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**CS 311 Discrete Math and Data Structures: Homework1**

2. Which of these are propositions? What are the truth values of those that are propositions?   
a) Do not pass go. No proposition

b) What time is it? No proposition

c) There are no black ﬂies in Maine. Proposition

d) 4+x =5. No proposition

e) The moon is made of green cheese. Proposition, False.

f) 2n ≥100. No proposition

5. What is the negation of each of these propositions?

a) Steve has more than 100 GB free disk space on his laptop.

**Negation**: Steve has less than or equal to 100 GB free disk space on his laptop.

b) Zach blocks e-mails and texts from Jennifer.

**Negation**: Zach does not blocks e-mails and texts from Jennifer.

c) 7·11·13=999. **Negation**: 7·11·13!= 999.

d) Diane rode her bicycle 100 miles on Sunday.

**Negation** : Diane did not rode her bicycle 100 miles on Sunday.

6. Suppose that Smart phone A has 256 MB RAM and 32 GB ROM, and the resolution of its camera is 8 MP; Smart phone B has 288 MB RAM and 64 GB ROM, and the resolution of its camera is 4 MP; and Smartphone C has 128 MB RAM and 32 GB ROM, and the resolution of its camera is 5 MP. Determine the truth value of each of these propositions.

a) Smart phone B has the most RAM of these three smart phones. **True**

b) Smart phone C has more ROM or a higher resolution camera than Smartphone B. **True**

c) Smartphone B has more RAM, more ROM, and a higher resolution camera than Smart phone A. **False**

d) If Smart phone B has more RAM and more ROM than Smartphone C, then it also has a higher resolution camera. **False**

e) Smart phone A has more RAM than Smartphone B if and only if Smart phone B has more RAM than Smart phone A. **False**

7. Suppose that during the most recent ﬁscal year, the annual revenue of Acme Computer was 138 billion dollars and its net proﬁt was 8 billion dollars, the annual revenue of Nadir Software was 87 billion dollars and its net proﬁt was 5 billion dollars, and the annual revenue of Quixote Media was 111 billion dollars and its net proﬁt was 13 billion dollars. Determine the truth value of each of these propositions for the most recent ﬁscal year.

a) Quixote Media had the largest annual revenue. **False**

b) Nadir Software had the lowest net proﬁt and Acme Computer had the largest annual revenue. **True**

c) Acme Computer had the largest net proﬁt or Quixote Media had the largest net proﬁt. **True**

d) If Quixote Media had the smallest net proﬁt, then Acme Computer had the largest annual revenue. **True**

e) Nadir Software had the smallest net proﬁt if and only if Acme Computer had the largest annual revenue. **True**

11. Let p and q be the propositions p: It is below freezing. q: It is snowing. Write these propositions using p and q and logical connectives (including negations).

a) It is below freezing and snowing. p ∧ q

b) It is below freezing but not snowing. p∧¬q

c) It is not below freezing and it is not snowing. ¬(p ∧ q)

d) It is either snowing or below freezing (or both). p ∨ q

e) If it is below freezing, it is also snowing. p → q

f) Either it is below freezing or it is snowing, but it is not snowing if it is below freezing. (p ∨ q) ∧ (q → ¬p)

g) That it is below freezing is necessary and sufﬁcient for it to be snowing.

(q → p) ∧ (p → q)

30. How many rows appear in a truth table for each of these compound propositions? Solution: (2 the power of n)

Where n is number of prepositions or variable like p,q,r,s,t….

a) (q →¬p)∨(¬p →¬q) : 4

b) (p∨¬t)∧(p∨¬s) : 8

c) (p →r)∨(¬s →¬t)∨(¬u→v): 64

d) (p∧r ∧s)∨(q ∧t)∨(r ∧¬t): 32

32. Construct a truth table for each of these compound propositions.

a) p →¬p

|  |  |  |
| --- | --- | --- |
| p | ¬p | p →¬p |
| T | F | F |
| F | T | T |

b) p ↔¬p

|  |  |  |
| --- | --- | --- |
| p | ¬p | p ↔¬p |
| T | F | F |
| F | T | F |

c) p⊕ (p∨ q)

|  |  |  |  |
| --- | --- | --- | --- |
| p | q | p∨ q | p⊕ (p∨ q) |
| T | T | T | F |
| T | F | T | F |
| F | T | T | T |
| F | F | F | F |

d) (p∧ q ) → (p∨ q)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | p∧ q | p∨ q | (p∧ q) → (p∨ q) |
| T | T | T | T | T |
| T | F | F | T | T |
| F | T | F | T | T |
| F | F | F | F | T |

e) (q →¬p)↔(p ↔q)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| p | ¬p | q | q →¬p | p ↔q | (q →¬p) ↔ (p ↔q) |
| T | F | T | F | T | F |
| T | F | F | T | F | F |
| F | T | T | T | F | F |
| F | T | F | T | T | T |

f) (p ↔q)⊕(p ↔¬q)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| p | q | ¬q | p →¬q | p ↔q | (p ↔q)⊕(p ↔¬q) |
| T | T | F | F | T | T |
| T | F | T | T | F | T |
| F | T | F | T | F | T |
| F | F | T | T | T | F |

43. Find the bitwise OR, bitwise AND, and bitwise XOR of each of these pairs of bit strings.

a) 101 1110, 010 0001

bitwise OR: 111 1111

bitwise AND: 000 0000

bitwise XOR: 111 1111

b) 1111 0000, 1010 1010

bitwise OR: 1111 1010

bitwise AND: 1010 0000

bitwise XOR: 0101 1010

c) 00 0111 0001, 10 0100 1000

bitwise OR: 10 0111 1001

bitwise AND: 00 0100 0000

bitwise XOR: 10 0011 1001

d) 11 1111 1111, 00 0000 0000

bitwise OR: 11 1111 1111

bitwise AND: 00 0000 0000

bitwise XOR: 11 1111 1111

44. Evaluate each of these expressions.

a) 1 1000∧ (0 1011∨1 1011): 1 1000

b) (0 1111∧1 0101) ∨0 1000: 0 1101

c) (0 1010⊕1 1011) ⊕0 1000: 1 1001

d) (1 1011∨0 1010) ∧ (1 0001∨1 1011): 1 1011

2. You can see the movie only if you are over 18 years old or you have the permission of a parent. Express your answer interims of m: “You can see the movie,” e: “You are over 18 years old ,”and p: “You have the permission of a parent.” **(e →m) ∨ p**

4. To use the wireless network in the airport you must pay the daily fee unless you are a subscriber to the service. Express your answer in terms of w:“You can use the wireless network in the airport,” d: “You pay the daily fee,” and s: “You are a subscriber to the service.” **(w ∧ d) ∨ (w ∧ s)**

10. Are these system speciﬁcations consistent? “Whenever the system software is being upgraded, users cannot access the ﬁle system. If users can access the ﬁle system, then they can save new ﬁles. If users cannot save new ﬁles, then the system software is not being upgraded.”

**Solution: To determine whether these speciﬁcations are consistent, we ﬁrst express them using logical expressions.**

**Let p:” the system software is being upgraded “T**

**Let q: “users cannot access the ﬁle system “T**

**Let r: “users can save new ﬁles “T**

**p →q: T**

**¬q→ r: T**

**¬r→¬p: T**

**Yes, it is.**

12. Are these system speciﬁcations consistent? “If the ﬁle system is not locked, then new messages will be queued. If the ﬁle system is not locked, then the system is functioning normally, and conversely. If new messages are not queued, then they will be sent to the message buffer. If the ﬁle system is not locked, then new messages will be sent to the message buffer. New messages will not be sent to the message buffer.”

**No. Because, New messages will not be sent to the message buffer.” And New messages will be sent to the message buffer cannot be true at the same time.**

14. What Boolean search would you use to look for Web pages about hiking in West Virginia? What if you wanted to ﬁnd Web pages about hiking in Virginia, but not in West Virginia?

West Virginia? Or, AND

Virginia: NOR

16. An explorer is captured by a group of cannibals. There are two types of cannibals—those who always tell the truth and those who always lie. The cannibals will barbecue the explorer unless he can determine whether a particular cannibal always lies or always tells the truth. He is allowed to ask the cannibal exactly one question.

a) Explain why the question “Are you a liar?” does not work.

**Because some cannibals cannot tell the truth.**

b) Find a question that the explorer can use to determine whether the cannibal always lies or always tells the truth.

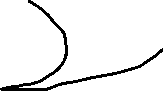
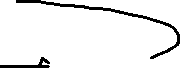
**Are you a person?**

40. Find the output of each of these combinatorial circuits. Page (24)

a) -p∨-q

b) -q

42. Construct a combinatorial circuit using inverters, OR gates, and AND gates that produces the output (p∧¬r)∨ (¬q ∧r)from input bits p, q, and r.



9. Show that each of these conditional statements is a tautology by using truth tables.

a) (p∧ q)→p

|  |  |  |  |
| --- | --- | --- | --- |
| p | q | p∧ q | (p∧ q)→p |
| T | T | T | T |
| T | F | F | T |
| F | T | F | T |
| F | F | F | T |

b) p →(p∨ q)

|  |  |  |  |
| --- | --- | --- | --- |
| p | q | p∨ q | p →(p∨ q) |
| T | T | T | T |
| T | F | T | T |
| F | T | T | T |
| F | F | F | T |

c) ¬p →(p →q)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | ¬p | p →q | ¬p →(p →q) |
| T | T | F | T | T |
| T | F | F | F | T |
| F | T | T | T | T |
| F | F | T | T | T |

d) (p∧ q) →(p →q)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | p∧ q | p →q | (p∧ q) →(p →q) |
| T | T | T | T | T |
| T | F | F | F | T |
| F | T | F | T | T |
| F | F | F | T | T |

e) ¬(p →q)→p

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | (p →q) | ¬(p →q) | ¬(p →q)→p |
| T | T | T | F | T |
| T | F | F | T | T |
| F | T | T | F | T |
| F | F | T | F | T |

f) ¬(p →q)→¬q

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| p | q | (p →q) | ¬(p →q) | ¬q | ¬(p →q)→¬q |
| T | T | T | F | F | T |
| T | F | F | T | T | T |
| F | T | T | F | F | T |
| F | F | T | F | T | T |

1. Use truth tables to verify these equivalences.
2. p∧T≡p

|  |  |  |
| --- | --- | --- |
| p | p∧T | p∧T≡p |
| T | T | T |
| F | F | F |

1. p∨F≡p

|  |  |  |
| --- | --- | --- |
| p | p∨F | p∨F≡p |
| T | T | T |
| F | F | F |

1. p∧F≡F

|  |  |  |
| --- | --- | --- |
| p | p∧F | p∧F≡F |
| T | F | F |
| F | F | F |

1. p∨T≡T

|  |  |  |
| --- | --- | --- |
| p | p∨T | p∨T≡T |
| T | T | T |
| F | T | T |

1. p∨p ≡p

|  |  |  |
| --- | --- | --- |
| p | p∨p | p∨p ≡p |
| T | T | T |
| F | F | F |

1. p∧p ≡p

|  |  |  |
| --- | --- | --- |
| p | p∧p | p∧p ≡p |
| T | T | T |
| F | F | F |

17. Show that¬ (p ↔q) and p ↔¬q are logically equivalent.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| p | q | ¬ q | p↔ q | ¬ (p ↔q) | p ↔¬q | ¬ (p ↔ q ) **≡ (**p ↔¬q) |
| T | T | F | T | F | F | F |
| T | F | T | F | T | T | T |
| F | T | F | F | T | T | T |
| F | F | T | T | F | F | F |

8. Use De Morgan’s laws to ﬁnd the negation of each of the following statements.

a) Kwame will take a job in industry or go to graduate school.

**¬ (p∨ q) ≡ ¬p ∧ ¬q**

b) Yoshiko knows Java and calculus. **¬ (p∧ q) ≡ ¬p∨ ¬q**

c) James is young and strong. **¬ (p∧ q) ≡ ¬p∨ ¬q**

d) Rita will move to Oregon or Washington.  **¬ (p∨ q) ≡ ¬p ∧ ¬q**

61.Determine whether each of these compound propositions is satisﬁable.

a) (p∨¬q)∧(¬p∨q)∧(¬p∨¬q) satisﬁable

b) (p →q)∧(p →¬q)∧(¬p →q)∧(¬p →¬q) satisﬁable

c) (p ↔q)∧(¬p ↔q) Not satisﬁable