CS 205 Sections 07 and 08
Homework 1 – Accepted for grading 2/18

1. Formalize the following English sentences in propositional logic. Use the key provided.

   (a) No shirt – no shoes – no service.
   I: you wear a shirt
   O: you wear shoes
   E: you are served.

   (b) The deluxe burger comes with fries and a coke.
   B: you get a deluxe burger.
   F: you get fries.
   C: you get a coke.

   (c) Delivery is available in New Brunswick for orders of $10 or more.
   N: you order from within New Brunswick.
   T: your order costs at least $10.
   D: we will deliver your order.

   (d) If you are not satisfied, you get your money back.
   S: you are satisfied.
   M: you get your money back.

   (e) No refund without a receipt.
   M: you get your money back.
   C: you have a receipt.

2. Each item below offers a pair of compound propositions. In each case, say whether the two are logically equivalent. If they are not, give truth values for p, q, and r where the two compound propositions have different truth values.

   (a) $r \rightarrow (\neg p \vee \neg q)$
   $\neg(p \wedge q \wedge \neg r)$

   (b) $(p \vee q) \rightarrow (\neg p \vee \neg q)$
   $p \rightarrow \neg q$

   (c) $p \rightarrow (q \rightarrow r)$
   $\neg r \rightarrow \neg p$

   (d) $(p \rightarrow q) \rightarrow (p \rightarrow r)$
   $p \rightarrow (q \rightarrow r)$

   (e) $\neg(p \rightarrow q) \rightarrow r$
   $(r \rightarrow p) \rightarrow q$

3. Let the domain of discourse consist of all real numbers. Let $P(x,y)$ mean $yx^2 = y^3$. Which of the following propositions are true, and which are false?

   (a) $P(0,0)$

   (b) $P(-1,-1) \rightarrow P(0,1)$

   (c) $P(1,2) \rightarrow P(1,-1)$

   (d) $\forall x P(x,x)$

   (e) $\forall x P(x,-x)$

   (f) $\exists x P(x,2x)$

   (g) $\exists x \neg P(x,2x)$

   (h) $\exists x \forall y P(x,y)$

   (i) $\exists y \forall x P(x,y)$

   (j) $\forall x \forall y \forall z (P(x,y) \rightarrow P(xz,yz))$

4. Formalize the following English sentences in predicate logic. Use the key provided. Use the constant a to represent the store about which these rules are true.

   (a) We honor competitors' coupons.
   $M(x,y)$: x competes with y.
   $C(x,y)$: x is a coupon for store y.
   $H(x,y)$: x honors y.

   (b) None of our pizzas contain any artificial ingredients.
   $Z(x)$: x is a pizza.
   $S(x,y)$: x sells y.
   $A(x)$: x is artificial.
   $C(x,y)$: x contains y.

   (c) Buy one pizza get one free.
   $P(x,y,z)$: x pays y z dollars.
   $G(x,y,o)$: x gives y object o.
   $Z(x)$: x is a pizza.
   $F(z)$: z is the full price for a pizza.

   (d) Opened CDs can only be exchanged for another copy of the same title.
   $C(x)$: x is a CD.
   $O(x)$: x has been opened.
   $T(x,t)$: the title of x is t (the type of recording).
   $E(x,y,o,p)$: x gives y object o and y gives x object p in exchange.

   (e) Our prices are the lowest.
   $P(o,x,z)$: the price of product o in store x is z dollars.