**Q1.**

a Write out a truth table for the Boolean function

$$f(a,b,c) = (a \wedge b \wedge \neg c) \vee (a \wedge \neg b \wedge c) \vee (\neg a \wedge \neg b \wedge c),$$

then decide how many

i input combinations, and
ii outputs where $f(a,b,c) = 1$

exist in it.

b Consider the Boolean function

$$f(a,b,c,d) = \neg a \wedge b \wedge \neg c \wedge d.$$

Which of the following assignments

i $a = 0$, $b = 0$, $c = 0$ and $d = 1$,
ii $a = 0$, $b = 1$, $c = 0$ and $d = 1$,
iii $a = 1$, $b = 1$, $c = 1$ and $d = 1$,
iv $a = 0$, $b = 0$, $c = 1$ and $d = 0$.

produces the output $f(a,b,c,d) = 1$?

c Which of the following Boolean expressions

i $(a \vee b \vee d) \wedge (\neg c \vee d)$,
ii $(a \wedge b \wedge d) \vee (\neg c \wedge d)$,
iii $(a \vee b \vee d) \vee (\neg c \vee d)$.

is in Sum-of-Products (SoP) standard form?

d Identify **each** equivalence that is correct:

i $a \vee 1 \equiv a.$
ii $a \oplus 1 \equiv \neg a.$
iii $a \wedge 1 \equiv a.$
iv $\neg(a \wedge b) \equiv \neg a \vee \neg b.$

e Identify **each** equivalence that is correct:

i $\neg\neg a \equiv a.$
ii $\neg(a \wedge b) \equiv \neg a \vee \neg b.$
iii $\neg a \wedge b \equiv a \wedge \neg b.$
iv $\neg a \equiv a \oplus a.$

**Q2.**

a The OR form of the null axiom is $x \vee 1 \equiv 1$. Which of the following options

i $x \wedge 1 \equiv 1$,
ii $x \wedge 0 \equiv 0$,
iii $x \vee 0 \equiv 0$,
iv $x \wedge x \equiv x$,

is the dual of this axiom?

b Given the Boolean equation

$$f = \neg a \wedge \neg b \vee \neg c \vee \neg d \vee \neg e,$$

which of the following

i $\neg f = a \vee b \vee c \vee d \vee e$,
ii $\neg f = a \wedge b \wedge c \wedge d \wedge e$,

iii $\neg f = a \wedge b \wedge (c \vee d \vee e)$,
iv $\neg f = a \wedge b \vee \neg c \vee \neg d \vee \neg e$,
v $\neg f = (a \vee b) \wedge c \wedge d \wedge e$

is correct?

c If we write the de Morgan axiom in English, which of the following

i NOR is equivalent to AND if each input to AND is complemented,
ii NAND is equivalent to OR if each input to OR is complemented,
iii AND is equivalent to NOR if each input to NOR is complemented, or
iv NOR is equivalent to NAND if each input to NAND is complemented.

describes the correct equivalence?

**Q3.** a Identify which **one** of these Boolean expressions

i $c \vee d \vee e$
ii $\neg c \wedge \neg d \wedge \neg e$
iii $\neg a \wedge \neg b$
iv $\neg a \wedge \neg b \wedge \neg c \wedge \neg d \wedge \neg e$

is the correct result of simplifying

$$(\neg(a \vee b) \wedge \neg(c \vee d \vee e)) \vee \neg(a \vee b).$$

b If you simplify the Boolean expression

$$(a \vee b \vee c) \wedge \neg(d \vee e) \vee (a \vee b \vee c) \wedge (d \vee e)$$

into a form that contains the fewest operators possible, which of the following options

i $a \vee b \vee c$,
ii $\neg a \wedge \neg b \wedge \neg c$,
iii $d \vee e$,
iv $\neg d \wedge \neg e$,
v none of the above

do you end up with and why?

c If you simplify the Boolean expression

$$a \wedge c \vee c \wedge (\neg a \vee a \wedge b)$$

into a form that contains the fewest operators possible, which of the following options

i $(b \wedge c) \vee c$,
ii $c \vee (a \wedge b \wedge c)$,
iii $a \wedge c$,
iv $a \vee (b \wedge c)$,
v none of the above

do you end up with and why?

d Consider the Boolean expression

$$a \wedge b \vee a \wedge b \wedge c \vee a \wedge b \wedge c \wedge d \vee a \wedge b \wedge c \wedge d \wedge e \vee a \wedge b \wedge c \wedge d \wedge e \wedge f.$$

Which of the following simplifications

i $a \wedge b \wedge c \wedge d \wedge e \wedge f$,

ii $a \wedge b \vee c \wedge d \vee e \wedge f$,
iii $a \vee b \vee c \vee d \vee e \vee f$,
iv $a \wedge b$,
v $c \wedge d$,
vi $e \wedge f$,
vii $a \vee b \wedge (c \vee d \wedge (e \vee f))$
viii $((a \vee b) \wedge c) \vee d \wedge e \vee f$

is correct?

e Given the options

i 1,
ii 2,
iii 3,
iv 4,

decide which is the least number of operator required to compute the same result as

$$f(a, b, c) = (a \wedge b) \vee a \wedge (a \vee c) \vee b \wedge (a \vee c).$$

Show how you arrived at your decision.

f Prove that

$$(\neg x \wedge y) \vee (\neg y \wedge x) \vee (\neg x \wedge \neg y) \quad \equiv \quad \neg x \vee \neg y.$$

g Prove that

$$(x \wedge y) \vee (y \wedge z \wedge (y \vee z)) \quad \equiv \quad y \wedge (x \vee z).$$