BLG 231E

HW2

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1)

i)

1’st canonical form: Sum of special products called minterms.
Minterms: Rows in the truth table where the output is “1”.

F(a, b, c, d) = Σm(1,4,5,6,7,9,12,13,14,15)

F(a, b, c, d) = a’b’c’d + a’bc’d’ + a’bc’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d + abcd’ + abcd → the 1’st canonical form of F.

ii)

2’nd canonical form: Product of special sums called maxterms.

Maxterms: Rows in the truth table where the output is “0”.

F(a, b, c, d) = ΠM(0, 2, 3, 8, 10, 11)

F(a, b, c, d) = (a + b + c + d)(a + b + c’ + d)(a + b + c’ + d’)

(a’ + b + c + d)(a’ + b + c’ + d)(a’ + b + c’ + d’) → the 2’nd canonical form of F.

2)

-1) (a + b + c + d)(a + b + c’ + d)(a + b + c’ + d’)(a’ + b + c + d)(a’ + b + c’ + d)(a’ + b + c’ + d’)

-2) ((a + b + d) + (cc’))(a + b + c’ + d’)(a’ + b + c + d)(a’ + b + c’ + d)(a’ + b + c’ + d’) (distributivity)

-3) (a + b + d)(a + b + c’ + d’)(a’ + b + c + d)(a’ + b + c’ + d)(a’ + b + c’ + d’) (inverse)

-4) (a + b + d)(a + b + c’ + d’)(a’ + b + c + d)(a’ + b + c’ + d)((a’ + b + d) + (cc’))(a’ + b + c’ + d’) (distributivity)

-5) (a’ + b + d)(a + b + d)(a + b + c’ + d’)(a’ + b + c + d)(a’ + b + c’ + d)(a’ + b + c’ + d’) (inverse)

-6) (a’ + b + d)(a + b + d)(a + b + c’ + d’)(a’ + b + c + d)((a’ + b + c’) + (dd’)) (distributivity)

-7) (a’ + b + c’)(a’ + b + d)(a + b + d)(a + b + c’ + d’)(a’ + b + c + d) (inverse)

-8) (a’ + b + c’)((a’a) + (b + d))(a + b + c’ + d’)(a’ + b + c + d) (distributivity)

-9) (b + d)(a’ + b + c’)(a + b + c’ + d’)(a’ + b + c + d) (inverse)

-10) (b + d)(a’ + b + c’)(a + b + c’ + d’) (absorption)

-11) (a’b + bb + bc’ + a’d + bd + c’d)(a + b + c’ + d’) (distributivity)

-12) (b + a’b + bc’ + a’d + bd + c’d)(a + b + c’ + d’) (idempotency)

-13) (b + a’d + c’d)(a + b + c’ + d’) (absorption)

-14) ab + bb + bc’ + bd’ + a’ad + a’bd + a’c’d + a’dd’ + ac’d + bc’d + c’c’d + c’dd’ (distributivity)

-15) ab + b + bc’ + bd’ + a’ad + a’bd + a’c’d + a’dd’ + ac’d + bc’d + c’c’d + c’dd’ (idempotency)

-16) b + a’ad + a’c’d + a’dd’ + ac’d + c’c’d + c’dd’ (absorption)

-17) b + 0d + a’c’d + a’0 + ac’d + c’c’d + c’0 (inverse)

-18) b + a’c’d + ac’d + c’c’d (dominance)

-19) b + a’c’d + ac’d + c’d (idempotency)

-20) b + c’d (absorption)

-21) (a + a’)b + c’d (inverse)

-22) ab + a’b + c’d (distributivity)

-23) ab(c + c’) + a’b(c + c’) + c’d(a + a’) (inverse)

-24) abc + abc’ + a’bc + a’bc’ + ac’d + a’c’d (distributivity)

-25) abc(d + d’) + abc’(d + d’) + a’bc(d + d’) + a’bc’(d + d’) + ac’d(b + b’) + a’c’d(b + b’) (inverse)

-26) abcd + abcd’ + abc’d + abc’d’ + a’bcd + a’bcd’ + a’bc’d + a’bc’d’ + abc’d + ab’c’d + a’bc’d + a’b’c’d (distributivity)

-27) abcd + abcd’ + abc’d + abc’d’ + a’bcd + a’bcd’ + a’bc’d + a’bc’d’ + ab’c’d + a’b’c’d (idempotency) -> same as 1’st canonical form

3)

-1) a’b’c’d + a’bc’d’ + a’bc’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d + abcd’ + abcd

-2) a’bc’ + a’b’c’d + a’bc’d’ + a’bc’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d + abcd’ + abcd (consensus with respect to d)

-3) a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d + abcd’ + abcd (absorption)

-4) a’bc’ + abc + a’b’c’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d + abcd’ + abcd (consensus with respect to d)

-5) abc + a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d (absorption)

-6) abc’ + a’bc’ + abc + a’b’c’d + a’bcd’ + a’bcd + ab’c’d + abc’d’ + abc’d (consensus with respect to d)

-7) abc’ + abc + a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d (absorption)

-8) ab + abc’ + abc + a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d (consensus with respect to c)

-9) ab + a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d + (absorption)

-10) ab + a’bc + a’bc’ + a’b’c’d + a’bcd’ + a’bcd + ab’c’d (consensus with respect to d)

-11) ab + a’bc’ + a’bc + ab’c’d + a’b’c’d (absorption)

-12) ab + a’b + a’bc’ + a’bc + a’b’c’d + ab’c’d (consensus with respect to c)

-13) ab + a’b + a’b’c’d + ab’c’d (absorption)

-14) b + ab + a’b + a’b’c’d + ab’c’d (consensus with respect to a)

-15) b + a’b’c’d + ab’c’d (absorption)

-16) b + b’c’(a’d + ad) (distributivity)

-17) b + b’c’(d + a’d + ad) (consensus with respect to a)

-18) b + b’c’d (absorption)

-19) b + b’c’d + bc’d (absorption)

-20) b + c’d(b’ + b) (distributivity)

-21) b + c’d(1) (inverse)

-22) b + c’d → the simplest form

4) Since NAND -> Z = (XY)’ = X|Y, (b +c’d) must be converted into (XY)’ form.

Z = (b + c’d)

= (bb + c’d) (idempotency)

= ((bb + c’d)’)’ (involution)

= ((bb)’(c’d)’)’ (De Morgan)

Z = ((bb)’(d(cc)’)’)’ (idempotency)

Consequently, only NAND gate with 2-input representation is: (b|b)|(d|(c|c))

Representation of the simplified circuit: