Digital Logic PYQ

NUMBER SYSTEM

Which of the following is/are EQUAL to 224 in radix 5 (i.e., base 5) notation?

A. 64 in radix 10
B. 100 in radix 8
C. 50 in radix 16
D. 121 in radix 7

A particular number is written as 132 in radix-4 representation. The same number in radix-5 representation is _____________.

Consider the equation $(43)_x=(y3)_8$ where x and y are unknown. The number of possible solutions is _____

Consider the equation $(123)_5=(x8)_y$ where x and y are unknown. The number of possible solutions is _____

The base (or radix) of the number system such that the following equation holds is ____________ $\frac{312}{20} = 13.1$

$(1217)_8$ is equivalent to

A. $(1217)_{16}$
B. $(028F)_{16}$
C. $(2297)_{10}$
D. $(0B17)_{16}$

Let X be the number of distinct 16-bit integers in complement representation. Let Y be the number of distinct 16-bit integers in sign magnitude representation. Then X-Y is ______________.

The 16-bit 2's complement representation of an integer is 1111 1111 1111 0101; its decimal representation is ______________.

In 16-bit 2's complement representation, the decimal number -28 is:

(A) 1000 0000 1110 0100

(B) 0000 0000 1110 0100

(C) 1111 1111 1110 0100

(D) 1111 1111 0001 1100

Let the representation of a number in base 3 be 210. What is the hexadecimal representation of the number?

A. 21

B. 528

C. D2

D. 15

LOGIC GATES, BOOLEAN ALGEBRA

Let, $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$ where $x_1,\ x_2,\ x_3,\ x_4$ are Boolean Variables, and $\oplus$ is the XOR operator.

Which one of the following must always be **TRUE**?

A. $x_1x_2x_3x_4 = 0$
B. $x_1x_3 + x_2 = 0$
C. x_1' xor $x_3' = x_2'$ xor x_4'
D. $x_1 + x_2+x_3+x_4 = 0$

GATE-2016 set-1

Consider the Boolean operator $\neq$ with the following properties:

$x \neq 0 = x,\ \ x \neq 1 = \overline{x},\ \ x \neq x = 0$ and $x \neq \overline{x} = 1$. Then $x \neq y$ is equivalent to

A. xy’ + x’y

B. xy‘ + x’y’

C. x’y + xy

D. xy + x’y’

GATE-2015 set-3

Let $\neq$ be a binary operator defined as $X \neq Y = X' + Y'$ where X and Y are Boolean variables. Consider the following two statements.

$$(S1) \quad (P \neq Q) \neq R = P \neq (Q \neq R)$$
$$(S2) \quad Q \neq R = R \neq Q$$

Which of the following is/are true for the Boolean variables P, Q and R?

A. Only S1 is true
B. Only S2 is true
C. Both S1 and S2 are true
D. Neither S1 nor S2 are true

GATE-2013

Which one of the following expressions does NOT represent the exclusive NOR of x and y?

(A) $xy + x'y'$
(B) $x \oplus y'$
(C) $x' \oplus y$
(D) $x' \oplus y'$

Consider the following Boolean expression for F:
F(P, Q, R, S) = PQ + P'QR + P'QR'S

The minimal sum-of-products form of F is

A. PQ + QR + QS
B. P + Q + R + S
C. P' + Q' + R' + S'
D. P'R + P'R'S + P

GATE-2019

Which one of the following is NOT a valid identity?

A. $(x \oplus y) \oplus z = x \oplus (y \oplus z)$

B. $(x + y) \oplus z = x \oplus (y + z)$

C. $x \oplus y = x + y$, if $xy = 0$

D. $x \oplus y = (xy + x'y')'$

The dual of a Boolean function $F(x_1, x_2, \ldots, x_n, +, ., ')$, written as F^D is the same expression as that of F with $+$ and $\cdot$ swapped. F is said to be self-dual if $F = F^D$. The number of self-dual functions with n Boolean variables is

A. 2^n
B. 2^{n-1}
C. 2^{2^n}
D. $2^{2^{n-1}}$

A function is self dual if it is equal to its dual (A dual function is obtained by interchanging . and +).

For self-dual functions,

1. Number of min terms equals number of max terms
2. Function should not contain two complementary minterms - whose sum equals 2^n-1, where n is the number of variables.

Consider the following Boolean expression for F:
$F(P, Q, R, S) = PQ + P'QR + P'QR'S$

The minimal sum-of-products form of F is

A. $PQ + QR + QS$
B. $P + Q + R + S$
C. $P' + Q' + R' + S'$
D. $P'R + P'R'S + P$

Gate CSE 2011

The simplified SOP (Sum of product) form of the Boolean expression $\left(P+\overline{Q}+\overline{R}\right).\left(P+\overline{Q}+R\right).\left(P+Q+\overline{R}\right)$ is

A $\left(\overline{P}.Q+\overline{R}\right)$

B $\left(P+\overline{Q}.\overline{R}\right)$

C $\left(\overline{P}.Q+R\right)$

D $(P.Q+R)$

Gate CSE 2008

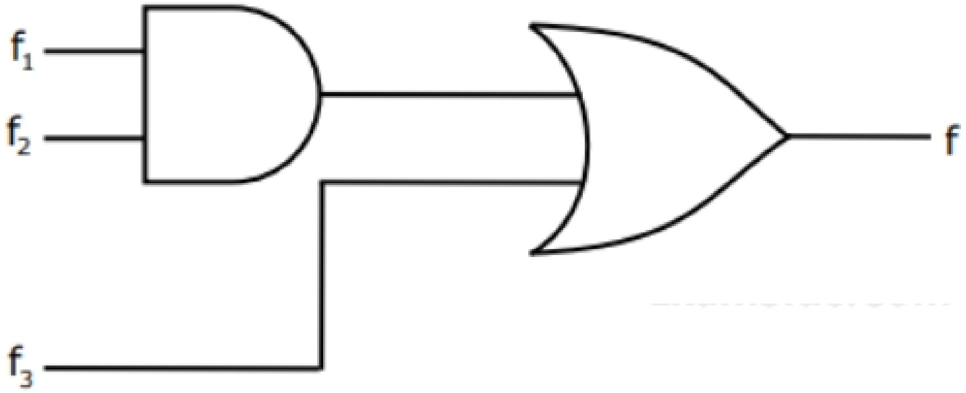
Given f_1, f_3, and f in canonical sum of products form (in decimal) for the circuit.

$$f_1 = \sum m\,(4,5,6,7,8)$$

$$f_3 = \sum m\,(1,6,15)$$

$$f = \sum m\,(1,6,8,15)$$

Then f_2 is



A $\sum m\,(4,6)$

B $\sum m\,(4,8)$

C $\sum m\,(6,8)$

D $\sum m\,(4,6,8)$

Practice

The minterm expansion of the F(P,Q,R) = PQ+QR’+PR’ is

A. m2+m4+m6+m7
B. m0+m1+m6+m7
C. m2+m3+m4+m5
D. m0+m1+m3+m7

CIRCUIT OPTIMIZATION, K-MAP

Practice-1

Which is the simplified equation of given K-map.

A. B1'B2 + B2'B1
B. B3'B0 + B4'B3
C. B3'B2 + B2'B3
D. B1'B0 + B0'B1

	B1'B0'	B1'B0	B1B0	B1B0'
B3'B2'	0	0	1	1
B3'B2	1	1	0	0
B3B2	1	1	0	0
B3B2'	0	0	1	1

Consider the following Boolean expression for F:
$F(P, Q, R, S) = PQ + P'QR + P'QR'S$

The minimal sum-of-products form of F is

A. $PQ + QR + QS$
B. $P + Q + R + S$
C. $P' + Q' + R' + S'$
D. $P'R + P'R'S + P$

Practice-2

Product of Sums Example

- **Find the optimum POS solution:**

$$\mathbf{F(A,B,C,D) = \Sigma m(3,9,11,12,13,14,15) + \Sigma d\,(1,4,6)}$$

- **Hint: Solve F’ and then complement it to get the result.**

Consider the following minterm expression for F :
$F(P,Q,R,S) = \sum (0, 2, 5, 7, 8, 10, 13, 15)$

The minterms 2, 7, 8 and 13 are 'do not care' terms. The minimal sum-of-products form for F is :

(A) $QS' + Q'S$
(B) $Q'S' + QS$
(C) $Q'R'S' + Q'RS' + QR'S + QRS$
(D) $P'Q'S' + P'QS + PQS + PQ'S'$

Gate CSE 2002

Minimum SOP for f(w, x, y, z) shown in karnaugh map is

yz \ wx	00	01	11	10
00	0	1	1	0
01	x	0	0	1
11	x	0	0	1
10	0	1	1	x

A $xz + y'z$

B $xz' + zx'$

C $x'y + zx'$

D None

Consider the Karnaugh map given below, where X represents " don't care" and blank represents 0.
Assume for all inputs (a, b, c, d) the respective complements (a', b', c', d') are also available. The above logic is implemented 2-input NOR gates only.
The minimum number of gates required is ____________.

$dc \backslash ba$	00	01	11	10
00		X	X	
01	1			X
11	1			1
10		X	X	

In the Karnaugh map shown below, X denotes a don't care term. What is the minimal form of the function represented by the Karnaugh map?

cd \ ab	00	01	11	10
00	1	1		1
01	X			
11	X			
10	1	1		X

A $\overline{b}\,.\,\overline{d}+\overline{a}\,.\,\overline{d}$

B $\overline{a}\,.\,\overline{b}+\overline{b}\,.\,\overline{d}+\overline{a}\,.\,\overline{b}\,.\,\overline{d}$

C $\overline{b}\,.\,\overline{d}+\overline{a}\,.\,\overline{b}\,.\,\overline{d}$

D $\overline{a}\,.\,\overline{b}+\overline{b}\,.\,\overline{d}+\overline{a}\,.\,\overline{a}\,.\,\overline{d}$

GATE 2001

Given the following Karnaugh map, which one of the following represents the minimal Sum-Of-Products of the map?

A $xy + y'z$

B $wx'y' + xy + xz$

C $w'x + y'z + xy$

D $xz + y$

yz \ wx	00	01	11	10
00	0	X	0	X
01	X	1	X	1
11	0	X	1	0
10	0	1	X	0

GATE 2019

What is the minimum number of 2-input NOR gates required to implement a 4-variable function function expressed in sum-of-minterms form as

$f = \Sigma(0, 2, 5, 7, 8, 10, 13, 15)$?

GATE 2018

Consider the minterm function as

$$F(P,Q,R,S) = \sum m(0,2,5,7,9,11) + d(3,8,10,12,14)$$

Here, m denotes a minterm and d denotes a don't care term. The number of essential prime implicants of the function F is ______.

GATE 2012

What is the minimal form of the Karnaugh map shown below? Assume that x denotes a don't care term.

(A) $\overline{bd}$

(B) $\overline{bd} + \overline{bc}$

(C) $\overline{bd} + a\overline{bc}d$

(D) $\overline{bd} + \overline{bc} - \overline{cd}$

cd \ ab	00	01	11	10
00	1	X	X	1
01	X			1
11				
10	1			X

GATE 2003

The literal count of a Boolean expression is the sum of the number of times each literal appears in the expression. For example, the literal count of $(xy + xz)$ is 4. What are the minimum possible literal counts of the product -of -sum and sum -of-product representations respectively of the function given by the following Karnaugh map? Here, X denotes "don't care"

xy \ zw	00	01	11	10
00	X	1	0	1
01	0	1	X	0
11	1	X	X	0
10	X	0	0	X

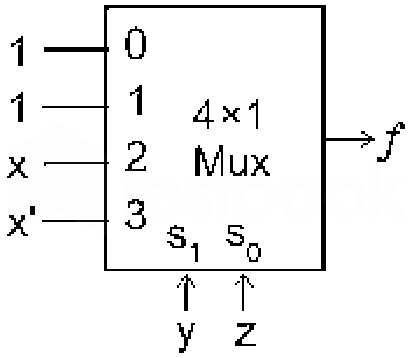
A. $(11, 9)$
B. $(9, 13)$
C. $(9, 10)$
D. $(11, 11)$

COMBINATIONAL CIRCUIT

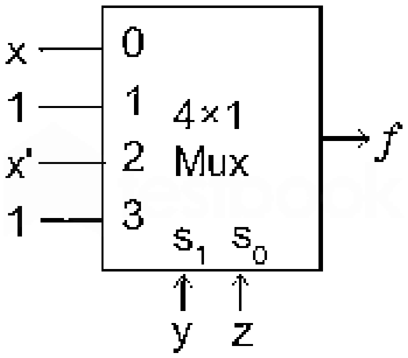
Which one of the following circuits implements the Boolean function given below?

$f(x, y, z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6$, where m_i is the i^{th} minterm.

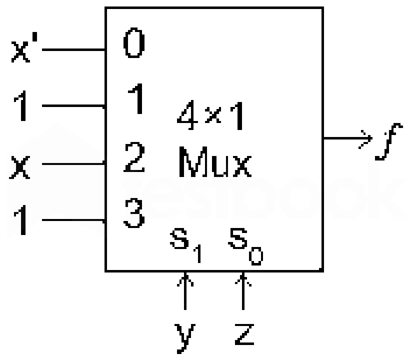
A



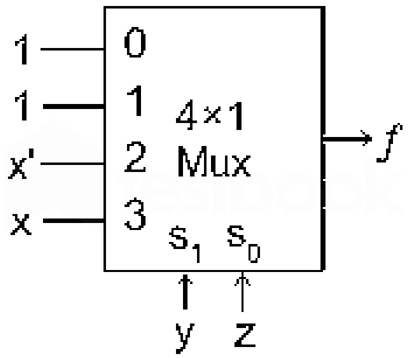
B



C



D



GATE 2020

A multiplexer is placed between a group of 32 registers and an accumulator to regulate data movement such that at any given point in time the content of only one register will move to the accumulator. The minimum number of select lines needed for the multiplexer is _____.

GATE 2020

If there are m input lines and n output lines for a decoder that is used to uniquely address a byte addressable 1 KB RAM, then the minimum value of m + n is _____.

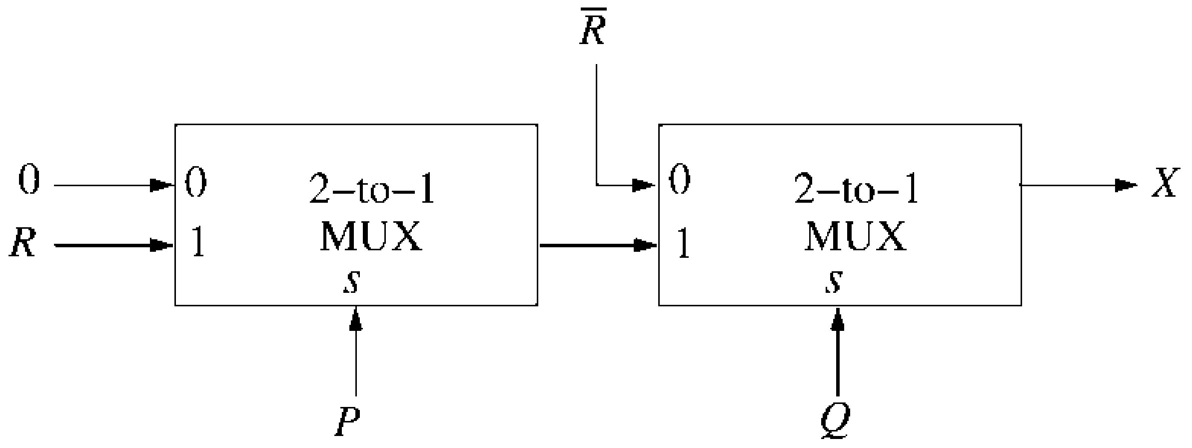
GATE 2013

In the following truth table V=1 if and only if the input is valid. What function does the truth table represent?

- (A) Priority encoder
- (B) Decoder
- (C) Multiplexer
- (D) Demultiplexer

Inputs				Outputs		
D_0	D_1	D_2	D_3	X_0	X_1	V
0	0	0	0	x	x	0
1	0	0	0	0	0	1
x	1	0	0	0	1	1
x	x	1	0	1	0	1
x	x	x	1	1	1	1

Consider the two cascaded 2-to-1 multiplexers as shown in the figure. The minimal sum of products form of the output X is



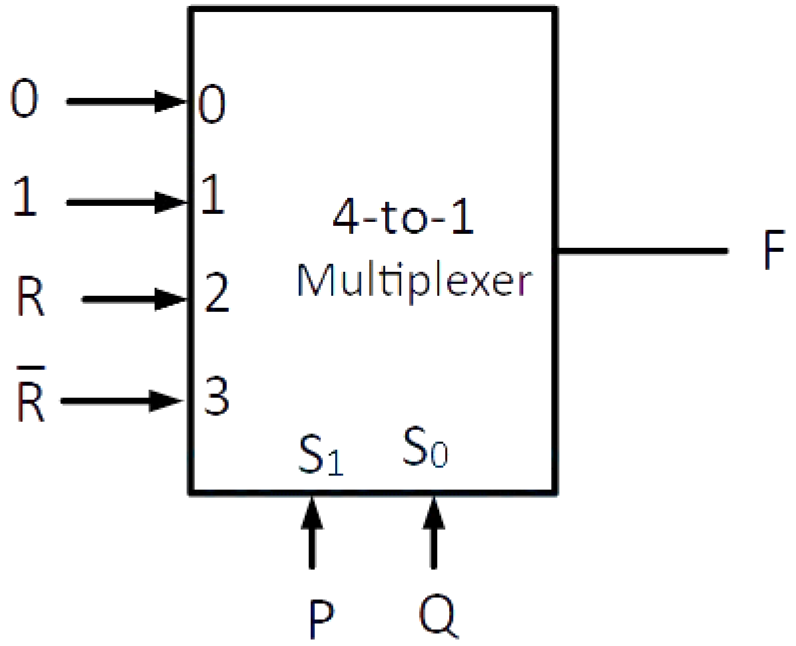
A $\overline{P}\overline{Q} + PQR$

B $\overline{P}Q + QR$

C $PQ + \overline{P}\overline{Q}R$

D $\overline{Q}\overline{R} + PQR$

Consider the 4-to-1 multiplexer with two select lines S0 and S1 given below. The minimal sum-of-products form of the Boolean expression for the output of the multiplexer F is



A. $\overline{P}Q + Q\overline{R} + P\overline{Q}R$

B. $\overline{P}Q + \overline{P}Q\overline{R} + PQ\overline{R} + P\overline{Q}R$

C. $\overline{P}QR + \overline{P}Q\overline{R} + Q\overline{R} + P\overline{Q}R$

D. $PQ\overline{R}$

GATE 2007

Suppose only one multiplexer and one inverter are allowed to be used to implement any Boolean function of n variables. What is the minimum size of the multiplexer needed?

(A) 2^n line to 1 line

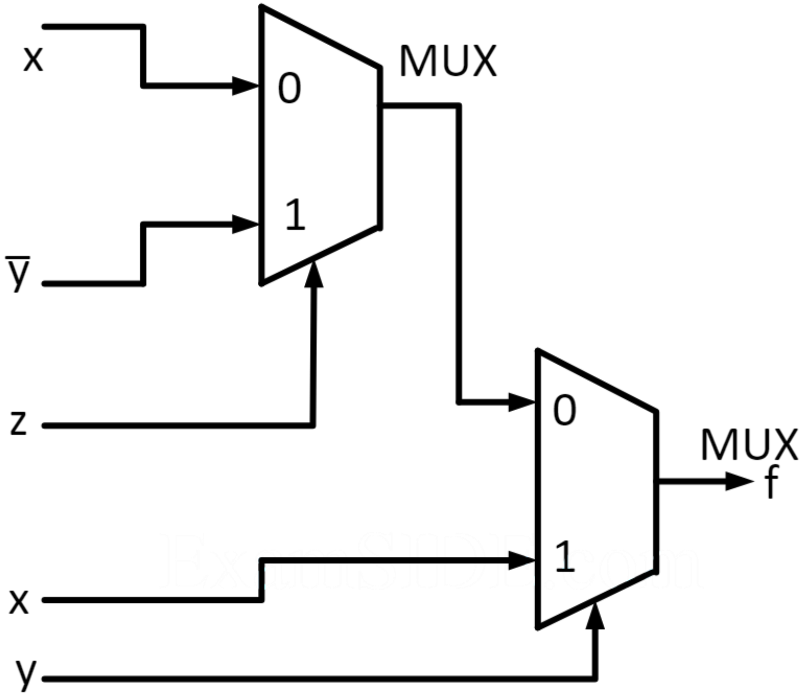
(B) 2^{n+1} line to 1 line

(C) 2^{n-1} line to 1 line

(D) 2^{n-2} line to 1 line

GATE 2006

Consider the circuit above. Which one of the following options correctly represents F(x,y,z)?



A. $x\bar{z} + xy + \bar{y}z$

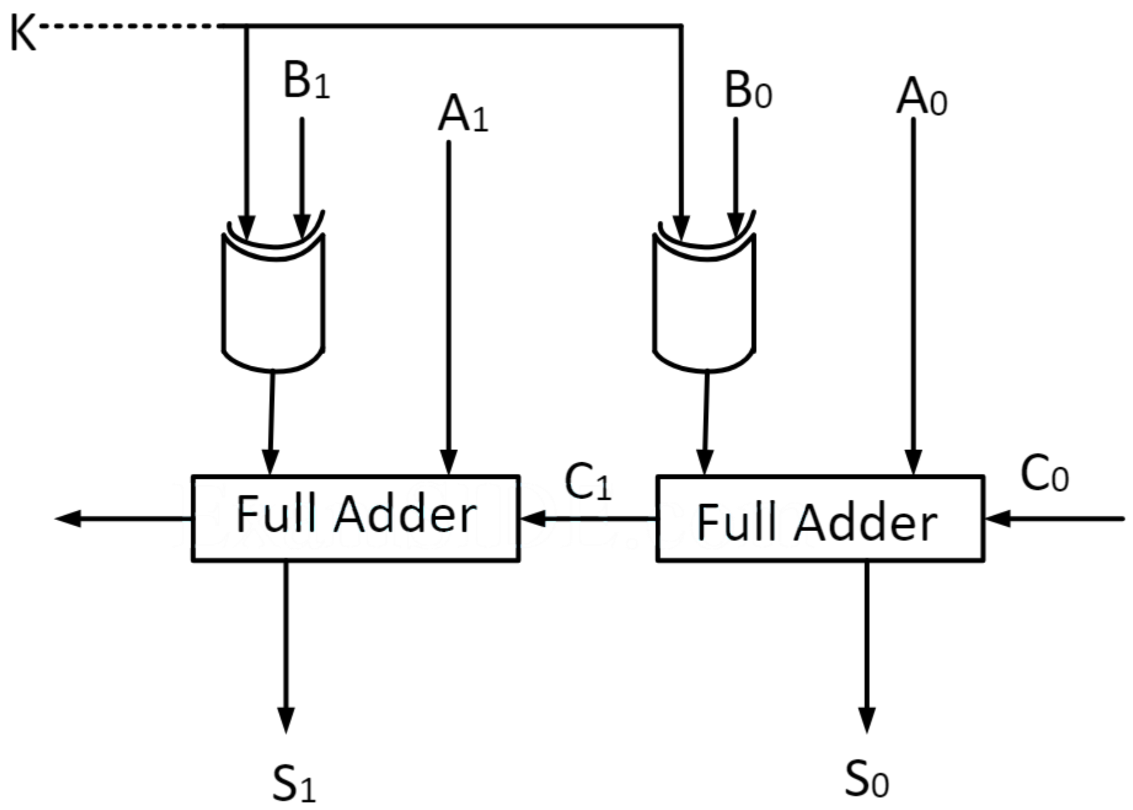
B. $x\bar{z} + xy + \overline{yz}$

C. $xz + xy + \overline{yz}$

D. $xz + x\bar{y} + \bar{y}z$

Consider the ALU shown below

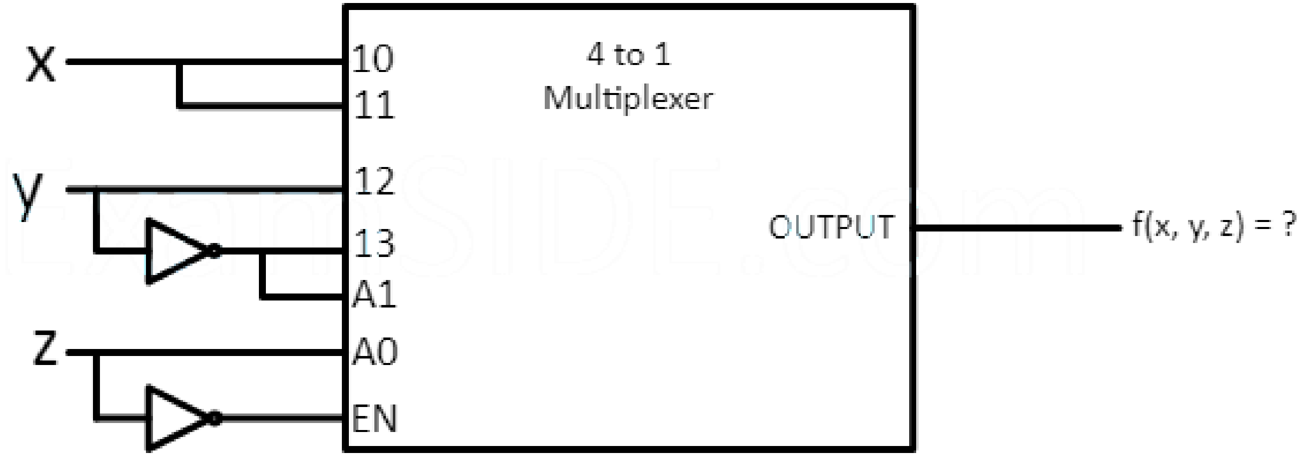
If the operands are in $2's$ complement representation, which of the following operations can be performed by suitably setting the control lines K and C_0 only (+ and - denote addition and subtraction respectively)?



- **A** $A+B$, and $A-B$, but not $A+1$
- **B** $A+B$, and $A+1$, but not $A-B$
- **C** $A+B$, but not $A-B$, or $A+1$
- **D** $A+B$, and $A-B$, and $A+1$

Consider the following multiplexer where 10,11,12,13 are four data input lines selected by two address line combinations $A1A0$=00,01,10,11 respectively and f is the output of the multiplex (or). EN is the Enable input.

The function $f(x, y, z)$ implemented by the above circuit is



A. xyz'

B. $xy + z$

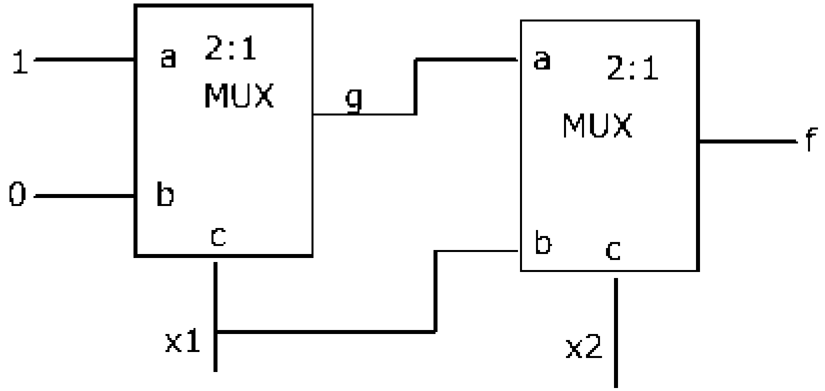
C. $x + y$

D. None of the above

GATE 2001

Consider the circuit shown below. The output of a 2:1 Mux is given by the function $(ac+bc)$

Which of the following is true?



A. $f = x_1^1 + x_2$

B. $f = x_1^{\ 1} + x_2 + x_1 x_2^{\ 1}$

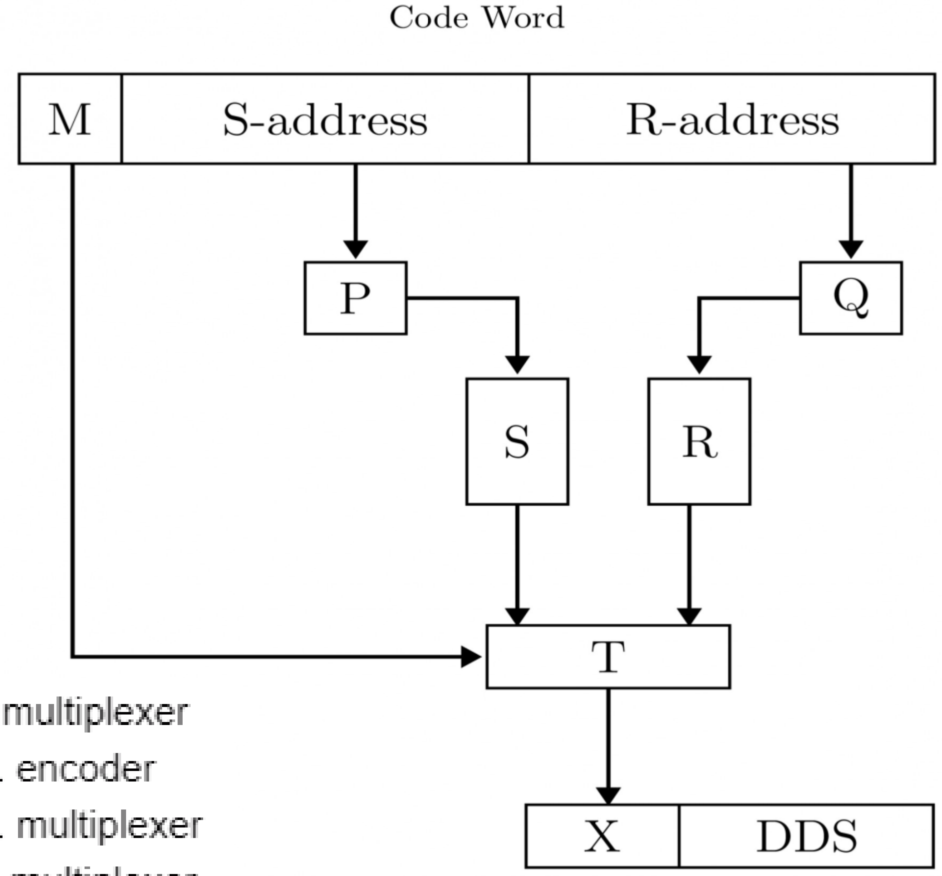
C. $f = x_1 x_2 + x_1{}^1 x_2{}^1$

D. $f = x_1 + x_2^1$

SEQUENTIAL CIRCUIT

GATE 2022

Consider a digital display system (DDS) shown in the figure that displays the contents of register X. A 16-bit code word is used to load a word in X, either from S or from R. S is a 1024-word memory segment and R is a 32-word register file. Based on the value of mode bit M, T selects an input word to load in X. P and Q interface with the corresponding bits in the code word to choose the addressed word. Which one of the following represents the functionality of P, Q. and T?



A. P is $10:1$ multiplexer; Q is $5:1$ multiplexer; T is $2:1$ multiplexer

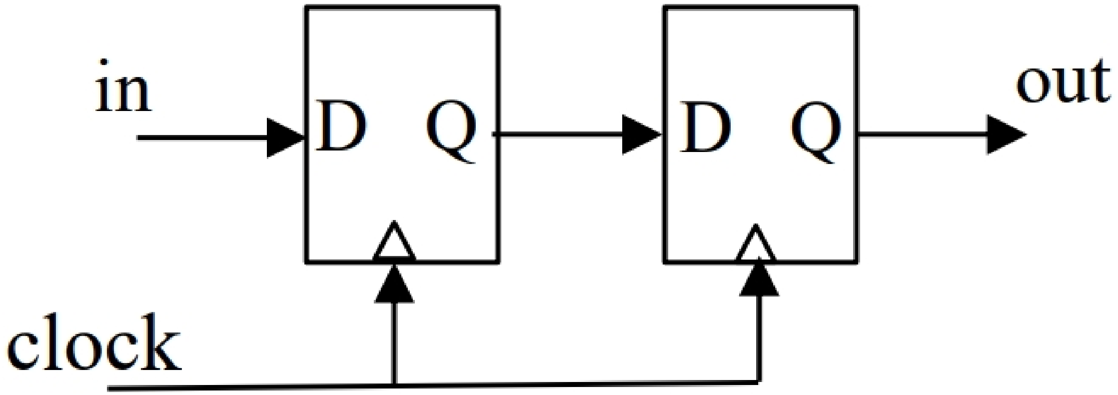
B. P is $10:2^{10}$ decoder; Q is $5:2^5$ decoder; T is $2:1$ encoder

C. P is $10:2^{10}$ decoder; Q is $5:2^5$ decoder; T is $2:1$ multiplexer

D. P is $1:10$ de-multiplexer; Q is $1:5$ de-multiplexer; T is $2:1$ multiplexer

Consider the sequential circuit shown in the figure, where both flip-flops used are positive edge-triggered D flip-flops.

The number of states in the state transition diagram of this circuit that have a transition back to the same state on some value of "in" is _____.



GATE 2016 set1

We want to design a synchronous counter that counts the sequence 0−1−0−2−0−3 and then repeats. The minimum number of J−K flip-flops required to implement this counter is __________.

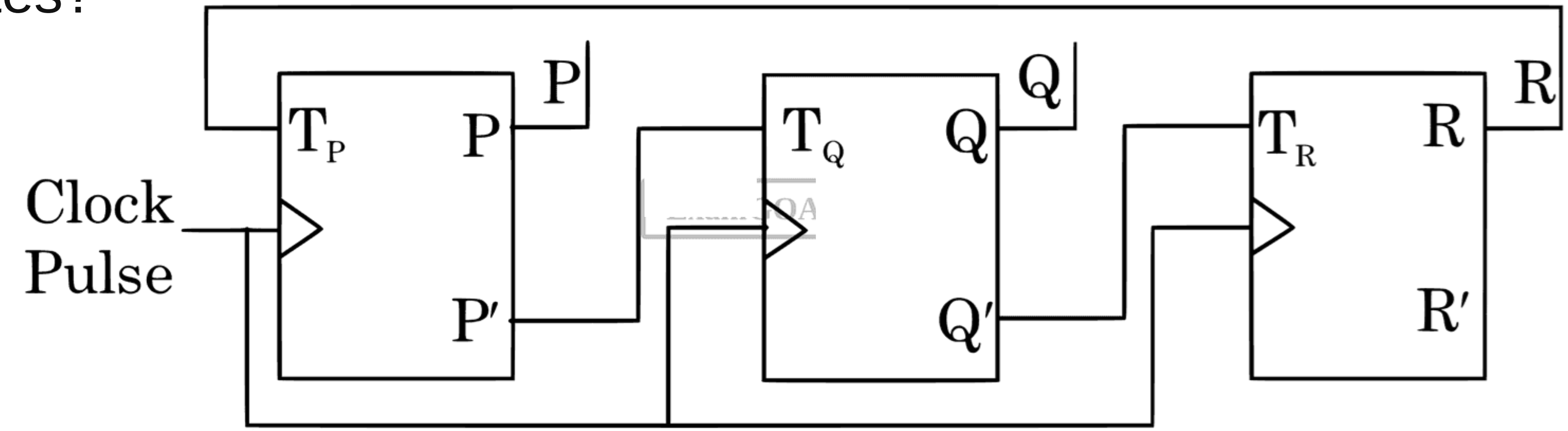
GATE 2015

The minimum number of JK flip-flops required to construct a synchronous counter with the count sequence (0,0,1,1,2,2,3,3,0,0,...) is ______________.

GATE 2021

Consider a 3-bit counter, designed using T flip-flop, as shown below:

Assuming the initial state of the counter given by PQR as 000, what are the next three states?



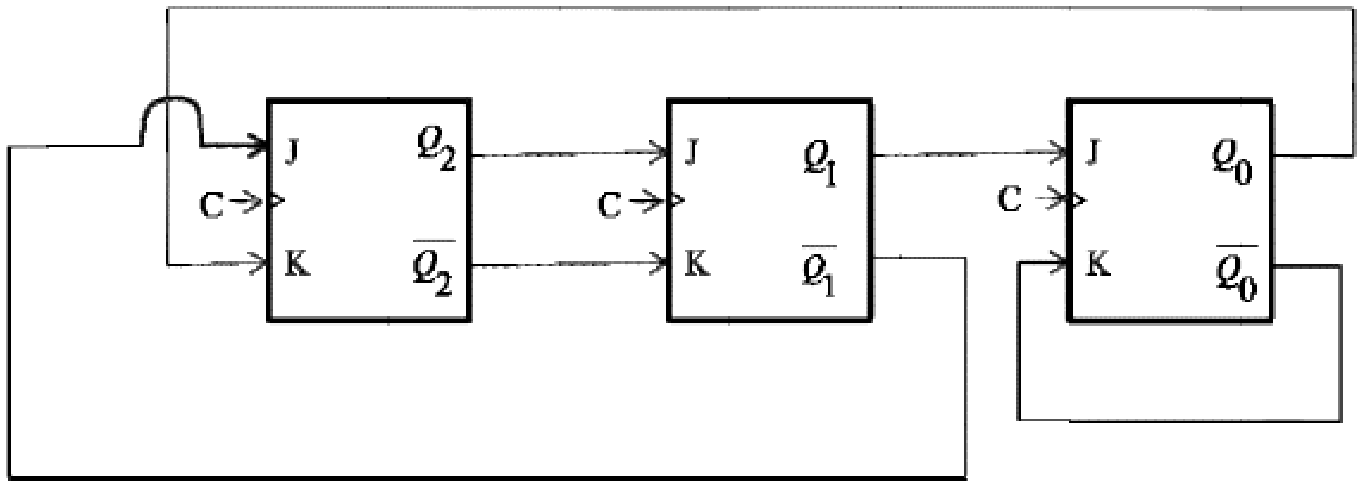
A. 001, 010, 000

B. 001, 010, 111

C. 011, 101, 111

D. 011, 101, 000

The above synchronous sequential circuit built using JK flip-flops is initialized with $Q2Q1Q0$=000. The state sequence for this circuit for the next 3 clock cycles is



A. 001, 010, 011

B. 111, 110, 101

C. 100, 110, 111

D. 100, 011, 001