

GATE

MADE EASY **WORKBOOK** 2027



**Detailed Explanations of
Try Yourself *Questions***

Instrumentation Engineering
Digital Electronics



1

Number Systems and Binary Codes



Detailed Explanation of Try Yourself Questions

T1. Sol.

$$\begin{array}{r}
 1\ 1\ 1\ 1\ 1 \\
 -\ 1\ 0\ 0\ 1\ 1 \\
 \hline
 1\ 1\ 0\ 0 \\
 +\ 1 \\
 \hline
 1\ 1\ 0\ 1
 \end{array}$$

$$(1101)_2 = (13)_{10}$$

Therefore, the decimal equivalent value = -13.

T2. (d)

Given that,

$$(10)_x \times (10)_x = (100)_x$$

$$x \times x = x^2$$

and

$$(100)_x \times (100)_x = (10000)_x$$

$$x^2 \times x^2 = x^4$$

so, above conditions are valid for all values of x .

T3. (c)

Converting both sides into decimal

$$(2^4 \times 1 + 0 + 2^2 \times w + 2^1 \times 1 + 2^0 \times z) \times 15 = 2^8 y + 2^6 \times 1 + 2^4 \times 1 + 2^3 \times 1 + 2^0 \times 1$$

$$(18 + 4w + z) \times 15 = 256y + 64 + 16 + 8 + 1$$

$$270 + 60w + 15z = 256y + 89$$

Only $w = 1$, $z = 1$ and $y = 1$ satisfies.

T4. (a)

$$\begin{array}{r}
 9\ 9\ 9\ 9\ 9 \\
 -\ 2\ 5\ .\ 6\ 3\ 9 \\
 \hline
 7\ 4\ .\ 3\ 6\ 0
 \end{array}$$





Detailed Explanation of Try Yourself Questions

T1. (c)

Bulb is On when both switch S1 and S2 are in same state, either off or on.

S1	S2	Bulb
0	0	ON
0	1	OFF
1	0	OFF
1	1	ON

Above truth table derives EX-NOR operation.

T2. (a)

EXNOR gate on logic is called coincidence logic.

So,

$$f = AB + A'B'$$

T3. (b)

D will be '1' majority of input is 1, so

$$D = A \oplus B \oplus C$$

■■■■

3

Combinational Logic Circuits



Detailed Explanation of Try Yourself Questions

T1. (c)

Since the delay is of $1 \mu\text{sec}$ the output will a square wave with time period of $2 \mu\text{sec}$.
So, frequency = 0.5 MHz

T2. (a)

For

A_2	A_1	A_0	S_0 (A_1)	S_1 (A_2)
0	0	0	0	0

MUX is enabled and output is I_0

For

A_2	A_1	A_0	S_0	S_1
0	0	1	0	0

MUX is disable and output is '1'

Similarly, for

A_2	A_1	A_0	S_0	S_1	\bar{E} (A_0)	O/P
0	0	0	0	0	0	I_0
0	0	1	0	0	1	1
0	1	1	0	1	1	1
0	1	0	0	1	0	I_1
1	1	0	1	1	0	I_3
1	1	1	1	1	1	1
1	0	1	1	0	1	1
1	0	0	1	0	0	I_2

T3. (6)

When, $T = \text{logic } 0$, the path followed by the circuit would be,
NOR gate \rightarrow MUX 1 \rightarrow MUX 2

$$\Rightarrow 2 \text{ ns} \rightarrow 1.5 \text{ ns} \rightarrow 1.5 \text{ ns}$$

$$\Rightarrow 5 \text{ ns}$$

When, $T = \text{logic } 1$, the path followed by the circuit would be,
NOR gate \rightarrow MUX 1 \rightarrow NOR gate \rightarrow MUX 2

$$\Rightarrow 1 \text{ ns} \rightarrow 1.5 \text{ ns} \rightarrow 2 \text{ ns} \rightarrow 1.5 \text{ ns}$$

$$\Rightarrow 6 \text{ ns}$$

\therefore Maximum propagation delay is 6 ns

T4. (c)

T5. (b)

So, the input to adder is y and 1's complement x since carry input in 1.
So, output is complement of $x + 1$, so output is $y - x$.

T6. (b)

P_1	P_2	a	b	c	d	e	f	g
0	0	1	1	1	1	1	1	0
0	1	1	0	1	1	0	1	1
1	0	1	1	0	1	1	0	1
1	1	1	0	0	1	1	1	1

$$a = 1$$

$$b = \bar{P}_2 \quad \dots 1 \text{ (NOT)}$$

$$c = \bar{P}_1 \quad \dots 1 \text{ (NOT)}$$

$$d = 1 = c + e$$

$$e = P_1 + \bar{P}_2 \quad \dots 1 \text{ (OR)}$$

$$f = \bar{P}_1 + P_2 \quad \dots 1 \text{ (OR)}$$

$$g = P_1 + P_2 \quad \dots 1 \text{ (OR)}$$

$$\Rightarrow \begin{aligned} g &= P_1 + P_2 \\ d &= 1 = c + e \end{aligned}$$

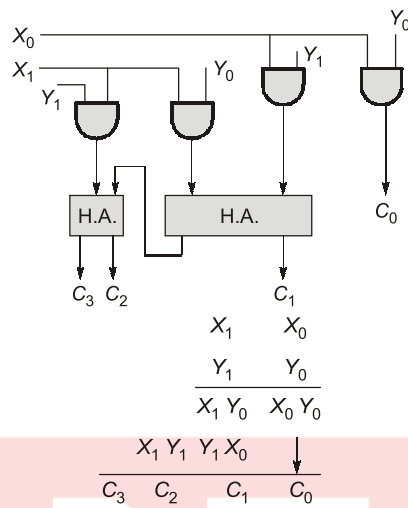
T7. (d)

2 – NOT gates

3 – OR gates

T8. (b)

Two bit binary multiplier



4

Sequential Circuits



Detailed Explanation of Try Yourself Questions

T1. (76.92)

Total propagation delay
 $= (t_{pd} + t_{set-up})_{max} = 8ns + 5 ns = 13 ns$
 \therefore Frequency of operations
 $= \frac{1000}{13} \text{ MHz} = 76.92 \text{ MHz}$

T2. (c)

T3. (6)

JK Flip-flop 1 and 2 form a synchronous sequential circuits and they are synchronized with the output of 0th JK Flip-flop.

J_1	K_1	J_2	K_2	Q_2	Q_1	Q_0
1	1	0	1	0	0	0
1	1	1	1	0	1	1
0	1	0	1	1	0	0
1	1	0	1	0	0	0

$\left. \begin{array}{l} \text{---} \\ \text{---} \\ \text{---} \end{array} \right\} T_1$
 $\left. \begin{array}{l} \text{---} \\ \text{---} \end{array} \right\} T_2$
 $\left. \begin{array}{l} \text{---} \\ \text{---} \end{array} \right\} T_3$

Number of cycles = 3 i.e. equal to 6 clock cycles.

T4. (d)

Trick up/down = $CP \oplus Q$, 1 for up and 0 for down.

CP = (clock pulse)

Q = (O/P)

0 = -ve edge; $Q = 1$

1 = +ve edge; $\bar{Q} = 1$

$= 1 \oplus 1 = 0$ (down counter)

Counting sequence

1	1	1	
1	1	0	
1	0	1	
1	0	0	
0	1	1	(preset state) so Mod 5

T5. (b)

T6. Sol.

Clock	Q_A	Q_B	Q_C	Q'_A	Q'_B	Q'_C	$Q_A \oplus Q'_A$	$Q_B \oplus Q'_B$	$Q_C \oplus Q'_C$	Z
0	1	0	0	1	0	0	0	0	0	0
1	0	1	0	1	1	0	1	0	0	1
2	0	0	1	1	1	1	1	1	0	1
3	1	0	0	0	1	1	1	1	1	1
4	0	1	0	0	0	1	0	1	1	1
5	0	0	1	0	0	0	0	0	1	1
6	1	0	0	1	0	0	0	0	0	0

The output Z will again become zero after 6 clock cycles.

T7. (c)

The counter represents a Johnson counter. Thus, total number of states = $2n$. Where $n = 3$.

Therefore the MOD of the counter = $2 \times 3 = 6$

T8. (d)

In a 2^8 Counter the range would be from 0-255.

Hence to go from 10101100 (172) to 00100111 (39), the counter has to go initially from 172 to 255 and then from 0 to 39.

Hence to go from 172 to 255, $255 - 172 = 83$ Clock pulses would be required.

From 255 to 0, again 1 clock pulse would be required.

Then from 0 to 39, 39 clock pulses would be required.

Hence in total $83 + 1 + 39 = 123$ Clock pulses would be required.



5

Integrated-Circuit Logic Families



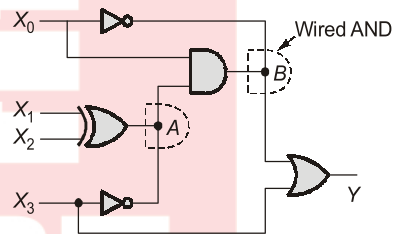
Detailed Explanation of Try Yourself Questions

T1. (8)

$$A = (X_1 \oplus X_2) \bar{X}_3$$

$$B = [(X_1 \oplus X_2) \bar{X}_3 X_0] \cdot \bar{X}_0 = 0$$

$$Y = B + X_3 = 0 + X_3 = X_3$$



Out of 16 possible combinations of $X_3 X_2 X_1 X_0$, X_3 will be high for 8 combinations. So, Y will be high for 8 combinations.

T2. (b)

$$V_{OH} > V_{IH} > V_{IL} > V_{OL}$$

T3. (b)

It is CMOS gate where 2 PMOS are parallel and in series with 2 NMOS (series combination of NMOS). It is equivalent to NAND gate.

Series combination of NMOS equivalent to parallel combination of PMOS.

T4. (c)

Truth table:

X	Y	V_0
0	0	1
0	1	0
1	0	0
1	1	0

$$V_0 = \overline{X+Y}$$

T5. (a)

Series combination of n-mos is equivalent to AND and parallel combination is equivalent to OR.

$$\text{So, } Y = \overline{C} \cdot (\overline{A+B}) = \overline{C} + \overline{(A+B)} = \overline{C} + \overline{A} \cdot \overline{B}$$

T6. (c)

HTL → High noise immunity

CMOS → Highest fanout

I^2L → Lowest of product power and delay

ECL → Highest speed of operation

T7. (a)

For TTL logic floating input = 1

$$\therefore Y = (AB + 1)' = \overline{AB} \cdot 0 = 0$$

T8. (a)

ECL is the fastest logic family.



6

ADC and DAC



Detailed Explanation of Try Yourself Questions

T1. (a)

Sequence of Johnson counter is

Q_2	Q_1	Q_0	D_2	D_1	D_0	V_0
0	0	0	0	0	0	0
1	0	0	1	0	0	4
1	1	0	1	1	0	6
1	1	1	1	1	1	7
0	1	1	0	1	1	3
0	0	1	0	0	1	1
0	0	0	0	0	0	0

T2. (a)

- (i) Conversion time is the time taken for a new digital output to appear in response to a change in the input voltage.
- (ii) Flash converter is the fastest converter. It uses no clock signal.
- (iii) **Type of N -bit ADC** **Max. conversion time**
 - Successive approximation N clock cycles
 - Counter ramp $2^N - 1$ clock cycles

T3. (c)

Initial stage of the counter = $(111)_2 = (7)_{10}$

So output will be equal to 7 V.

Next state of counter = $(110)_2 = (6)_{10}$

So output should be = 6 V

But output is 3 V that means LSB of counter is connected to MSB of DAC and MSB of counter is connected to LSB of DAC.

Similarly next state of counter = $(101)_2 = (5)_{10}$

Input to DAC = $(101)_2 = (5)_{10}$

So output = 5 V

When counter goes to $(100)_2$ then input to DAC = $(001)_2 = (1)_{10}$

So output = 1 V

So connections are not proper.

T4. (c)

No. of comparators in a flash ADC is equal to $2^n - 1$ where n = no. of bits.

$$2^4 - 1 = 15$$

T5. (a)

The reference voltage is 5 V.

The number of bits in ADC are 8.

$$\text{So, the resolution will be} = \frac{5}{2^8 - 1} = \frac{5}{255}$$

The applied input is 3.5 V.

The successive approximation ADC start working from the MSB so.

After one clock:

SAR will toggle its MSB from 0 → 1 so output of SAR will be 1000 0000.

After second clock:

SAR will toggle its 7th bit from 0 → 1 but 1100 0000 will result in value greater than 3.5 so output of SAR after 2nd clock will be 1000 0000.

After third clock:

SAR will toggle its 6th bit from 0 → 1 and output will be 10100000.



