1, Boolean Algebra

$$\overline{A(\overline{B}+C)+\overline{B}C} \oplus \left(\overline{B}\,\overline{(\overline{A}+C)(\overline{AC}+B)}\right)$$

$$=\overline{A\overline{B}+AC+\overline{B}C} \oplus \left(\overline{B}\left(\overline{(\overline{A}+C)}+\overline{(\overline{AC}+B)}\right)\right)$$

$$=\left(\overline{(A\overline{B})}\,\overline{(AC)}\,\overline{(\overline{B}C)}\right) \oplus (A\overline{B}\,\overline{C}+A\overline{B}C)$$

$$=((\overline{A}+B)(\overline{A}+\overline{C})(B+\overline{C})) \oplus (A\overline{B}(\overline{C}+C))$$

$$=(\overline{A}B+\overline{A}\,\overline{C}+B\overline{C}) \oplus A\overline{B}$$

To be FALSE, LHS = RHS.

If LHS = RHS = 0 and $A = 1$, then

$$0B+0\overline{C}+B\overline{C}=0 \quad \wedge \quad 1\overline{B}=0$$

$$B=1$$

$$0*1+0+1*\overline{C}=0$$

$$C=1 \qquad \Rightarrow (1,\ 1,\ 1)$$

If LHS = RHS = 0 and $A = 0$, then

$$1*B+1*\overline{C}+B\overline{C}=0 \quad \wedge \quad 0*\overline{B}=0$$

$$B=0 \wedge C=1 \qquad B=*$$

$$\Rightarrow (0,\ 0,\ 1)$$

If LHS = RHS = 1 and $A = 1$, then

$$0*B+0*\overline{C}+B\overline{C}=1 \quad \wedge \quad 1*\overline{B}=1$$

$$B=1 \wedge C=0 \qquad B=0$$

which is impossible.

IF LHS = RHS = 1 and $A = 0$, then

$$1*B+1*C+B\overline{C}=1 \quad \wedge \quad 0*\overline{B}=1$$

$$1=1 \qquad 0=1$$

which is impossible.

C. (0, 0, 1) (1, 1, 1)

2. Bit-String Flicking Let x = abcdef x OR (LCIRC-4 x) AND (RSHIFT-1 x) = abcdef OR (LCIRC-4 abcdef) AND (RSHIFT-1 abcdef) = abcdef OR efabcd AND 0abcde = abcdef OR e0 af ab bc cd de This sets up six equations: $a + e0 = 0 \rightarrow a = 0$ $b + af = 0 \rightarrow b = 0$ $c + ab = 1 \rightarrow c = 1$ $d + bc = 1 \rightarrow d = 1$ $e + cd = 1 \rightarrow e + 1 = 1$ $f + de = 0 \rightarrow f + e = 0 \rightarrow e = 0$ and $f = 0$ Therefore x = 001100	A. 1
3. Recursive Functions $f(4, -1, 2) = f(4 - 2, -1 + 1, [-\frac{1}{4}]) + 2$ $= f(2, 0, -1) + 2 = 1 + 2 = 3$ $f(2, 0, -1) = f(2 - 2, 0 + 1, [0/2]) + (-1)$ $= f(0, 1, 0) - 1 = 2 - 1 = 1$ $f(0, 1, 0) = f(3, 1 + 1, 0 - 1) + 1 * 0$ $= f(3, 2, -1) + 0 = 2 + 0 = 2$ $f(3, 2, -1) = f(3 - 2, 2 + 1, [\frac{2}{3}]) + (-1)$ $= f(1, 3, 0) - 1 = 3 - 1 = 2$ $f(1, 3, 0) = f(1 + 1, 3 - 2, 3 - 1) - 1 * 3$ $= f(2, 1, 2) - 3 = 6 - 3 = 3$ $f(2, 1, 2) = f(2 - 2, 1 + 1, [\frac{1}{2}]) + 2$ $= f(0, 2, 0) + 2 = 4 + 2 = 6$ $f(0, 2, 0) = f(3, 2 + 1, 0 - 2) - 0 * 2$ $= f(3, 3, -2) - 0 = 4 - 0 = 4$ $f(3, 3, -2) = 3 + 3 + (-2) = 4$	C. 3

4. Prefix-Infix-Postfix

$ / − ^ 5 2 * 2 2 + 1 @ 6 4 / − + ^ 3 2
* & 8 4 4 $ 1 2 * * @ 3 2 2 & 6 4
= $ / − (^ 5 2) (* 2 2) + 1 (@ 6 4) / − + (^ 3 2)
* (& 8 4) 4 ($ 1 2) * * (@ 3 2) 2 (& 6 4)
= $ / (− 25 4) (+ 1 6) / − + 9 (* 6 4) 3 * (* 3 2) 5
= $ (/ 21 7) / − (+ 9 24) 3 (* 6 5)
= $ 3 / − 33 3 30
= $ 3 / (− 33 3) 30
= $ 3 (/ 30 30)
= $ 3 1
= -8

A. -8

5. Digital Electronics

The digital circuits translates to:

$$\overline{(A((AB)\oplus(B+C)))} \oplus \overline{\left(\left((B+C)\overline{(C+D)}\right)+\overline{D}\right)}$$

The LHS of $\oplus$ simplifies to: $\overline{A}+AB+\overline{B}\,\overline{C}$

The RHS of $\oplus$ simplifies to: D

To be TRUE the sides of $\oplus$ must be opposites.

If $D = 1$, then $\overline{A}+AB+\overline{B}\,\overline{C} = 0$.

$\rightarrow$ $\overline{A} = 0 \wedge AB = 0 \wedge \overline{B}\,\overline{C} = 0$

$\rightarrow$ $A = 1,\ B = 0,\ C = 1$ (1, 0, 1, 1)

If $D = 0$, then $\overline{A} + AB + \overline{B}\,\overline{C} = 1$.

If $A = 0$, then $1 + 0B + \overline{B}\,\overline{C} = 1 \rightarrow B = * \wedge C = *$.

(0, *, *, 0)

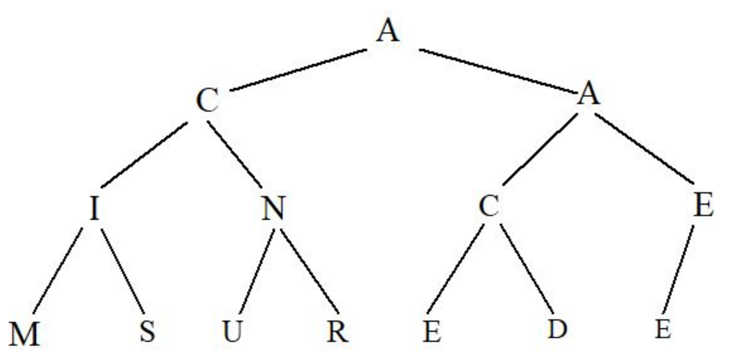
If $A = 1$, then $0 + B + \overline{B}\,\overline{C} = 1$.

If $B = 1$, then $C = *$. (1, 1, *, 0)

If $B = 0$, then $C = 0$. (1, 0, 0, 0)

Therefore there are 8 ordered quadruples that make it TRUE

A. 8

6. Computer Number Systems $2000_{10} = 3720_8$ and $2199_{10} = 4227_8$ 41 appears once from 3720_8 to 3777_8 : 3741_8 41 appears once from 4000_8 to 4077_8 : 4041_8 41 appears at the beginning of each from 4100_8 to 4177_8 which adds 64 and 4141_8 adds one more. The total is 67.	C. 67
7. What Does This Program Do? This program counts the number of deficient, perfect, and abundant numbers that are inputted. There were 3 deficient numbers (2, 21, 59), 2 perfect numbers (6, 28), and 5 abundant numbers (80, 36, 12, 100, 24)	D. 3 2 5
8. Data Structures The min-heap for **`ICECREAMSUNDAE`** is: 	C. I, N, C, E
9. Graph Theory The round trips from A with just ACSL Air are: ADA, ABA, ABCDA, ABDA, ACDA, ACBA, and ACBDA. After merging with CompSci Air 5 new round trips were added: ABGFCDA, ACGFBA, ACFBA, ACFBDA, and ACGFBDA.	B. 5

10. LISP (CDADR (REVERSE (CDADDR '(a (b e) (a (b (c d)) (e f (g h))) f (d a))))) = (CDADR (REVERSE (CDADR '((b e) (a (b (c d)) (e f (g h))) f (d a))))) = (CDADR (REVERSE (CDAR '((a (b (c d)) (e f (g h)))f (d a))))) = (CDADR (REVERSE (CDR '(a (b (c d)) (e f (g h)))))) = (CDADR (REVERSE '((b (c d)) (e f (g h))))) = (CDADR '((e f (g h)) (b (c d)))) = (CDAR '((b (c d)))) = (CDR '(b (c d))) = ((c d))	D. ((c d))
11. FSAs and Regular Expressions `[0-9]*[[A-Z][a-z]*]*[&,@,/,.][^d, e, t]*` a) `1978RICSLwasestablished` Missing special character after the "d" b) `AllStar@NJ` MATCHES c) `41Consecutive/yr` MATCHES d) `12CategorieS@SR` MATCHES e) `Programmingisfun&challenging.` Fails at the "e" in challenging f) `ACSL.org` MATCHES	D. b, c, d, f
12. Assembly Language This program counts the number of even factors of the numbers from 1 to 10, inclusive. There are 10 of them.	A. 10