Digital Systems & Microcontrollers

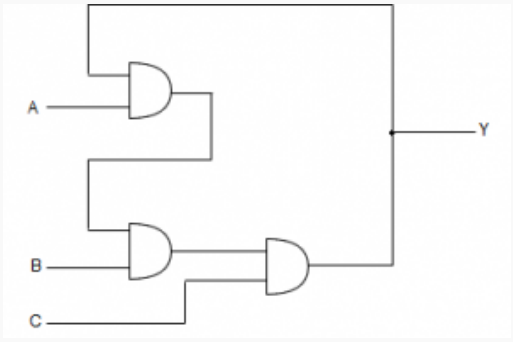
Tutorial Quiz 4

October 7, 2025

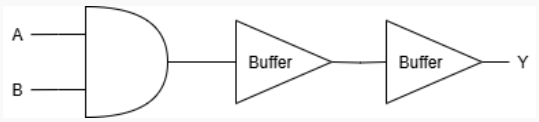
Set A

(a) What do you understand by sequential circuits? How do they differ from combinational circuits?

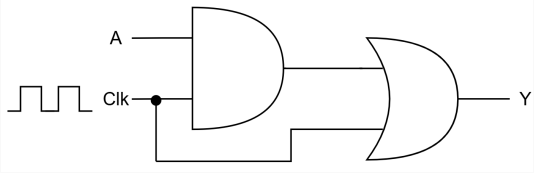
(b) Based on your understanding of sequential and combinational circuits, classify each of the following circuits as either sequential or combinational. If a circuit is sequential, specify whether it is synchronous or asynchronous. Justify your classification for each circuit.



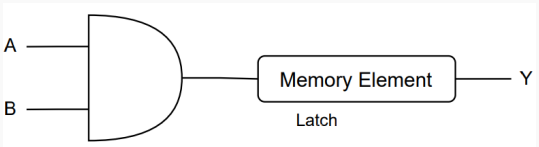
(a)



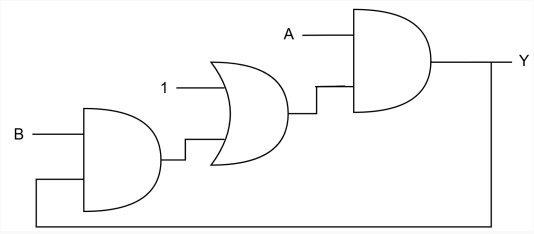
(b)



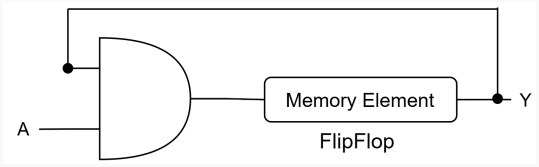
(c)



(d)



(e)



(f)

Set B

(a) What is a flip-flop? How is it different from a latch?

(b) Given below the master-slave configuration of D flip-flop. Draw the timing diagram for intermediate stage output (Y) and final output (Q), if the input D and clock signals are as shown. Also identify if the flip-flop is positive edge triggered or negative edge triggered.

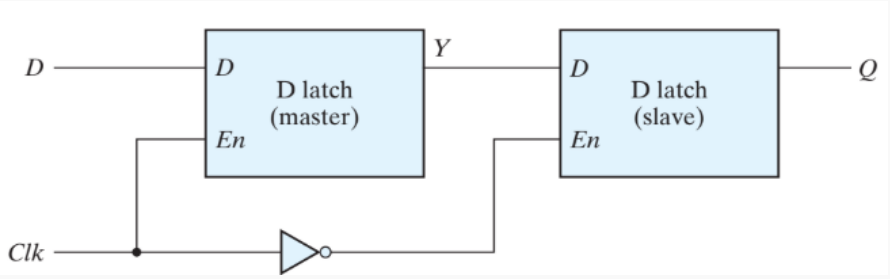


Figure 1: Master-Slave D Flip-Flop

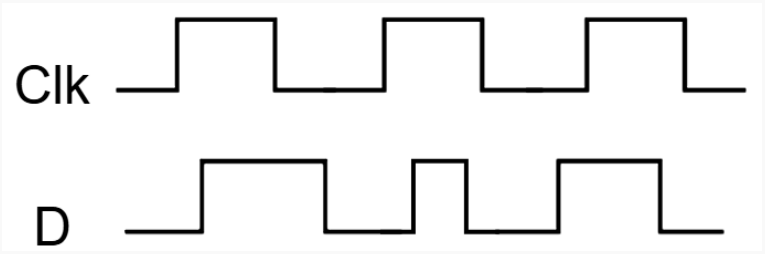


Figure 2: Input Signals

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Tutorial Quiz 4

October 8, 2025

Set A

Derive the characteristic equation for the **complement output** of a **D flip-flop**, given that

$$Q(t+1) = D.$$

Express $\overline{Q}(t+1)$ in terms of D and $\overline{Q}(t)$.

Set B

Show that the characteristic equation of a **T flip-flop** is

$$Q(t+1) = T \oplus Q(t)$$

and derive it from the JK flip-flop by setting $J = K = T$.

Note: Show all the steps clearly and simplify the final expressions.

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Tutorial Quiz 4

October 9, 2025

Set A

A sequential circuit has two JK flip-flops A and B and one input x. The circuit is described by the following flip-flop input equations:

$$J_A = x, \quad K_A = B$$

$$J_B = x, \quad K_B = A$$

(a) Derive the state equations $A(t+1)$ and $B(t+1)$ by substituting the input equations for the J and K variables.

(b) Draw the state diagram of the circuit.

Set B

A sequential circuit has two JK flip-flops P and Q, and one input y. The circuit is described by the following flip-flop input equations:

$$J_P = Q + y, \quad K_P = y'$$

$$J_Q = y, \quad K_Q = P$$

(a) Derive the state equations $P(t+1)$ and $Q(t+1)$ by substituting the input equations for the J and K variables.

(b) Draw the state diagram of the circuit.

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Tutorial Quiz 4

October 9, 2025

Set A

Draw a JK flip-flop circuit, and then show how it can be configured to simulate a D flip-flop.
Clearly indicate the connections and explain how the input and output relationships correspond to that of a D flip-flop.

Set B

Draw a JK flip-flop circuit, and then show how it can be configured to simulate a T flip-flop.
Clearly indicate the connections and explain how the input and output relationships correspond to that of a T flip-flop.