CS 381 Solutions to Homework 4

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32(c) Universe: The set of koalas
\( C(x) : x \) can climb
Original: \( \forall x C(x) \)
Negation: \( \exists x \neg C(x) \)
English: Some koalas can not climb.
(d) Universe: The set of monkeys
\( F(x) : x \) can speak French
Original: \( \forall x \neg F(x) \)
Negation: \( \exists x F(x) \)
English: Some monkeys can speak French.
(e) Universe: The set of pigs
\( S(x) : x \) can swim
\( C(x) : x \) can catch fish
Original: \( \exists x [S(x) \land C(x)] \)
Negation: \( \forall x [\neg S(x) \lor \neg C(x)] \)
English: Every pig can not swim or can not catch fish.

62 (a) \( \forall x [P(x) \rightarrow \neg S(x)] \) or
\( \neg \exists x [P(x) \land S(x)] \)
(b) \( \neg \exists x [R(x) \land \neg S(x)] \), or
\( \forall x [R(x) \rightarrow S(x)] \)
(c) \( \forall x [Q(x) \rightarrow P(x)] \)
(d) \( \forall x [Q(x) \rightarrow \neg R(x)] \)
(e) Yes.

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4 (d) There is a computer science course which every student has taken.
(e) For every computer science course there is a student who has taken it.
(f) Every student has taken every computer science course.

8 (b) \( \neg \exists x \exists y Q(x,y) \)
(c) \( \exists x [Q(x, Jeopardy) \land Q(x, WheelofFortune)] \)
10 (c) \( \forall x \exists y F(x, y) \)
(d) \( \neg \exists x \forall y F(x, y) \)
(f) \( \neg \exists x [F(x, Fred) \land F(x, Jerry)] \)
(h) \( \exists x \forall y [F(y, x) \land \forall z (F(y, z) \rightarrow z = x)] \)

12 (f) \( \exists x \neg I(x) \)
(k) \( \exists x [I(x) \land \forall y [y \neq x \rightarrow \neg C(x, y)]] \)
(m) \( \exists x \forall y C(x, y) \)