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Question 1:

A. Convert the following numbers to their decimal representation. Show your work.

1. 10011011_2 =
$1x2^7 + 0x2^6 + 0x2^5 + 1x2^4 + 1x2^3 + 0x2^2 + 1x2^1 + 1x2^0$ =
$128 + 0 + 0 + 16 + 8 + 0 + 2 + 1$ =
Answer: 155_{10}

2. 456_7 =
$4x7^2 + 5x7^1 + 6x7^0$ =
$196 + 35 + 6$ =
Answer: 237_{10}

3. $38A_{16}$ =
$3x16^2 + 8x16^1 + 10x16^0$ =
$768 + 128 + 10$ =
Answer: 906_{10}

4. 2214_5 =
$2x5^3 + 2x5^2 + 1x5^1 + 4x5^0$ =
$125 + 50 + 5 + 4$ =
Answer: 184_{10}

B. Convert the following numbers to their binary representation:

1. 69_{10} =
69/2 = 34 remainder 1 | 34/2 = 17 remainder 0 | 17/2 = 8 remainder 1 | 8/2 = 4 remainder 0 | 4/2 = 2 remainder 0 | 2/2 = 1 remainder 0 | 1/2 = 0 remainder 1
Answer: 1000101_2

2. 485_{10}=
485/2 = 242 remainder 1| 242/2 = 121 remainder 0| 121/2 = 60 remainder 1| 60/2 = 30 remainder 0| 30/2 = 15 remainder 0| 15/2 = 7 remainder 1| 7/2 = 3 remainder 1| 3/2 = 1 remainder 1| 1/2 = 0 remainder 1
Answer: 111100101_2

3. $6D1A_{16}$ =
6 = 0110| D = 1101| 1 = 0001| A = 1010
Answer: 0110110100011010_2

C. Convert the following numbers to their hexadecimal representation:

1. 1101011_2 =
110 = 6| 1011 = B
Answer: $6B_{16}$

2. 895_{10} =
895/16 = 55 remainder 15| 55/16 = 3 remainder 7| 3/16 = 0 remainder 3
Answer: $37F_{16}$

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Question 2:
Solve the following, do all calculations in the given base. Show your work.

1. $7566_8 + 4515_8 =$

$$\begin{array}{r} {\scriptstyle 111} \\ 7566_8 \\ 4515_8 \\ \hline \end{array}$$

Answer: 14303_8

---

2. $10110011_2 + 1101_2 =$

$$\begin{array}{r} {\scriptstyle 111111} \\ 10110011_2 \\ 00001101_2 \\ \hline \end{array}$$

Answer: 11000000_2

---

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

$$\begin{array}{r} {\scriptstyle 11} \\ 7A66_{16} \\ 45C5_{16} \\ \hline \end{array}$$

Answer: $C02B_{16}$

---

4. $3022_5 - 2433_5 =$

$$\begin{array}{r} {\scriptstyle \ 46} \\ 2517 \\ 3022_5 \\ 2433_5 \\ \hline \end{array}$$

Answer: 0034_5 | 34_5

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Question 3:
A. Convert the following numbers to their 8-bits two’s complement representation. Show your work.

1. 124_{10} =
   124/2 = 62 remainder 0| 62/2 = 31 remainder 0| 31/2 = 15 remainder 1| 15/2 = 7 remainder 1| 7/2 = 3 remainder 1| 3/2 = 1 remainder 1| 1/2 = 0 remainder 1

Answer: $01111100_{2'S\ COMPLEMENT}$

---

2. -124_{10} =

$$\begin{array}{r} 1111 \\ 01111100 \\ +\ 10000100 \\ \hline 100000000 \end{array}$$

Answer: $10000100_{2'S\ COMPLEMENT}$

---

3. 109_{10} =
   109/2 = 54 remainder 1| 54/2 = 27 remainder 0| 27/2 = 13 remainder 1| 13/2 = 6 remainder 1| 6/2 = 3 remainder 0| 3/2 = 1 remainder 1| 1/2 = 0 remainder 1

Answer: $01101101_{2'S\ COMPLEMENT}$

---

4. -79_{10} =
   79/2 = 39 remainder 1| 39/2 = 19 remainder 1| 19/2 = 9 remainder 1| 9/2 = 4 remainder 1| 4/2 = 2 remainder 0| 2/2 = 1 remainder 0| 1/2 = 0 remainder 1

$$1001111_2$$

$$\begin{array}{r} 1111111 \\ 01001111 \\ +10110001 \\ \hline 100000000 \end{array}$$

Answer: $10110001_{2'S\ COMPLEMENT}$

B. Convert the following numbers (represented as 8-bit two’s complement) to their decimal representation. Show your work.

1. $00011110_{8\ bit\ 2's\ comp}$ =
   0011110_2 =
   $0x2^6 + 0x2^5 + 1x2^4 + 1x2^3 + 1x2^2 + 1x2^1 + 0x2^0$ =
   0 + 0 + 16 + 8 + 4 + 2 + 0 =

Answer: 30_{10}

---

2. $11100110_{8\ bit\ 2's\ comp}$ =

$$\begin{array}{r} 111111 \\ 11100110 \\ +00011010 \end{array}$$

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100000000
$0011010_2 = 0x2^6 + 0x2^5 + 1x2^4 + 1x2^3 + 0x2^2 + 1x2^1 + 0x2^0 =$
0 + 0 + 16 + 8 + 0 +2 + 0 =
Answer: $-\ 26_{10}$

---

3. $00101101_{\text{8 bit 2's comp}} =$
$0101101_2 =$
$0x2^6 + 1x2^5 + 0x2^4 + 1x2^3 + 1x2^2 + 0x2^1 + 1x2^0 =$
0 + 32 + 0 + 8 + 4 + 0 + 1 =
Answer: 45_{10}

---

4. $10011110_{\text{8 bit 2's comp}} =$
111111
10011110
+01100010
100000000
$11000100_2 =$
$1x2^6 + 1x2^5 + 0x2^4 + 0x2^3 + 0x2^2 + 1x2^1 + 0x2^0 =$
64 + 32 + 0 + 0 + 0 + 2 + 0 =
Answer: $-\ 98_{10}$

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Question 4: Solve the following questions from the Discrete Math zyBook:
1. Exercise 1.2.4, sections b, c

b. -(p v q)
Answer:

p	q	p v q	¬(p v q)
T	T	T	F
T	F	T	F
F	T	T	F
F	F	F	T

---

c. r v (p v -q)
Answer:

p	q	r	¬q	p v ¬q	r v (p v ¬q)
T	T	T	F	T	T
T	T	F	F	T	T
T	F	T	T	T	T
T	F	F	T	T	T
F	T	T	F	F	T
F	T	F	F	F	F
F	F	T	T	T	T
F	F	F	T	T	T

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2.Exercise 1.3.4,sections b, d
b. (p -> q) -> (q -> p)
Answer:

p	q	(p -> q)	(q -> p)	(p -> q) -> (q -> p)
T	T	T	T	T
T	F	F	T	T
F	T	T	F	F
F	F	T	T	T

---

d. (p ↔ q) (p ↔ ¬q)
Answer:

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

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Question 5: Solve the following questions from the Discrete Math zyBook:

1. Exercise 1.2.7, sections b, c

   b. **Answer:** (b ∧ d) ∨ (b ∧ m) ∨ (m ∧ d)

   c. **Answer:** b ∨ (d ∧ m)

---

2. Exercise 1.3.7, sections b - e

   b. **Answer:** (s ∨ y) → p

   c. **Answer:** p → y

   d. **Answer:** p ↔ (s ∧ y)

   e. **Answer:** p → (s ∨ y)

---

3. Exercise 1.3.9, sections c, d

   c. **Answer:** c → p

   d. **Answer:** p → c

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Question 6: Solve the following questions from the Discrete Math zyBook:

1. Exercise 1.3.6, sections b - d

   b. **Answer:** **If** Joe maintains a B average, **then** Joe is eligible for the honors program.

   C. **Answer:** **If** Rajiv can go on the roller coaster, **then** he is at least four feet tall.

   d. **Answer:** **If** Rajiv is at least four feet tall, **then** he can go on the roller coaster.

---

2. Exercise 1.3.10, sections c - f

   c. **Answer:** **False**! Both the hypothesis and the conclusion must be either true or false.

   d. **Answer:** **Unknown**! IF r is false the expression is true, IF r is true the expression is false.

   e. **Answer:** **Unknown**! IF r is false the expression is false, IF r is true the expression is true.

   f. **Answer:** True! IF r is either true or false the expression is always true.

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Question 7: Solve Exercise 1.4.5, sections b - d, from the Discrete Math zyBook

b.**Answer:**

j	l	r	¬j →(l V ¬r)	(r ¬l) → 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.**Answer:**

j	l	j → ¬l	¬j → l
T	T	T	F
T	F	T	T
F	T	T	T
F	F	F	T

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d. **Answer:**

j	l	r	(r V ¬l) → j	j → (r ¬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

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Question 8: Solve the following questions from the Discrete Math zyBook:

1. Exercise 1.5.2, sections c, f, i

c. **Answer:** (p → q) (p → r) ≡ p → (q r)

(p → q) (p → r)	
(¬p V q) (¬p V r)	Conditional Identities Law
¬p (q r)	Distributive Law
p → (q r)	Conditional Identities Law

---

f. **Answer:** ¬(p V ((¬p q)) ≡ ¬p ¬q

¬(p V (¬p q))	
¬ p ¬(¬p q)	DeMorgan’s Law
¬ p ¬¬p ¬q	DeMorgan’s Law
¬ (p p) ¬q	Double Negation Law
¬ p ¬q	Idempotent Law

---

i. **Answer:**(p q) → r ≡ (p ¬r) → ¬q

(p q) → r	
¬(p q) V r	Conditional Identities
¬p V ¬q V r	DeMorgan’s Law
¬(p V r) V ¬q	Associative Law
¬p ¬r V ¬q	DeMorgan’s Law
¬p ¬¬r V	Double Negation Law

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¬q	
¬(p ¬r) V ¬q	DeMorgan’s Law
(p ¬r) → ¬q	Conditional Identities

---

2. Exercise 1.5.3, sections c, d

c.**Answer:** ¬r V (¬r → p)

¬r V (¬r → p)	
¬r V (¬¬r V p)	Conditional Identities
¬r V (r V p)	Double Negation Law
(¬r V r) V p	Associative Law
T V p	Complement Law
T	Domination Law

---

d.**Answer:** ¬(p → q) → ¬q

¬(p → q) → ¬q	
¬(¬p V q) → ¬q	Conditional Identities
¬¬p V ¬q → ¬q	DeMorgan’s Law
p V ¬q → ¬q	Double Negation Law
¬(p V ¬q) V ¬q	Conditional Identities
¬p V ¬¬q V ¬q	DeMorgan’s Law
¬p V q V ¬q	Double Negation Law

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¬p V (q V ¬q)	Associative Law
¬p V T	Complement Law
¬T	Domination Law
F	Complement Law

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Question 9: Solve the following questions from the Discrete Math zyBook: 1. Exercise 1.6.3, sections c, d

c. There is a number that is equal to its square.
Answer: $\exists x\ (x^2=x)$

d. Every number is less than or equal to its square.
Answer: $x\ (x \leq x^2)$

---

2. Exercise 1.7.4, sections b - d

b. **Answer:** x (¬S(x) W(x))

c. **Answer:** x (S(x) ¬ W(x))

d. **Answer:** ∃x (S(x) W(x))

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Question 10: Solve the following questions from the Discrete Math zyBook: 1. Exercise 1.7.9, sections c - i

c. **Answer:** True
d. **Answer:** When x = e, True
e. **Answer:** True
f. **Answer:** True
g. **Answer:** False
h. **Answer:** True
i. **Answer:** True

---

2. Exercise 1.9.2, sections b - i

b. **Answer:** True
c. **Answer:** True
d. **Answer:** False
e. **Answer:** False
f. **Answer:** True
g. **Answer:** False
h. **Answer:** True
i. **Answer:** True

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Question 11: Solve the following questions from the Discrete Math zyBook:
1.10.4, sections c - g

c. **Answer:** ∃x ∃y (x + y = xy)

d. **Answer:** ∀x ∀y ((x > 0 ∧ y > 0) → x/y > 0)

e. **Answer:** ∀x ((x > 0 ∧ x < 1) → 1/x > 1)

f. **Answer:** ¬∃x ∀y (x <= y)

g. **Answer:** ∀x ∃y (x ≠ 0 → xy = 1)

1.10.7, sections c - f

c. **Answer:** ∃x (N(x) → D(x))

d. **Answer:** ∃x ∀y D(y) -> P(Sam, y)

e. **Answer:** ∃x ∀y N(x) → P(x,y)

f. **Answer:** ∃x (N(x) ∧ ∀y((x ≠ y) → ¬L(y)))

1.10.10, sections c - f

c. **Answer:** ∀x ∃y ((y ≠ Math 101) ∧ T(x, y))

d. **Answer:** ∃x ∀y ((y ≠ Math 101) → T(x, y))

e. **Answer:** ∀x ∃y ∃z ((x ≠ Sam) → ((y ≠ z) ∧ T(x, y) ∧ T(x, z)))

f. **Answer:** ∃y ∃z ∀w ((z ≠ y) ∧ T(Sam, y) ∧ T(Sam, z) ∧ ((w ≠ y ∧ w ≠ z) → ¬T(Sam, w)))

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Question 12: Solve the following questions from the Discrete Math zyBook:

1.8.2, sections b - e

b. **Answer:** ∀x (D(x) ∨ P(x))

Negation: ¬ ∀x (D(x) ∨ P(x))

Applying De Morgan’s law: ∃x (¬D(x) ∧ ¬P(x))

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

C. **Answer:** ∃x (D(x) ∧ M(x))

Negation: ¬ ∃x (D(x) ∧ M(x))

Applying De Morgan’s law: ∀x (¬D(x) ∨ ¬M(x))

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

d. **Answer:** ∀x (P(x) → M(x))

Negation: ¬ ∀ x (P(x) → M(x))

Applying De Morgan’s law: ∃x (P(x) ∧ ¬M(x))

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

e. **Answer:** ∃x (M(x) ∧ P(x))

Negation: ¬ ∃x (M(x) ∧ P(x))

Applying De Morgan’s law: ∀x (¬ M(x) ∨ ¬P(x))

English: Every patient either did not have migraine or was not given the placebo or both.

1.9.4, sections c - e

c. **Answer:** ∃x ∀y (P(x, y) → Q(x, y))

Negation: ∀x ∃y (P(x, y) ∧ ¬Q(x, y))

d. **Answer:** ∃x ∀y (P(x, y) ↔ P(y, x))

¬(∃x ∀y ((P(x,y) → P(y,x)) ∧ (P(y,x) → P(x,y))))

¬(∃x ∀y ((¬P(x,y) ∨ P(y,x)) ∧ (¬P(y,x) ∨ P(x,y))))

∀x ∃y (¬ (¬P(x,y) ∨ P(y,x)) ∨ ¬ (¬P(y,x) ∨ P(x,y)))

Negation: ∀x ∃y ((P(x,y) ∧ ¬P(y,x)) ∨ (P(y,x) ∧ ¬P(x,y)))

e. **Answer:** ∃x ∃y P(x, y) ∧ ∀x ∀y Q(x, y)

¬(∃x ∃y P(x, y) ∧ ∀x ∀y Q(x, y))

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Negation: ∀x ∀y ¬P(x, y) ⋁ ∃x ∃y ¬Q(x, y)
