WI23_CSBR-NY_1_NC_INT2 HW1

Aaron Bengochea

TOTAL POINTS

89 / 100

QUESTION 1

1 Q1 10 / 10

✓ **- 0 pts** *Correct*

- 5 pts no work shown

- 10 pts Incorrect/ No submission

- 1 pts A1 is incorrect, correct answer:

155

- 1 pts A2 is incorrect, correct answer:

237

- 1 pts A3 is incorrect, correct answer:

906

- 1 pts A4 is incorrect, correct answer:

309

- 1 pts B1 is incorrect, correct answer:

1000101

- 1 pts B2 is incorrect, correct answer:

111100101

- 1 pts B3 is incorrect, correct answer:

110110100011010

- 1 pts C1 is incorrect, correct answer:

6B

- 1 pts C2 is incorrect, correct answer:

37F

- 0.5 pts B1 is correct but no work shown

- 0.5 pts B2 is correct but no work shown

- 0.5 pts B3 is correct but no work shown

- 0.5 pts C1 is correct but no work shown

- 0.5 pts C2 is correct but no work shown

- 0.5 pts A1 is correct but no work shown

- 0.5 pts A2 is correct but no work shown

- 0.5 pts A3 is correct but no work shown

- 0.5 pts A4 is correct but no work shown

QUESTION 2

2 Q2 5 / 5

✓ **- 0 pts** *Correct*

- 5 pts No submission / Incorrect

- 1.25 pts 2.1 - $$14303_8$$

- 1.25 pts 2.2 - $$11000000_2$$

- 1.25 pts 2.3 - $$C02B_{16}$$

- 1.25 pts 2.4 - $$34_5$$

- 0.5 pts 2.1 - Correct answer but no work shown

- 0.5 pts 2.2 - Correct answer but no work shown

- 0.5 pts 2.3 - Correct answer but no work shown

- 0.5 pts 2.4 - Correct answer but no work shown

QUESTION 3

3 Q3 **9 / 9**

✓ **- 0 pts** *Correct*

- 9 pts Missing

- 2 pts Insufficient work shown

3A

- 1 pts A1 incorrect or missing. Should be 0111 1100.

- 1 pts A2 incorrect or missing. Should be 1000 0100.

- 1 pts A3 incorrect or missing. Should be 0110 1101.

- 1 pts A4 incorrect or missing. Should be 1011 0001.

3B

- 1 pts B1 incorrect or missing. Should be 30.

- 1 pts B2 incorrect or missing. Should be -26.

- 1 pts B3 incorrect or missing. Should be 45.

- 1 pts B4 incorrect or missing. Should be -98

QUESTION 4

4 Q4 **5 / 5**

✓ **- 0 pts** *Correct*

- 1 pts 1.2.4.b incorrect

p q (p ∨ q)
T T T
T F T
F T T
F F F

- 1 pts 1.2.4.c incorrect

p q ∨ (p ∧ ¬q)
T T T T
T F T T
F T F F
F F F F

- 1 pts 1.3.4.b incorrect

p q (p → q) → (q → p)
T T T T
T F F T
F T T F
F F T T

- 1 pts 1.3.4.d incorrect

p q (p ↔ q) ⊕ (p ↔ ¬q)
T T T T
T F F T
F T F T
F F T T

- 5 pts Question missing

QUESTION 5

5 Q5 **7 / 9**

- 0 pts Correct; good job

- 1 pts 1.2.7b incorrect. Should be "(B∧M)∨(B∧D)∨(M∧D)" or equivalent.

- 1 pts 1.2.7c incorrect. Should be "B∨(D∧M)".

- 1 pts 1.3.7b incorrect. Should be "(s ∨ y) → p".

- 1 pts 1.3.7c incorrect or missing. Should be "p → y".

- 1 pts 1.3.7d incorrect or missing. Should be "p ↔ (s ∧ y)".

- 1 pts 1.3.7e incorrect or missing. Should be "p → (s ∨ y)".

✓ **- 1 pts** *1.3.9c incorrect or missing. Should be "c → p".*

✓ **- 1 pts** *1.3.9d incorrect or missing. Should be "c → p".*

- 9 pts Entirely incorrect or missing

QUESTION 6

6 Q6 6 / 8

- 0 pts Correct

- 8 pts not submitted

Click here to replace this description.

✓ **- 1 pts** *1.3.6 B If Joe is eligible for the honors program, then he has maintained a B average.*

✓ **- 1 pts** *1.3.6 C If Rajiv can go on the roller coaster, then he is at least four feet tall.*

- 1 pts 1.3.6 D If Rajiv is at least four feet tall, then he can go on the roller coaster.

Click here to replace this description.

- 1 pts 1.3.10 C False. p ∨ r is true and q ∧ r is false. Therefore (p ∨ r) ↔ (q ∧ r) is false.

- 1 pts 1.3.10 D Unknown. If r is true, then the expression is false. If r is false, then the expression is true.

- 1 pts 1.3.10 E Unknown. If r is true, then the expression is true. If r is false, then the expression is false.

- 2 pts 1.3.10 F True. Since the hypothesis p ∧ q is false, the conditional statement (p ∧ q) → r is true.

QUESTION 7

7 Q7 4 / 4

✓ **- 0 pts** *Correct*

- 4 pts No submission

- 3.5 pts At least one of the answers is correct, but no proof/disproof of logical equivalences exist

- 2 pts 1.4.5B

$$\lnot j \rightarrow (l \lor \lnot r)$$

$$(r \land \lnot l) \rightarrow j$$

Logically equivalent.

- 1.5 pts 1.4.5B

Did not provide proof of logical equivalence.

- 0.75 pts 1.4.5B

Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 0.5 pts 1.4.5B

Correct conclusion but incorrect truth table values.

- 1 pts 1.4.5C

$$j \rightarrow \lnot l$$

$$\lnot j \rightarrow l$$

Not logically equivalent. if $$j = l = T$$, then $$j \rightarrow \lnot l$$ is false but $$\lnot j \rightarrow l$$ is true.

- 0.75 pts 1.4.5C

Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 0.5 pts 1.4.5C

Correct conclusion but incorrect truth table values.

- 1 pts 1.4.5D

$$(r \lor \lnot l) \rightarrow j$$
$$j \rightarrow (r \land \lnot l)$$

Not logically equivalent. if $$j = l = r = T$$, then $$(r \lor \lnot l) \rightarrow j$$ is true but $$j \rightarrow (r \land \lnot l)$$ is false.

- 0.5 pts 1.4.5D
Correct conclusion but incorrect truth table values.

- 0.75 pts 1.4.5D
Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 4 pts No conclusion and no proof/disproof of logical equivalences

- 3 pts All answers are correct, but did not provide proof/disproof of logical equivalences

- 3.5 pts Did not state whether logically equivalent or not, and did not provide proof/disproof of logical equivalences.

- 4 pts Incorrect

QUESTION 8

8 Q8 **5 / 6**

- 0 pts Correct; good job

- 1 pts 1.5.2c is incorrect or missing

- 1 pts 1.5.2f is incorrect or missing

- 1 pts 1.5.2i is incorrect or missing

- 1.5 pts 1.5.3c is incorrect or missing

- 1.5 pts 1.5.3d is incorrect or missing

- 2 pts Did not include which law was being used, otherwise correct

- 6 pts Completely incorrect or missing

- 0.5 pts Small mistake, otherwise correct.

✓ **- 1 pts** *Did not include Laws of Logic for some problems*

- 2 pts Did not include the logic statements (showing how they change when Laws are applied)

QUESTION 9

9 Q9 **6 / 6**

✓ **- 0 pts** *Correct*

- 6 pts No submission

- 1.2 pts 1.6.3.c) $$\exists x (x^2 = x)$$

- 1.2 pts 1.6.3.d) $$\forall x (x \leq x^2)$$
OR
1.6.3.d) $$\forall x (x \leq x^2) + 1$$

- 1.2 pts 1.7.4.b) $$\forall x(\lnot S(x) \land W(x))$$

- 1.2 pts 1.7.4.c) $$\forall x (S(x) \rightarrow \lnot W(x))$$

- 1.2 pts 1.7.4.d) $$\exists x (S(x) \land W(x))$$

- 0.6 pts Failed to use parentheses

QUESTION 10

10 Q10 **15 / 16**

- 0 pts Correct; good job

✓ **- 1 pts** *1.7.9 c incorrect. Answer is True*

- 1 pts 1.7.9 d incorrect. Answer is True

- 1 pts 1.7.9 e incorrect. Answer is True

- 1 pts 1.7.9 f incorrect. Answer is True

- 1 pts 1.7.9 g incorrect. Answer is False

- 1 pts 1.7.9 h incorrect. Answer is True

- 1 pts 1.7.9 i incorrect. Answer is True

- 1 pts 1.9.2 b incorrect. Answer is True

- 1 pts 1.9.2 c incorrect. Answer is True

- 1 pts 1.9.2 d incorrect. Answer is False

- **1 pts** 1.9.2 e incorrect. Answer is False
- **1 pts** 1.9.2 f incorrect. Answer is True
- **1 pts** 1.9.2 g incorrect. Answer is False
- **1 pts** 1.9.2 h incorrect. Answer is True
- **1 pts** 1.9.2 i incorrect. Answer is True
- **16 pts** Entirely incorrect or missing

QUESTION 11

11 Q11 **7 / 14**

- **0 pts** Correct

1.10.4

- **1 pts** 1.10.4 C is incorrect

$\exists x\ \exists y\ (x + y = xy)$

- **1 pts** 1.10.4 D is incorrect

$\forall x\ \forall y\ (((x > 0) \wedge (y > 0)) \rightarrow (x/y > 0))$

- **1 pts** 1.10.4 E is incorrect

$\forall x\ (((x > 0) \wedge (x < 1)) \rightarrow (1/x > 1))$

or

$\forall x\ ((0 < x < 1) \rightarrow (1/x > 1))$

✓ **- 1 pts** *1.10.4 F is incorrect*

$\neg\exists x\ \forall y\ (x \leq y)$

or

$\forall x\ \exists y\ (x > y)$

or

$\forall x\ \exists y\ (y < x)$

- **1 pts** 1.10.4 G is incorrect

$\forall x\ \exists y\ ((x \neq 0) \rightarrow (xy = 1))$

or

$\forall x\ \exists y\ ((x \neq 0) \rightarrow (y = 1/x))$

or

$\forall x\ \exists y\ ((x > 0)\ v\ (x < 0) \rightarrow (xy = 1))$

or

$\forall x\ \exists y\ ((x > 0)\ v\ (x < 0) \rightarrow (x\text{^-}1 = y))$

1.10.7

- **1 pts** 1.10.7 C is incorrect

$\exists x\ (N(x) \wedge D(x))$

- **1 pts** 1.10.7 D is incorrect

$\forall x\ (D(x) \rightarrow P(Sam, x))$

✓ **- 1 pts** *1.10.7 E is incorrect*

$\exists x\ \forall y\ (N(x) \wedge P(x, y))$

✓ **- 1 pts** *1.10.7 F is incorrect*

$\exists x\ \forall y\ (N(x) \wedge D(x) \wedge ((x \neq y \wedge N(y)) \rightarrow \neg D(y)))$

1.10.10

- **1 pts** 1.10.10 C is incorrect

$\forall x\ \exists y\ ((y \neq \text{Math } 101) \wedge T(x, y))$

✓ **- 1 pts** *1.10.10 D is incorrect*

$\exists x\ \forall y\ ((y \neq \text{Math } 101) \rightarrow T(x, y))$

✓ **- 1 pts** *1.10.10 E is incorrect*

$\forall x\ \exists y\ \exists z\ ((x \neq Sam) \rightarrow ((y \neq z) \wedge T(x, y) \wedge T(x, z)))$

✓ **- 2 pts** *1.10.10 F is incorrect*

$\exists y\ \exists z\ \forall w\ ((z \neq y) \wedge T(Sam, y) \wedge T(Sam, z) \wedge ((w \neq y \wedge w \neq z) \rightarrow \neg T(Sam, w)))$

or (different variable naming)

$\exists x\ \exists y\ \forall z\ ((y \neq x) \wedge T(Sam, x) \wedge T(Sam, y) \wedge ((z \neq x \wedge z \neq y) \rightarrow \neg T(Sam, z)))$

- 14 pts Incorrect/ No submission

1 Question 11 should begin on a new page and be tagged accordingly.

QUESTION 12

12 Q12 **5 / 8**

- 0 pts Correct

- 8 pts No Submission

1.8.2 B Incorrect

Correct: $\exists x\ (\neg D(x) \wedge \neg P(x))$

- 0.5 pts English statement is incorrect

English: There is a patient who was not given the medication and not given the placebo.

- 1 pts 1.8.2b is incorrect:

$\forall x\ (D(x) \vee P(x))$
Negation: $\neg \forall x\ (D(x) \vee P(x))$
Applying De Morgan's law: $\exists x\ (\neg D(x) \wedge \neg P(x))$
English: There exists a patient who was not given the medication and not given the placebo.

- 0.5 pts Incorrect bracket use

- 0.75 pts Didn't do negation, simplification(s), or new English sentence.

- 0.5 pts Final expression Incorrect

1.8.2 C Incorrect

Correct: $\forall x\ (\neg D(x) \vee \neg M(x))$

- 1 pts Incorrect

$\exists x\ (D(x) \wedge M(x))$
Negation: $\neg \exists x\ (D(x) \wedge M(x))$
Applying De Morgan's law: $\forall x\ (\neg D(x) \vee \neg M(x))$
English: Every patient did not get the medication or did not have migraines or both.

- 0.5 pts English Statement Incorrect:

English: Every patient did not get the medication or did not have migraines or both.

- 0.5 pts Final expression Incorrect

- 0.5 pts Incorrect bracket use

- 0.75 pts Did not include new English statement

1.8.2 D Incorrect

Correct: $\exists x\ (P(x) \wedge \neg M(x))$

- 1 pts incorrect:

$\forall x\ (P(x) \rightarrow M(x))$
Negation: $\neg \forall x\ (P(x) \rightarrow M(x))$
Applying De Morgan's law: $\exists x\ (P(x) \wedge \neg M(x))$
English: Some patient took the placebo and did

not have migraines.

or "There exists a patient that did not take the placebo and did not have a migraine"

- 0.5 pts English statement is incorrect:

English: Some patient took the placebo and did not have migraines.

- "some patients" instead of "some patient". existential just implies at least one patient.

- 0.5 pts Incorrect bracket use

- 0.5 pts Didn't fully simplify

- 0.75 pts Did not do negation, simplification(s), or new English sentence.

1.8.2 E Incorrect

Correct: $\forall x\ (\neg M(x) \vee \neg P(x))$

- 0.5 pts English statement is incorrect:

English: Every patient did not have migraines or did not take the placebo

- 1 pts incorrect:

$\exists x\ (M(x) \wedge P(x))$
Negation: $\neg \exists x\ (M(x) \wedge P(x))$
Applying De Morgan's law: $\forall x\ (\neg M(x) \vee \neg P(x))$
English: Every patient did not have migraines or did not take the placebo.

- 0.5 pts incorrect bracket use

- 0.75 pts Did not do negation, simplification(s), or new English sentence.

- 0.5 pts Incorrect simplification

- 0.5 pts Final expression Incorrect

✓ **- 1 pts** *1.9.4c is incorrect:*

$\forall x\ \exists y\ (P(x, y) \wedge \neg Q(x, y))$

- 0.5 pts 1.9.4c

Did not include proper parentheses

✓ **- 1 pts** *1.9.4d is incorrect:*

$\forall x\ \exists y\ ((P(x, y) \wedge \neg P(y, x)) \vee (\neg P(x, y) \wedge P(y, x)))$

- 0.5 pts 1.9.4d Did not include parentheses

✓ **- 1 pts** *1.9.4e is incorrect:*

$\forall x\ \forall y\ \neg P(x, y) \vee \exists x\ \exists y\ \neg Q(x, y)$

- 0.5 pts 1.9.4e

Improper parentheses

- 0.5 pts 1.9.4c

Correct answer but no work shown

- 0.5 pts 1.9.4d

Correct answer but no work shown

- 0.5 pts 1.9.4e

Correct answer but no work shown

2 question 12 should begin on a new page

3 typo here, see rubric

QUESTION 13

13 Extra credit for typing 5 / 0

✓ **+ 5 pts** *Entirely typed*

+ 0 pts Not entirely typed

QUESTION 14

14 Penalty for not tagging 0 / 0

✓ **- 0 pts** *Tagged*

- 0 pts Not fully and correctly tagged - in the future points will be taken off

Question #1

A. Convert to decimal.

1) $10011011_2 = (1 \times 2^7) + (0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0)$

$= 128 + 0 + 0 + 16 + 8 + 0 + 2 + 1 = 155_{10}$

2) $456_7 = (4 \times 7^2) + (5 \times 7^1) + (6 \times 7^0) = 196 + 35 + 6 = 237_{10}$

3) $38A_{16} = (3 \times 16^2) + (8 \times 16^1) + (10 \times 16^0) = 768 + 128 + 10 = 906_{10}$

4) $2214_5 = (2 \times 5^3) + (2 \times 5^2) + (1 \times 5^1) + (4 \times 5^0) = 250 + 50 + 5 + 4 = 309_{10}$

B. Convert to binary.

1) 69_{10} = (r = remainder)

= 69 / 2 = 34; r = 1

= 34 / 2 = 17; r = 0

= 17 / 2 = 8; r = 1

= 8 / 2 = 4; r = 0

= 4 / 2 = 2; r = 0

= 2 / 2 = 1; r = 0

= 1 / 2 = 0; r = 1

$69_{10} = 1000101_2$

2) 485_{10} = (r = remainder)

= 485 / 2 = 242; r = 1

= 242 / 2 = 121; r = 0

= 121 / 2 = 60; r = 1

= 60 / 2 = 30; r = 0

= 30 / 2 = 15; r = 0

= 15 / 2 = 7; r = 1

= 7 / 2 = 3; r = 1

= 3 / 2 = 1; r = 1

= 1 / 2 = 0; r = 1

$485_{10} = 111100101_2$

3) $6D1A_{16}$ = (using the binary <--> hexadecimal table from the lecture)

= 6 --> 0110

= D --> 1101

= 1 --> 0001

= A --> 1010

$6D1A_{16}$ = 0110 --> 1101 --> 0001 --> 1010

$6D1A_{16} = 110110100011010_2$

C. Convert to hexadecimal.

1) 1101011_2 = (using the binary <--> hexadecimal table from the lecture)

= 0110 and 1011

= 6 and B

$1101011_2 = 6B_{16}$

2) 895_{10} = (r = remainder)

= 895 / 16 = 55; r = 15

= 55 / 16 = 3; r = 7

= 3 / 16 = 0; r = 3

895_{10} = 3 --> 7 --> 15

$895_{10} = 37F_{16}$

Question #2

Addition/Subtraction

1) $7566_8 + 4515_8$ =

= 6 + 5 = 13 --> 3; carry-over = 1

= 6 + 1 + 1 = 8 --> 0; carry-over = 1

= 5 + 5 + 1 = 13 --> 3; carry-over = 1

= 7 + 4 + 1 = 14 --> 14

$7566_8 + 4515_8 = 14303_8$

2) $10110011_2 + 1101_2$ =

= 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 0 + 1 = 2 --> 0; carry-over = 1

1 Q1 **10 / 10**

✓ **- 0 pts** *Correct*

- 5 pts no work shown

- 10 pts Incorrect/ No submission

- 1 pts A1 is incorrect, correct answer:

155

- 1 pts A2 is incorrect, correct answer:

237

- 1 pts A3 is incorrect, correct answer:

906

- 1 pts A4 is incorrect, correct answer:

309

- 1 pts B1 is incorrect, correct answer:

1000101

- 1 pts B2 is incorrect, correct answer:

111100101

- 1 pts B3 is incorrect, correct answer:

110110100011010

- 1 pts C1 is incorrect, correct answer:

6B

- 1 pts C2 is incorrect, correct answer:

37F

- 0.5 pts B1 is correct but no work shown

- 0.5 pts B2 is correct but no work shown

- 0.5 pts B3 is correct but no work shown

- 0.5 pts C1 is correct but no work shown

- 0.5 pts C2 is correct but no work shown

- 0.5 pts A1 is correct but no work shown

- 0.5 pts A2 is correct but no work shown

- 0.5 pts A3 is correct but no work shown

- 0.5 pts A4 is correct but no work shown

= D --> 1101

= 1 --> 0001

= A --> 1010

$6D1A_{16}$ = 0110 --> 1101 --> 0001 --> 1010

$6D1A_{16} = 110110100011010_2$

C. Convert to hexadecimal.

1) 1101011_2 = (using the binary <--> hexadecimal table from the lecture)

= 0110 and 1011

= 6 and B

$1101011_2 = 6B_{16}$

2) 895_{10} = (r = remainder)

= 895 / 16 = 55; r = 15

= 55 / 16 = 3; r = 7

= 3 / 16 = 0; r = 3

895_{10} = 3 --> 7 --> 15

$895_{10} = 37F_{16}$

Question #2

Addition/Subtraction

1) $7566_8 + 4515_8$ =

= 6 + 5 = 13 --> 3; carry-over = 1

= 6 + 1 + 1 = 8 --> 0; carry-over = 1

= 5 + 5 + 1 = 13 --> 3; carry-over = 1

= 7 + 4 + 1 = 14 --> 14

$7566_8 + 4515_8 = 14303_8$

2) $10110011_2 + 1101_2$ =

= 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 0 + 1 = 2 --> 0; carry-over = 1

= 0 + 1 + 1 = 2 --> 0; carry-over = 1

= 0 + 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 1 = 2 --> 0; carry-over = 1

= 0 + 1 = 1 --> 1

= 1 = 1 --> 1

$10110011_2 + 1101_2 = 11000000_2$

3) $7A66_{16} + 45C5_{16}$ =

= 6 + 5 = B --> B

= 6 + C = 12 --> 2; carry-over = 1

= A + 5 + 1 = 10 --> 0; carry-over = 1

= 7 + 4 + 1 = C --> C

$7A66_{16} + 45C5_{16} = C02B_{16}$

4) $3022_5 - 2433_5$ =

= 7 – 3 = 4 --> 4 … (one's digit borrows 5 from the tens digit)

= 6 – 3 = 4 --> 3 … (ten's digit needs to borrow from hundreds digit, hundreds digit borrows from thousands digit)

= 4 – 4 = 0 --> 0

= 2 – 2 = 0 --> 0

$3022_5 - 2433_5 = 34_5$

Question #3

A. Convert to 8-bits two's complement.

1) 124_{10} = (r = remainder)

= 124 / 2 = 62; r = 0

= 62 / 2 = 31; r = 0

= 31 / 2 = 15; r = 1

= 15 / 2 = 7; r = 1

= 7 / 2 = 3; r = 1

= 3 / 2 = 1; r = 1

= 1 / 2 = 0; r = 1

2 Q2 5 / 5

✓ **- 0 pts** *Correct*

- 5 pts No submission / Incorrect

- 1.25 pts 2.1 - $$14303_8$$

- 1.25 pts 2.2 - $$11000000_2$$

- 1.25 pts 2.3 - $$C02B_{16}$$

- 1.25 pts 2.4 - $$34_5$$

- 0.5 pts 2.1 - Correct answer but no work shown

- 0.5 pts 2.2 - Correct answer but no work shown

- 0.5 pts 2.3 - Correct answer but no work shown

- 0.5 pts 2.4 - Correct answer but no work shown

= 0 + 1 + 1 = 2 --> 0; carry-over = 1

= 0 + 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 1 = 2 --> 0; carry-over = 1

= 1 + 1 = 2 --> 0; carry-over = 1

= 0 + 1 = 1 --> 1

= 1 = 1 --> 1

$10110011_2 + 1101_2 = 11000000_2$

3) $7A66_{16} + 45C5_{16}$ =

= 6 + 5 = B --> B

= 6 + C = 12 --> 2; carry-over = 1

= A + 5 + 1 = 10 --> 0; carry-over = 1

= 7 + 4 + 1 = C --> C

$7A66_{16} + 45C5_{16} = C02B_{16}$

4) $3022_5 - 2433_5$ =

= 7 – 3 = 4 --> 4 … (one's digit borrows 5 from the tens digit)

= 6 – 3 = 4 --> 3 … (ten's digit needs to borrow from hundreds digit, hundreds digit borrows from thousands digit)

= 4 – 4 = 0 --> 0

= 2 – 2 = 0 --> 0

$3022_5 - 2433_5 = 34_5$

Question #3

A. Convert to 8-bits two's complement.

1) 124_{10} = (r = remainder)

= 124 / 2 = 62; r = 0

= 62 / 2 = 31; r = 0

= 31 / 2 = 15; r = 1

= 15 / 2 = 7; r = 1

= 7 / 2 = 3; r = 1

= 3 / 2 = 1; r = 1

= 1 / 2 = 0; r = 1

Sign is + --> 0

124_{10} = $01111100_{\text{8-bit 2's compliment}}$

2) -124_{10} = we know 124_{10} equals 01111100 in 8-bit two's complement

Therefore, 01111100 + X = 100000000 where X is -124_{10}

We will now perform the arithmetic seen on the module video to match the 100000000

= 0 + X = 0; X = 0

= 0 + X = 0; X = 0

= 1 + X = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

-124_{10} = $10000100_{\text{8-bit 2's compliment}}$

3) 109_{10} = (r = remainder)

= 109 / 2 = 54; r = 1

= 54 / 2 = 27; r = 0

= 27 / 2 = 13; r = 1

= 13 / 2 = 6; r = 1

= 6 / 2 = 3; r = 0

= 3 / 2 = 1; r = 1

= 1 / 2 = 0; r = 1

Sign is + --> 0

109_{10} = $01101101_{\text{8-bit 2's complement}}$

4) -79_{10} = (r = remainder)

First, we must calculate $+79_{10}$ two's compliment to then calculate the -79_{10} two's compliment.

$+79_{10}$ =

= 79 / 2 = 39; r = 1

= 39 / 2 = 19; r = 1

= 19 / 2 = 9; r = 1

= 9 / 2 = 4; r = 1

= 4 / 2 = 2; r = 0

= 2 / 2 = 1; r = 0

= 1 / 2 = 0; r = 1

Sign is + --> 0

$+79_{10} = 01001111_{\text{8-bit 2's complement}}$

Now we know $+79_{10} = 01001111_{\text{8-bit 2's complement}}$

Therefore, 01001111 + X = 100000000 where X is -79_{10}

We will now perform the arithmetic seen on the module video to match the 100000000

= 1 + X = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

$-79_{10} = 10110001_{\text{8-bit 2's complement}}$

B. Convert to decimal.

1) $00011110_{\text{8-bit 2's complement}} = (0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 0 + 0 + 16 + 8 + 4 + 2 + 0 = +30_{10}$ --> positive because 0

2) $11100110_{\text{8-bit 2's complement}}$ = We must first find the two's complement of 11100110, we know the result will be a negative because of the 11100110. We can simply find its positive complement then use the positive as a negative for the final correct result of $11100110_{\text{8-bit 2's complement}}$ decimal representation.

Therefore, 11100110 + X = 100000000 where X is the positive two's complement of 11100110.

We will now perform the arithmetic seen on the module video to match the 100000000

= 0 + X = 0; X = 0

= 1 + X = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

$11100110_{\text{8-bit 2's complement}}$ two's complement = $00011010_{\text{8-bit 2's complement}}$

$00011010_{\text{8-bit 2's complement}} = (0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 0 + 0 + 16 + 8 + 0 + 2 + 0 = +26_{10}$

$11100110_{\text{8-bit 2's complement}} = -26_{10}$

3) $00101101_{\text{8-bit 2's complement}} = (0 \times 2^6) + (1 \times 2^5) + (0 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$

$= 0 + 32 + 0 + 8 + 4 + 0 + 1 = +45_{10}$ --> positive because 0

4) $10011110_{\text{8-bit 2's complement}}$ = We must first find the two's complement of 10011110, we know the result will be a negative because of the 10011110. We can simply find its positive complement then use the positive as a negative for the final correct result of $10011110_{\text{8-bit 2's complement}}$ decimal representation.

Therefore, 10011110 + X = 100000000 where X is the positive two's complement of 11100110.

We will now perform the arithmetic seen on the module video to match the 100000000

= 0 + X = 0; X = 0

= 1 + X = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 0; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 0 + X + 1 = 0; X = 1; carry-over = 1

= 1 + X + 1 = 0; X = 0; carry-over = 1

$10011110_{\text{8-bit 2's complement}}$ two's complement = $01100010_{\text{8-bit 2's complement}}$

$01100010_{\text{8-bit 2's complement}} = (1 \times 2^6) + (1 \times 2^5) + (0 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 64 + 32 + 0 + 0 + 0 + 2 + 0 = +98_{10}$

$10011110_{\text{8-bit 2's complement}} = -98_{10}$

3 Q3 **9 / 9**

✓ **- 0 pts** *Correct*

- 9 pts Missing

- 2 pts Insufficient work shown

3A

- 1 pts A1 incorrect or missing. Should be 0111 1100.

- 1 pts A2 incorrect or missing. Should be 1000 0100.

- 1 pts A3 incorrect or missing. Should be 0110 1101.

- 1 pts A4 incorrect or missing. Should be 1011 0001.

3B

- 1 pts B1 incorrect or missing. Should be 30.

- 1 pts B2 incorrect or missing. Should be -26.

- 1 pts B3 incorrect or missing. Should be 45.

- 1 pts B4 incorrect or missing. Should be -98

Question #4:

1) Exercise 1.2.4, sections b, c

B) $\neg(p \vee q)$

p	q	$\neg(p \vee q)$
T	T	F
T	F	F
F	T	F
F	F	T

C) $r \vee (p \wedge \neg q)$

r	p	q	$r \vee (p \wedge \neg q)$
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	F
F	T	F	T
F	F	T	F
F	F	F	F

2) Exercise 1.3.4, sections b, d

B) $(p \rightarrow q) \rightarrow (q \rightarrow p)$

p	q	$(p \rightarrow q) \rightarrow (q \rightarrow p)$
T	T	T
T	F	T
F	T	F
F	F	T

D) $(p \leftrightarrow q) \oplus (p \leftrightarrow \neg q)$

p	q	$(p \leftrightarrow q) \oplus (p \leftrightarrow \neg q)$
T	T	T
T	F	T
F	T	T

F	F	T

Question #5:

1) Exercise 1.2.7, sections b, c

B) The applicant must present at least two of the following forms of identification: birth certificate, driver's license, marriage license.

Answer = $(b \wedge d) \vee (b \wedge m) \vee (d \wedge m)$

C) Applicant must present either a birth certificate or both a driver's license and a marriage license.

Answer = $b \vee (d \wedge m)$

2) Exercise 1.3.7, sections b – e

B) A person can park in the school parking lot if they are a senior or at least seventeen years of age.

Answer = $(s \vee y) \rightarrow p$

C) Being 17 years of age is a necessary condition for being able to park in the school parking lot.

Answer = $p \rightarrow y$

D) A person can park in the school parking lot if and only if the person is a senior and at least 17 years of age.

Answer = $p \leftrightarrow (s \wedge y)$

E) Being able to park in the school parking lot implies that the person is either a senior or at least 17 years old.

Answer = $p \rightarrow (s \vee y)$

3) Exercise 1.3.9, sections c, d

C) The applicant can enroll in the course only if the applicant has parental permission.

Answer = $p \rightarrow c$

D) Having parental permission is a necessary condition for enrolling in the course.

Answer = $p \leftrightarrow c$

Question #6:

1) Exercise 1.3.6, sections b – d

B) Maintaining a B average is necessary for Joe to be eligible for the honors program.

4 Q4 **5 / 5**

✓ **- 0 pts** *Correct*

- 1 pts 1.2.4.b incorrect

p q (p ∨ q)
T T T
T F T
F T T
F F F

- 1 pts 1.2.4.c incorrect

p q (p ∨ (p ∧ ¬q)
T T T T F
T F T T T
F T F F F
F F F F F

- 1 pts 1.3.4.b incorrect

p q ((p → q) → (q → p)
T T T
T F T
F T F
F F T

- 1 pts 1.3.4.d incorrect

p q ((p ↔ q) ⊕ (p ↔ ¬q)
T T T
T F T
F T T
F F T

- 5 pts Question missing

F	F	T

Question #5:

1) Exercise 1.2.7, sections b, c

B) The applicant must present at least two of the following forms of identification: birth certificate, driver's license, marriage license.

Answer = $(b \wedge d) \vee (b \wedge m) \vee (d \wedge m)$

C) Applicant must present either a birth certificate or both a driver's license and a marriage license.

Answer = $b \vee (d \wedge m)$

2) Exercise 1.3.7, sections b – e

B) A person can park in the school parking lot if they are a senior or at least seventeen years of age.

Answer = $(s \vee y) \rightarrow p$

C) Being 17 years of age is a necessary condition for being able to park in the school parking lot.

Answer = $p \rightarrow y$

D) A person can park in the school parking lot if and only if the person is a senior and at least 17 years of age.

Answer = $p \leftrightarrow (s \wedge y)$

E) Being able to park in the school parking lot implies that the person is either a senior or at least 17 years old.

Answer = $p \rightarrow (s \vee y)$

3) Exercise 1.3.9, sections c, d

C) The applicant can enroll in the course only if the applicant has parental permission.

Answer = $p \rightarrow c$

D) Having parental permission is a necessary condition for enrolling in the course.

Answer = $p \leftrightarrow c$

Question #6:

1) Exercise 1.3.6, sections b – d

B) Maintaining a B average is necessary for Joe to be eligible for the honors program.

5 Q5 7 / 9

- **0 pts** Correct; good job
- **1 pts** 1.2.7b incorrect. Should be "(B∧M)∨(B∧D)∨(M∧D)" or equivalent.
- **1 pts** 1.2.7c incorrect. Should be "B∨(D∧M)".
- **1 pts** 1.3.7b incorrect. Should be "(s ∨ y) → p".
- **1 pts** 1.3.7c incorrect or missing. Should be "p → y".
- **1 pts** 1.3.7d incorrect or missing. Should be "p ↔ (s ∧ y)".
- **1 pts** 1.3.7e incorrect or missing. Should be "p → (s ∨ y)".

✓ **- 1 pts** *1.3.9c incorrect or missing. Should be "c → p".*

✓ **- 1 pts** *1.3.9d incorrect or missing. Should be "c → p".*

- **9 pts** Entirely incorrect or missing

F	F	T

Question #5:

1) Exercise 1.2.7, sections b, c

B) The applicant must present at least two of the following forms of identification: birth certificate, driver's license, marriage license.

Answer = $(b \wedge d) \vee (b \wedge m) \vee (d \wedge m)$

C) Applicant must present either a birth certificate or both a driver's license and a marriage license.

Answer = $b \vee (d \wedge m)$

2) Exercise 1.3.7, sections b – e

B) A person can park in the school parking lot if they are a senior or at least seventeen years of age.

Answer = $(s \vee y) \rightarrow p$

C) Being 17 years of age is a necessary condition for being able to park in the school parking lot.

Answer = $p \rightarrow y$

D) A person can park in the school parking lot if and only if the person is a senior and at least 17 years of age.

Answer = $p \leftrightarrow (s \wedge y)$

E) Being able to park in the school parking lot implies that the person is either a senior or at least 17 years old.

Answer = $p \rightarrow (s \vee y)$

3) Exercise 1.3.9, sections c, d

C) The applicant can enroll in the course only if the applicant has parental permission.

Answer = $p \rightarrow c$

D) Having parental permission is a necessary condition for enrolling in the course.

Answer = $p \leftrightarrow c$

Question #6:

1) Exercise 1.3.6, sections b – d

B) Maintaining a B average is necessary for Joe to be eligible for the honors program.

Answer = If grade average is a B or higher then Joe is eligible for the honors program.

C) Rajiv can go on the roller coaster only if he is at least four feet tall.

Answer = if Rajiv is at least four feet tall then he may ride the roller coaster.

D) Rajiv can go on the roller coaster if he is at least four feet tall.

Answer = if Rajiv is at least four feet tall then he can ride the roller coaster

2) Exercise 1.3.10, sections c – f

C) $(p \vee r) \leftrightarrow (q \wedge r)$ = False

D) $(p \wedge r) \leftrightarrow (q \wedge r)$ = Unknown

E) $p \rightarrow (r \vee q)$ = Unknown

F) $(p \wedge q) \rightarrow r$ = True

Question #7:

1) Exercise 1.4.5, sections b – d

B) If Sally did not get the job, then she was late for her interview or did not update her resume. If Sally updated her resume and was not late for her interview, then she got the job.

1st = $\neg j \rightarrow (l \vee \neg r)$

2nd = $(r \wedge \neg l) \rightarrow j$

Equivalent = Yes, below you may find a truth table for both expressions displaying that they each yield the same results.

j	l	r	$\neg j \rightarrow (l \vee \neg r)$	$(r \wedge \neg l) \rightarrow j$
T	T	T	T	T
T	T	F	T	T

6 Q6 6 / 8

- 0 pts Correct

- 8 pts not submitted

Click here to replace this description.

✓ **- 1 pts** *1.3.6 B If Joe is eligible for the honors program, then he has maintained a B average.*

✓ **- 1 pts** *1.3.6 C If Rajiv can go on the roller coaster, then he is at least four feet tall.*

- 1 pts 1.3.6 D If Rajiv is at least four feet tall, then he can go on the roller coaster.

Click here to replace this description.

- 1 pts 1.3.10 C False. $p \vee r$ is true and $q \wedge r$ is false. Therefore $(p \vee r) \leftrightarrow (q \wedge r)$ is false.

- 1 pts 1.3.10 D Unknown. If r is true, then the expression is false. If r is false, then the expression is true.

- 1 pts 1.3.10 E Unknown. If r is true, then the expression is true. If r is false, then the expression is false.

- 2 pts 1.3.10 F True. Since the hypothesis $p \wedge q$ is false, the conditional statement $(p \wedge q) \rightarrow r$ is true.

Answer = If grade average is a B or higher then Joe is eligible for the honors program.

C) Rajiv can go on the roller coaster only if he is at least four feet tall.

Answer = if Rajiv is at least four feet tall then he may ride the roller coaster.

D) Rajiv can go on the roller coaster if he is at least four feet tall.

Answer = if Rajiv is at least four feet tall then he can ride the roller coaster

2) Exercise 1.3.10, sections c – f

C) $(p \vee r) \leftrightarrow (q \wedge r)$ = False

D) $(p \wedge r) \leftrightarrow (q \wedge r)$ = Unknown

E) $p \rightarrow (r \vee q)$ = Unknown

F) $(p \wedge q) \rightarrow r$ = True

Question #7:

1) Exercise 1.4.5, sections b – d

B) If Sally did not get the job, then she was late for her interview or did not update her resume. If Sally updated her resume and was not late for her interview, then she got the job.

1st = $\neg j \rightarrow (l \vee \neg r)$

2nd = $(r \wedge \neg l) \rightarrow j$

Equivalent = Yes, below you may find a truth table for both expressions displaying that they each yield the same results.

j	l	r	$\neg j \rightarrow (l \vee \neg r)$	$(r \wedge \neg l) \rightarrow j$
T	T	T	T	T
T	T	F	T	T

T	F	T	T	T
T	F	F	T	T
F	T	T	T	T
F	T	F	T	T
F	F	T	F	F
F	F	F	T	T

C) If Sally got the job then she was not late for her interview.
If Sally did not get the job, then she was late for her interview.

$1^{st} = j \rightarrow \neg l$

$2^{nd} = \neg j \rightarrow l$

Equivalent = No, below you may find a truth table for both expressions displaying that they each yield different results.

j	l	$j \rightarrow \neg l$	$\neg j \rightarrow l$
T	T	F	T
T	F	T	T
F	T	T	T
F	F	T	F

D) If Sally updated her resume or she was not late for her interview, then she got the job.
If Sally got the job, then she updated her resume and was not late for her interview.

$1^{st} = (r \vee \neg l) \rightarrow j$

$2^{nd} = j \rightarrow (r \wedge \neg l)$

Equivalent = No, below you may find a truth table for both expressions displaying that they each yield different results.

j	l	r	$(r \vee \neg l) \rightarrow j$	$j \rightarrow (r \wedge \neg l)$
T	T	T	T	F
T	T	F	T	F
T	F	T	T	T
T	F	F	T	F
F	T	T	F	T
F	T	F	T	T
F	F	T	F	T
F	F	F	F	T

7 Q7 4 / 4

✓ **- 0 pts** *Correct*

- 4 pts No submission

- 3.5 pts At least one of the answers is correct, but no proof/disproof of logical equivalences exist

- 2 pts 1.4.5B

$$\lnot j \rightarrow (l \lor \lnot r)$$

$$(r \land \lnot l) \rightarrow j$$

Logically equivalent.

- 1.5 pts 1.4.5B

Did not provide proof of logical equivalence.

- 0.75 pts 1.4.5B

Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 0.5 pts 1.4.5B

Correct conclusion but incorrect truth table values.

- 1 pts 1.4.5C

$$j \rightarrow \lnot l$$

$$\lnot j \rightarrow l$$

Not logically equivalent. if $$j = l = T$$, then $$j \rightarrow \lnot l$$ is false but $$\lnot j \rightarrow l$$ is true.

- 0.75 pts 1.4.5C

Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 0.5 pts 1.4.5C

Correct conclusion but incorrect truth table values.

- 1 pts 1.4.5D

$$(r \lor \lnot l) \rightarrow j$$

$$j \rightarrow (r \land \lnot l)$$

Not logically equivalent. if $$j = l = r = T$$, then $$(r \lor \lnot l) \rightarrow j$$ is true but $$j \rightarrow (r \land \lnot l)$$ is false.

- 0.5 pts 1.4.5D

Correct conclusion but incorrect truth table values.

- 0.75 pts 1.4.5D

Correct conclusion but did not provide disproof of logical equivalence using counter example/truth table

- 4 pts No conclusion and no proof/disproof of logical equivalences

- 3 pts All answers are correct, but did not provide proof/disproof of logical equivalences

- 3.5 pts Did not state whether logically equivalent or not, and did not provide proof/disproof of logical equivalences.

- 4 pts Incorrect

Question #8:

1) Exercise 1.5.2, sections c, f, I

C) $(p \rightarrow q) \land (p \rightarrow r) \equiv p \rightarrow (q \land r)$

Conditional Identities: $(\neg p \lor q) \land (\neg p \lor r)$

Distributive Laws: $\neg p \lor (q \land r)$

Conditional Identities: $p \rightarrow (q \land r)$

Answer = Yes, they are both proven to be equivalent.

F) $\neg(p \lor (\neg p \land q)) \equiv \neg p \land \neg q$

Distributive laws: $\neg ((p \lor \neg p) \land (p \lor q)$

Complement laws: $\neg ((T) \land (p \lor q)$

Identity Laws: $\neg (p \lor q)$

De Morgan's Laws: $\neg p \land \neg q$

Answer = Yes, they are both proven to be equivalent.

I) $(p \land q) \rightarrow r \equiv (p \land \neg r) \rightarrow \neg q$

Left Hand Side:

Conditional Identities: $\neg (p \land q) \lor r$

De Morgan's Laws: $(\neg p \lor \neg q) \lor r$

Right Hand Side:

Conditional Identities: $\neg (p \land \neg r) \lor \neg q$

De Morgan's Laws: $(\neg p \lor \neg \neg r) \lor \neg q$

Simplifying: $(\neg p \lor r) \lor \neg q$

Answer = Yes, they are both proven to be equivalent given both sides final simplifications. This can also be proven by a truth table.

2) Exercise 1.5.3, sections c, d

C) $\neg r \vee (\neg r \rightarrow p)$

Answer = Yes, it is a tautology. Proof can be found below.

r	p	$\neg r \vee (\neg r \rightarrow p)$
T	T	T
T	F	T
F	T	T
F	F	T

D) $\neg(p \rightarrow q) \rightarrow \neg q$

Answer = Yes, it is a tautology. Proof can be found below.

p	q	$\neg (p \rightarrow q) \rightarrow \neg q$
T	T	T
T	F	T
F	T	T
F	F	T

Question #9:

1) Exercise 1.6.3, sections c, d

C) There is a number that is equal to its square.

Answer = $\exists$ x (x = x2)

D) Every number is less than or equal to its square plus 1.

Answer = $\forall$ x (x <= x2 + 1)

2) Exercise 1.7.4, sections b – d

B) Everyone was well and went to work yesterday.

Answer = $\forall$ x ($\neg$S(x) $\wedge$ W(x))

C) Everyone who was sick yesterday did not go to work.

Answer = $\forall$ x (S(x) $\rightarrow$ $\neg$ W(x))

D) Yesterday someone was sick and went to work.

8 Q8 5 / 6

- **0 pts** Correct; good job
- **1 pts** 1.5.2c is incorrect or missing
- **1 pts** 1.5.2f is incorrect or missing
- **1 pts** 1.5.2i is incorrect or missing
- **1.5 pts** 1.5.3c is incorrect or missing
- **1.5 pts** 1.5.3d is incorrect or missing
- **2 pts** Did not include which law was being used, otherwise correct
- **6 pts** Completely incorrect or missing
- **0.5 pts** Small mistake, otherwise correct.

✓ **- 1 pts** *Did not include Laws of Logic for some problems*

- **2 pts** Did not include the logic statements (showing how they change when Laws are applied)

2) Exercise 1.5.3, sections c, d

C) $\neg r \vee (\neg r \rightarrow p)$

Answer = Yes, it is a tautology. Proof can be found below.

r	p	$\neg r \vee (\neg r \rightarrow p)$
T	T	T
T	F	T
F	T	T
F	F	T

D) $\neg(p \rightarrow q) \rightarrow \neg q$

Answer = Yes, it is a tautology. Proof can be found below.

p	q	$\neg (p \rightarrow q) \rightarrow \neg q$
T	T	T
T	F	T
F	T	T
F	F	T

Question #9:

1) Exercise 1.6.3, sections c, d

C) There is a number that is equal to its square.

Answer = $\exists$ x (x = x2)

D) Every number is less than or equal to its square plus 1.

Answer = $\forall$ x (x <= x2 + 1)

2) Exercise 1.7.4, sections b – d

B) Everyone was well and went to work yesterday.

Answer = $\forall$ x ($\neg$S(x) $\wedge$ W(x))

C) Everyone who was sick yesterday did not go to work.

Answer = $\forall$ x (S(x) $\rightarrow$ $\neg$ W(x))

D) Yesterday someone was sick and went to work.

Answer = $\exists x (S(x) \land W(x))$

Question #10:

1) Exercise 1.7.9, sections c – I

C) $\exists x((x = c) \rightarrow P(x))$ = False

D) $\exists x(Q(x) \land R(x))$ = True

E) $Q(a) \land P(d)$ = True

F) $\forall x ((x \neq b) \rightarrow Q(x))$ = True

G) $\forall x (P(x) \lor R(x))$ = False

H) $\forall x (R(x) \rightarrow P(x))$ = True

I) $\exists x(Q(x) \lor R(x))$ = True

2) Exercise 1.9.2, sections b – I

B) $\exists x \forall y Q(x, y)$ = True

C) $\exists y \forall x P(x, y)$ = True

D) $\exists x \exists y S(x, y)$ = False

E) $\forall x \exists y Q(x, y)$ = False

F) $\forall x \exists y P(x, y)$ = True

G) $\forall x \forall y P(x, y)$ = False

H) $\exists x \exists y Q(x, y)$ = True

I) $\forall x \forall y \neg S(x, y)$ = True

Question #11:

1) Exercise 1.10.4, sections c – g

C) There are two numbers whose sum is equal to their product.

9 Q9 6 / 6

✓ **- 0 pts** *Correct*

- 6 pts No submission

- 1.2 pts 1.6.3.c) $$\exists x (x^2 = x)$$

- 1.2 pts 1.6.3.d) $$\forall x (x \leq x^2)$$

OR

1.6.3.d) $$\forall x (x \leq x^2) + 1$$

- 1.2 pts 1.7.4.b) $$\forall x(\lnot S(x) \land W(x))$$

- 1.2 pts 1.7.4.c) $$\forall x (S(x) \rightarrow \lnot W(x))$$

- 1.2 pts 1.7.4.d) $$\exists x (S(x) \land W(x))$$

- 0.6 pts Failed to use parentheses

Answer = $\exists x (S(x) \land W(x))$

Question #10:

1) Exercise 1.7.9, sections c – I

C) $\exists x((x = c) \rightarrow P(x))$ = False

D) $\exists x(Q(x) \land R(x))$ = True

E) $Q(a) \land P(d)$ = True

F) $\forall x ((x \neq b) \rightarrow Q(x))$ = True

G) $\forall x (P(x) \lor R(x))$ = False

H) $\forall x (R(x) \rightarrow P(x))$ = True

I) $\exists x(Q(x) \lor R(x))$ = True

2) Exercise 1.9.2, sections b – I

B) $\exists x \forall y Q(x, y)$ = True

C) $\exists y \forall x P(x, y)$ = True

D) $\exists x \exists y S(x, y)$ = False

E) $\forall x \exists y Q(x, y)$ = False

F) $\forall x \exists y P(x, y)$ = True

G) $\forall x \forall y P(x, y)$ = False

H) $\exists x \exists y Q(x, y)$ = True

I) $\forall x \forall y \neg S(x, y)$ = True

Question #11:

1) Exercise 1.10.4, sections c – g

C) There are two numbers whose sum is equal to their product.

10 Q10 **15 / 16**

- **0 pts** Correct; good job

✓ **- 1 pts** *1.7.9 c incorrect. Answer is True*

- **1 pts** 1.7.9 d incorrect. Answer is True
- **1 pts** 1.7.9 e incorrect. Answer is True
- **1 pts** 1.7.9 f incorrect. Answer is True
- **1 pts** 1.7.9 g incorrect. Answer is False
- **1 pts** 1.7.9 h incorrect. Answer is True
- **1 pts** 1.7.9 i incorrect. Answer is True
- **1 pts** 1.9.2 b incorrect. Answer is True
- **1 pts** 1.9.2 c incorrect. Answer is True
- **1 pts** 1.9.2 d incorrect. Answer is False
- **1 pts** 1.9.2 e incorrect. Answer is False
- **1 pts** 1.9.2 f incorrect. Answer is True
- **1 pts** 1.9.2 g incorrect. Answer is False
- **1 pts** 1.9.2 h incorrect. Answer is True
- **1 pts** 1.9.2 i incorrect. Answer is True
- **16 pts** Entirely incorrect or missing

Answer = $\exists x (S(x) \land W(x))$

Question #10:

1) Exercise 1.7.9, sections c – I

C) $\exists x((x = c) \rightarrow P(x))$ = False

D) $\exists x(Q(x) \land R(x))$ = True

E) $Q(a) \land P(d)$ = True

F) $\forall x ((x \neq b) \rightarrow Q(x))$ = True

G) $\forall x (P(x) \lor R(x))$ = False

H) $\forall x (R(x) \rightarrow P(x))$ = True

I) $\exists x(Q(x) \lor R(x))$ = True

2) Exercise 1.9.2, sections b – I

B) $\exists x \forall y Q(x, y)$ = True

C) $\exists y \forall x P(x, y)$ = True

D) $\exists x \exists y S(x, y)$ = False

E) $\forall x \exists y Q(x, y)$ = False

F) $\forall x \exists y P(x, y)$ = True

G) $\forall x \forall y P(x, y)$ = False

H) $\exists x \exists y Q(x, y)$ = True

I) $\forall x \forall y \neg S(x, y)$ = True

Question #11:

1) Exercise 1.10.4, sections c – g

C) There are two numbers whose sum is equal to their product.

Answer = $\exists x, y\ (x + y = x * y)$

D) The ratio of every two positive numbers is also positive.

Answer = $\forall x, y\ (x, y > 0) \rightarrow x / y > 0$

E) The reciprocal of every positive number less than one is greater than one.

Answer = $\forall x\ (x > 0 \wedge x < 1) \rightarrow ((1 / x) > 1)$

F) There is no smallest number.

Answer = $-\exists x\ (\ \wedge\ \forall y\ (\ y > x))$

G) Every number other than 0 has a multiplicative inverse.

Answer Ax $(\ x \neq 0) \rightarrow \exists y\ (x * y = 1)$

2) Exercise 1.10.7, sections c – f

C) There is at least one new employee who missed the deadline.

Answer = $\exists x\ (\ N(x) \wedge D(x))$

D) Sam knows the phone number of everyone who missed the deadline.

Answer = $\forall x\ (D(x) \rightarrow P(Sam, x))$

E) There is a new employee who knows everyone's phone number.

Answer = $\exists x\ (N(x) \wedge \forall x\ (P(x,y)))$

F) Exactly one new employee missed the deadline.

Answer = $\exists x\ (N(x) \wedge D(x) \wedge\ \forall x\ (N(y) \wedge -D(y) \rightarrow x = y))$

3) Exercise 1.10.10, sections c – f

C) Every student has taken at least one class other than Math 101.

Answer = $\forall x\ \exists y\ (T(x, y) \wedge y \neq$ Math 101)

D There is a student who has taken every math class other than Math 101.

Answer = $\exists x\ \forall y\ (T(x, y) \wedge y \neq$ Math 101)

E) Everyone other than Sam has taken at least two different math classes.

Answer = $\forall x\ (x \neq$ Sam) $\exists (y, z)(T(x, y) \wedge T(x, z) \wedge y \neq z)$

F) Sam has taken exactly two math classes.

Answer = $T(Sam, a) \wedge T(Sam, b) \wedge \forall y(\ T(Sam, y) \rightarrow (y = a) \vee (y = b))$

Question #12: 2

11 Q11 7 / 14

- 0 pts Correct

1.10.4

- 1 pts 1.10.4 C is incorrect

$\exists x\ \exists y\ (x + y = xy)$

- 1 pts 1.10.4 D is incorrect

$\forall x\ \forall y\ (((x > 0) \wedge (y > 0)) \rightarrow (x/y > 0))$

- 1 pts 1.10.4 E is incorrect

$\forall x\ (((x > 0) \wedge (x < 1)) \rightarrow (1/x > 1))$

or

$\forall x\ ((0 < x < 1) \rightarrow (1/x > 1))$

✓ **- 1 pts** *1.10.4 F is incorrect*

$\neg\exists x\ \forall y\ (x \leq y)$

or

$\forall x\ \exists y\ (x > y)$

or

$\forall x\ \exists y\ (y < x)$

- 1 pts 1.10.4 G is incorrect

$\forall x\ \exists y\ ((x \neq 0) \rightarrow (xy = 1))$

or

$\forall x\ \exists y\ ((x \neq 0) \rightarrow (y = 1/x))$

or

∀x ∃y ((x > 0) v (x < 0) → (xy = 1))

or

∀x ∃y ((x > 0) v (x < 0) → (x^-1 = y))

1.10.7

- 1 pts 1.10.7 C is incorrect

∃x (N(x) ∧ D(x))

- 1 pts 1.10.7 D is incorrect

∀x (D(x) → P(Sam, x))

✓ **- 1 pts** *1.10.7 E is incorrect*

∃x ∀y (N(x) ∧ P(x, y))

✓ **- 1 pts** *1.10.7 F is incorrect*

∃x ∀y (N(x) ∧ D(x) ∧ ((x ≠ y ∧ N(y)) → ¬D(y)))

1.10.10

- 1 pts 1.10.10 C is incorrect

∀x ∃y ((y ≠ Math 101) ∧ T(x, y))

✓ **- 1 pts** *1.10.10 D is incorrect*

∃x ∀y ((y ≠ Math 101) → T(x, y))

✓ **- 1 pts** *1.10.10 E is incorrect*

∀x ∃y ∃z ((x ≠ Sam) → ((y ≠ z) ∧ T(x, y) ∧ T(x, z)))

✓ **- 2 pts** *1.10.10 F is incorrect*

∃y ∃z ∀w ((z ≠ y) ∧ T(Sam, y) ∧ T(Sam, z) ∧ ((w ≠ y ∧ w ≠ z) → ¬T(Sam, w)))

or (different variable naming)

$\exists x\ \exists y\ \forall z\ ((y \neq x) \wedge T(Sam, x) \wedge T(Sam, y) \wedge ((z \neq x \wedge z \neq y) \rightarrow \neg T(Sam, z)))$

- 14 pts Incorrect/ No submission

1 Question 11 should begin on a new page and be tagged accordingly.

Answer = $\exists x, y\ (x + y = x * y)$

D) The ratio of every two positive numbers is also positive.

Answer = $\forall x, y\ (x, y > 0) \rightarrow x / y > 0$

E) The reciprocal of every positive number less than one is greater than one.

Answer = $\forall x\ (x > 0 \wedge x < 1) \rightarrow ((1 / x) > 1)$

F) There is no smallest number.

Answer = $-\exists x\ (\ \wedge\ \forall y\ (\ y > x))$

G) Every number other than 0 has a multiplicative inverse.

Answer Ax $(\ x \neq 0) \rightarrow \exists y\ (x * y = 1)$

2) Exercise 1.10.7, sections c – f

C) There is at least one new employee who missed the deadline.

Answer = $\exists x\ (\ N(x) \wedge D(x))$

D) Sam knows the phone number of everyone who missed the deadline.

Answer = $\forall x\ (D(x) \rightarrow P(Sam, x))$

E) There is a new employee who knows everyone's phone number.

Answer = $\exists x\ (N(x) \wedge \forall x\ (P(x,y)))$

F) Exactly one new employee missed the deadline.

Answer = $\exists x\ (N(x) \wedge D(x) \wedge\ \forall x\ (N(y) \wedge -D(y) \rightarrow x = y))$

3) Exercise 1.10.10, sections c – f

C) Every student has taken at least one class other than Math 101.

Answer = $\forall x\ \exists y\ (T(x, y) \wedge y \neq$ Math 101)

D There is a student who has taken every math class other than Math 101.

Answer = $\exists x\ \forall y\ (T(x, y) \wedge y \neq$ Math 101)

E) Everyone other than Sam has taken at least two different math classes.

Answer = $\forall x\ (x \neq$ Sam) $\exists (y, z)(T(x, y) \wedge T(x, z) \wedge y \neq z)$

F) Sam has taken exactly two math classes.

Answer = $T(Sam, a) \wedge T(Sam, b) \wedge \forall y(\ T(Sam, y) \rightarrow (y = a) \vee (y = b))$

Question #12: 2

1) Exercise 1.8.2, sections b – e

B) Every patient was given the medication or the placebo or both.

= ∀ x (D(x) ∨ P(x))

= ¬ ∀ x (D(x) ∨ P(x))

= ∃ x (-D(x) ∧ ¬ P(x))

Answer = Some patient was not given the placebo and the medication.

C) There is a patient who took the medication and had migraines.

= ∃ x (D(x) ∧ M(x))

= ¬ ∃ x

= ∀ x (¬ D(x) ∨ ¬ P(x))

Answer = Every patient was either not given the medication or not experiencing migraines.

D) Every patient who took the placebo had migraines. (Hint: you will need to apply the conditional identity, p → q ≡ ¬p ∨ q.)

= ∀ x (P(x) → M(x))

= ∀ x (¬ P(x) ∨ M(x))

= ¬ ∀ x

= ∃ x (¬ ¬ P(x) ∧ ¬ M(x))

= ∃ x (P(x) ∧ ¬ M(x))

Answer = Some patient was given the placebo and was not experiencing migraines.

E) There is a patient who had migraines and was given the placebo.

= ∃ x (M(x) ∧ P(x))

= ¬ ∃ x

= ∀ x (¬ M(x) ∨ ¬ P(x))

Answer = Every patient was either not given a placebo or did not experience migraines.

2) Exercise 1.9.4, sections c – e

C) ∃x ∀y (P(x, y) → Q(x, y))

Answer = ¬(∃x ∀y (P(x, y) → Q(x, y))) = ∀x ∃y (¬(P(x, y) →Q(x, y)))

D) ∃x ∀y (P(x, y) ↔ P(y, x))

Answer = ¬(∃x ∀y (P(x, y) ↔ P(y, x))) = ∃x ∃y (¬(P(x, y) ↔ P(y, x)))

E) $\exists x \exists y P(x, y) \wedge \forall x \forall y Q(x, y)$

Answer = $\neg(\exists x \exists y P(x, y) \wedge \forall x \forall y Q(x, y)) = (\neg\exists x \exists y P(x, y)) \vee (\neg\forall x \forall y Q(x, y))$

12 Q12 5 / 8

- **0 pts** Correct
- **8 pts** No Submission

1.8.2 B Incorrect

Correct: $\exists x\,(\neg D(x) \wedge \neg P(x))$

- **0.5 pts** English statement is incorrect

English: There is a patient who was not given the medication and not given the placebo.

- **1 pts** 1.8.2b is incorrect:

$\forall x\,(D(x) \vee P(x))$

Negation: $\neg\forall x\,(D(x) \vee P(x))$

Applying De Morgan's law: $\exists x\,(\neg D(x) \wedge \neg P(x))$

English: There exists a patient who was not given the medication and not given the placebo.

- **0.5 pts** Incorrect bracket use
- **0.75 pts** Didn't do negation, simplification(s), or new English sentence.
- **0.5 pts** Final expression Incorrect

1.8.2 C Incorrect

Correct: $\forall x\,(\neg D(x) \vee \neg M(x))$

- **1 pts** Incorrect

$\exists x\,(D(x) \wedge M(x))$

Negation: $\neg\exists x\,(D(x) \wedge M(x))$

Applying De Morgan's law: $\forall x\,(\neg D(x) \vee \neg M(x))$

English: Every patient did not get the medication or did not have migraines or both.

- **0.5 pts** English Statement Incorrect:

English: Every patient did not get the medication or did not have migraines or both.

- **0.5 pts** Final expression Incorrect
- **0.5 pts** Incorrect bracket use

- **- 0.75 pts** Did not include new English statement

1.8.2 D Incorrect

Correct: $\exists x\,(P(x) \wedge \neg M(x))$

- **- 1 pts** incorrect:

$\forall x\,(P(x) \rightarrow M(x))$

Negation: $\neg\forall x\,(P(x) \rightarrow M(x))$

Applying De Morgan's law: $\exists x\,(P(x) \wedge \neg M(x))$

English: Some patient took the placebo and did not have migraines.

or "There exists a patient that did not take the placebo and did not have a migraine"

- **- 0.5 pts** English statement is incorrect:

English: Some patient took the placebo and did not have migraines.

- "some patients" instead of "some patient". existential just implies at least one patient.

- **- 0.5 pts** Incorrect bracket use
- **- 0.5 pts** Didn't fully simplify
- **- 0.75 pts** Did not do negation, simplification(s), or new English sentence.

1.8.2 E Incorrect

Correct: $\forall x\,(\neg M(x) \vee \neg P(x))$

- **- 0.5 pts** English statement is incorrect:

English: Every patient did not have migraines or did not take the placebo

- **- 1 pts** incorrect:

$\exists x\,(M(x) \wedge P(x))$

Negation: $\neg\exists x\,(M(x) \wedge P(x))$

Applying De Morgan's law: $\forall x\,(\neg M(x) \vee \neg P(x))$

English: Every patient did not have migraines or did not take the placebo.

- **0.5 pts** incorrect bracket use

- **0.75 pts** Did not do negation, simplification(s), or new English sentence.

- **0.5 pts** Incorrect simplification

- **0.5 pts** Final expression Incorrect

✓ **- 1 pts** *1.9.4c is incorrect:*

$\forall x\ \exists y\ (P(x, y) \land \neg Q(x, y))$

- **0.5 pts** 1.9.4c

Did not include proper parentheses

✓ **- 1 pts** *1.9.4d is incorrect:*

$\forall x\ \exists y\ ((P(x, y) \land \neg P(y, x)) \lor (\neg P(x, y) \land P(y, x)))$

- **0.5 pts** 1.9.4d Did not include parentheses

✓ **- 1 pts** *1.9.4e is incorrect:*

$\forall x\ \forall y\ \neg P(x, y) \lor\ \exists x\ \exists y\ \neg Q(x, y)$

- **0.5 pts** 1.9.4e

Improper parentheses

- **0.5 pts** 1.9.4c

Correct answer but no work shown

- **0.5 pts** 1.9.4d

Correct answer but no work shown

- **0.5 pts** 1.9.4e

Correct answer but no work shown

2 question 12 should begin on a new page

3 typo here, see rubric

13 Extra credit for typing **5 / 0**

✓ **+ 5 pts** *Entirely typed*

+ 0 pts Not entirely typed

14 Penalty for not tagging **0 / 0**

✓ **- 0 pts** *Tagged*

- 0 pts Not fully and correctly tagged - in the future points will be taken off