K.Rosen page 28.
$(\neg p \lor q) \lor (\neg p \lor r) \equiv \neg p \lor (q \lor r)$ from Table 6 K.Rosen page 27, Distributive Laws.
$\neg p \lor (q \lor r) \equiv p \to (q \lor r)$ from Table 7 K.Rosen page 28.
$p \to (q \lor r) \equiv \neg(q \lor r) \to \neg p$ from Table 7 K.Rosen page 28.
$\neg(q \lor r) \to \neg p \equiv (\neg q \land \neg r) \to \neg p$ from Table 6 K.Rosen page 27, De Morgan's Laws.

# Answer 3

**1-a)** For all animal x, if x is a cat,then there exists an animal y such that y is a dog and x and y are friend.
**1-b)** There exists an animal x such that x is a cat and x is friend with all dog.

**2-a)** $\forall x \exists y (Eats(x, y) \to Customer(x))$
**2-b)** $\exists x \exists y (Chef(x) \land \neg Cooks(x.y))$
**2-c)** $\exists x \forall y (Customer(x) \land Eats(x, y) \land \exists z_1 \forall z_2 (Cooks(z_1, y) \land (Cooks(z_2, y) \to (z_2 = z_1))))$
**2-d)** $\forall x \exists c (Chef(x) \to (Chef(c) \land Knows(x, c) \land \exists z (Cooks(c, z) \land \neg Cooks(x, z))))$

# Answer 4

When p is false and q is true, premises which are $(p \to q)$ and $(\neg p)$ become true. Since q is true, $\neg q$ is false. Therefore, by counterexample, the invalidity of the conclusion is proven.

# Answer 5

| | | |
|---|---|---|
| 1 | $p \to q$ | *premise* |
| 2 | $q \to r$ | *premise* |
| 3 | $r \to p$ | *premise* |
| 4 | $q$ | *assumption* |
| 5 | $r$ | $\to e$ $2, 4$ |
| 6 | $p$ | $\to e$ $3, 5$ |
| 7 | $q \to p$ | $\to$i $4 - 6$ |
| 8 | $p \to r$ | $\to$i $6, 5$ |
| 9 | $p \leftrightarrow q$ | $\leftrightarrow$i $1, 7$ |
| 10 | $p \leftrightarrow r$ | $\leftrightarrow$i $3, 8$ |
| 11 | $(p \leftrightarrow q) \land (p \leftrightarrow r)$ | $\land$i $9, 10$ |

# Answer 6

| | | | |
|---|---|---|---|
| 1 | | $\forall x (Q(x) \to R(x))$ | *premise* |
| 2 | | $\exists x (P(x) \to Q(x))$ | *premise* |
| 3 | | $\forall x P(x)$ | *premise* |
| 4 | $x_0$ | $P(x_0) \to Q(x_0)$ | *assumption* |
| 5 | | $P(x_0)$ | $\forall x e$ 3 |
| 6 | | $Q(x_0)$ | $\to e$ $4, 5$ |
| 7 | | $Q(x_0) \to R(x_0)$ | $\forall x$e 1 |
| 8 | | $R(x_0)$ | $\to e$ $6, 7$ |
| 9 | | $P(x_0) \to R(x_0)$ | $\to$i $5, 8$ |
| 10 | | $\exists x (P(x) \to R(x))$ | $\exists x$i 9 |
| 11 | | $\exists x (P(x) \to R(x))$ | $\exists x$e $2, 4 - 10$ |