AKTU

GATEWAY CLASSES

Digital System Design

B.Tech. 3rd Sem

EC & Allied



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DIGITAL SYSTEM DESIGN

UNIT 3 : Sequential logic design

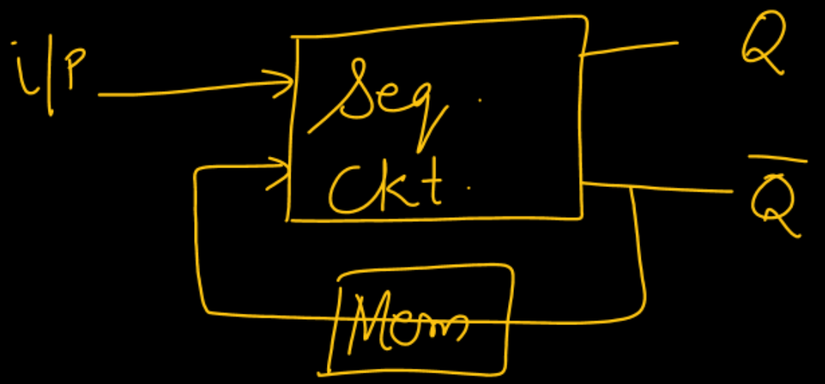
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Today's Target

- Introduction of Sequential circuit
- Difference between combinational and sequential circuit
- Sequential Logic Representation
- Classification of Sequential Logic
- Latches and flip-flops
- University Questions

Introduction of Sequential circuit

- Circuits whose output depends upon both the present input of the circuit and its previous state.
- We need circuits that have memory.
- Three characteristics are:
  - ➢ the device must have two stable states
  - ➢ there must be a way to read the state of the device
  - ➢ there must be a way to set the state at least once.



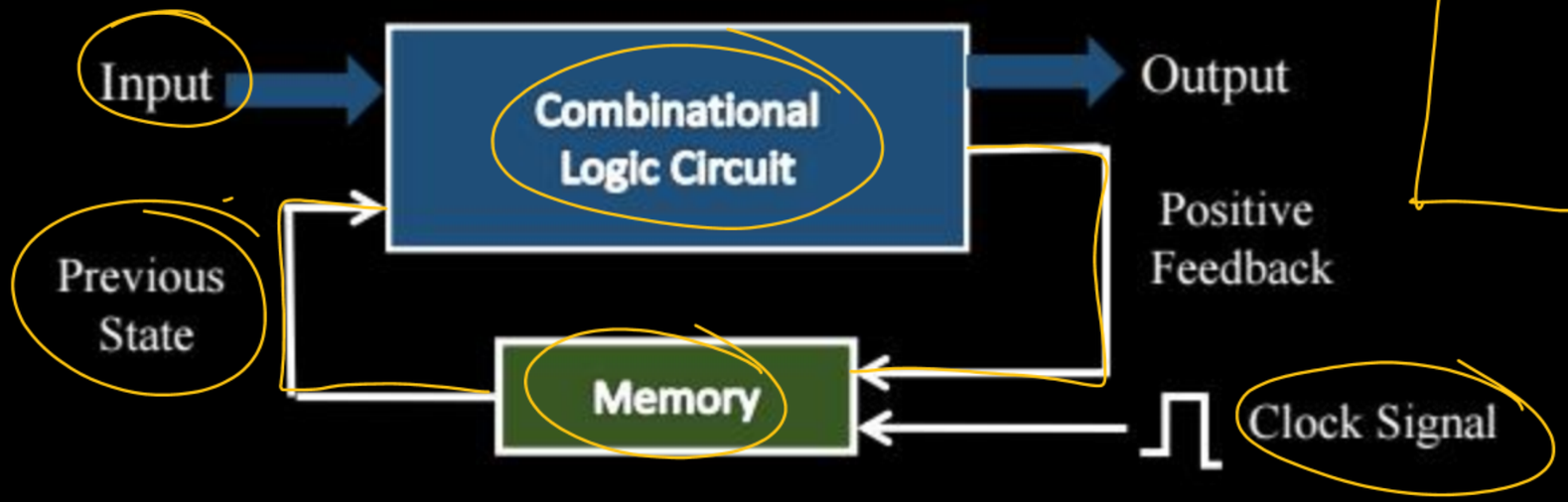
Difference between combinational and sequential circuit

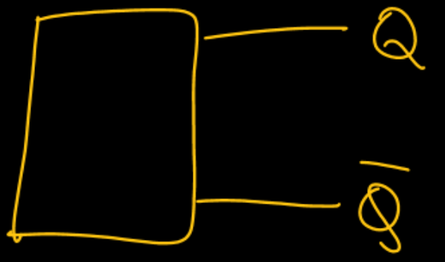
Sr. No.	Key	Combinational Circuit	Sequential Circuit
1	Definition	Combinational Circuit is the type of circuit in which output is independent of time and only relies on the input present at that particular instant.	On other hand Sequential circuit is the type of circuit where output not only relies on the current input but also depends on the previous output.
2	Feedback	In Combinational circuit as output does not depend on the time instant, no feedback is required for its next output generation.	On other hand in case of Sequential circuit output relies on its previous feedback so output of previous input is being transferred as feedback used with input for next output generation.
3	Performance	As the input of current instant is only required in case of Combinational circuit, it is faster and better in performance as compared to that of Sequential circuit.	On other hand Sequential circuit are comparatively slower and has low performance as compared to that of Combinational circuit.

Sr. No.	Key	Combinational Circuit	Sequential Circuit
4	Complexity	No implementation of feedback makes the combinational circuit less complex as compared to sequential circuit.	However on other hand implementation of feedback makes sequential circuit more complex as compared to combinational circuit.
5	Elementary Blocks	Elementary building blocks for combinational circuit are logic gates.	On other hand building blocks for sequential circuit are flip flops..
6	Operation	Combinational circuit are mainly used for arithmetic as well as Boolean operations.	On other hand Sequential circuit is mainly used for storing data.

Sequential Logic Representation

- The word "Sequential" means that things happen in a "sequence", one after another.
- The actual clock signal determines when things will happen next.
- Simple sequential logic circuits can be constructed from standard Bistable circuits such as: Flip-flops, Latches and Counters.
- Bistable circuits can be made by universal NAND Gates and/or NOR Gates in a particular combinational way.





Classification of Sequential Logic

1. Event Driven – asynchronous circuits that change state immediately when enabled.

2. Clock Driven – synchronous circuits that are synchronised to a specific clock signal.

3. Pulse Driven – which is a combination of the two that responds to triggering pulses.



Latches and flip-flops

- latches and flip-flops are the building blocks of sequential circuits.
- The difference between a latch and a flip-flop are:

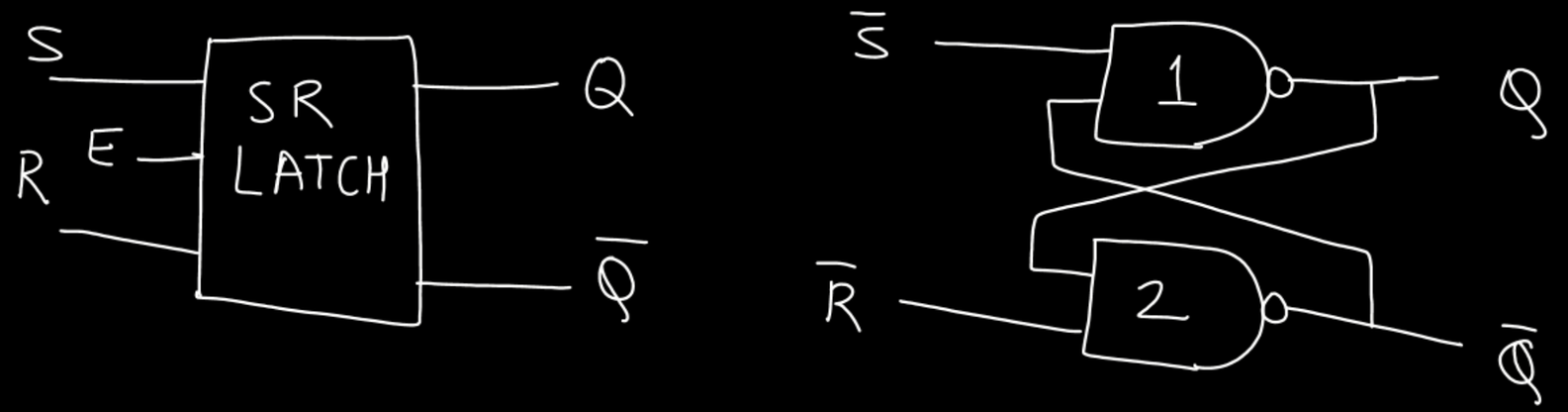
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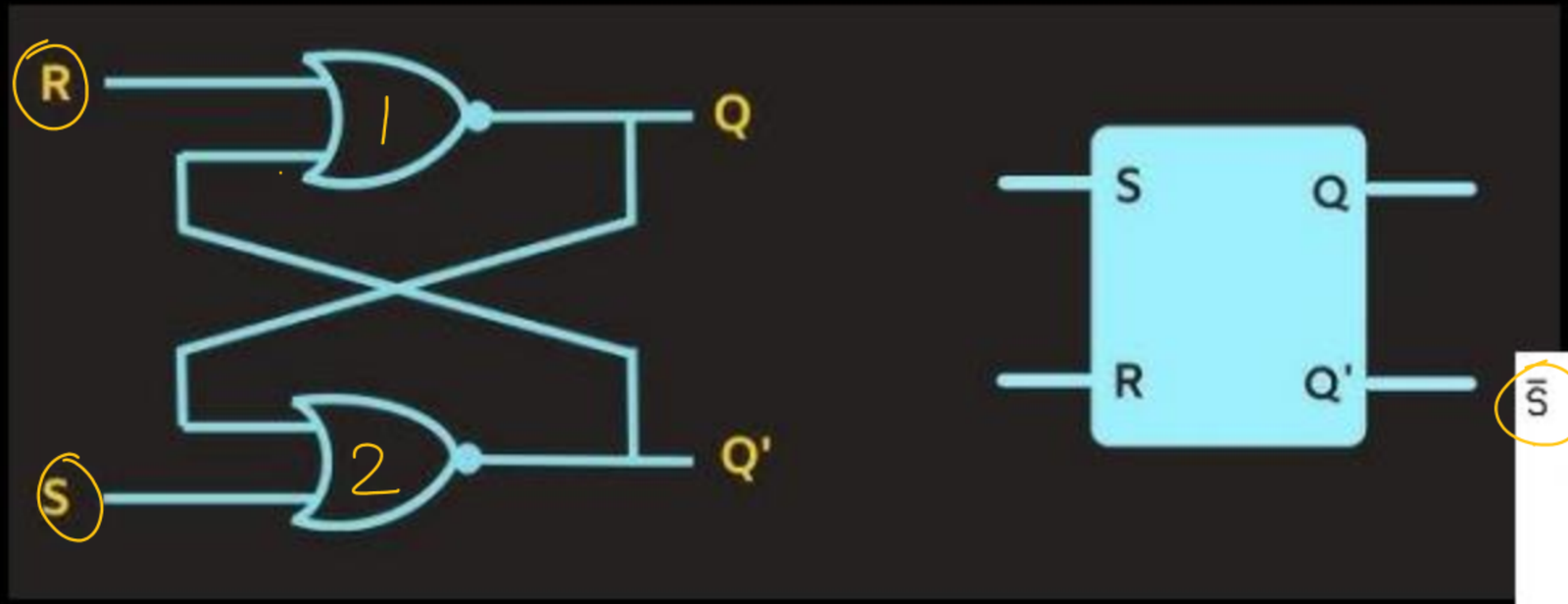
LATCH	FLIP FLOP
latches can be built from gates	flip-flops can be built from latches
latch does not have a clock signal	flip-flop always have a clock signal
latch is a level-triggered type of memory circuit	flip-flop is an edge-triggered type of memory circuit
Latch serve as memory elements in asynchronous sequential circuits.	flip flops serve as memory elements in synchronous sequential Circuits

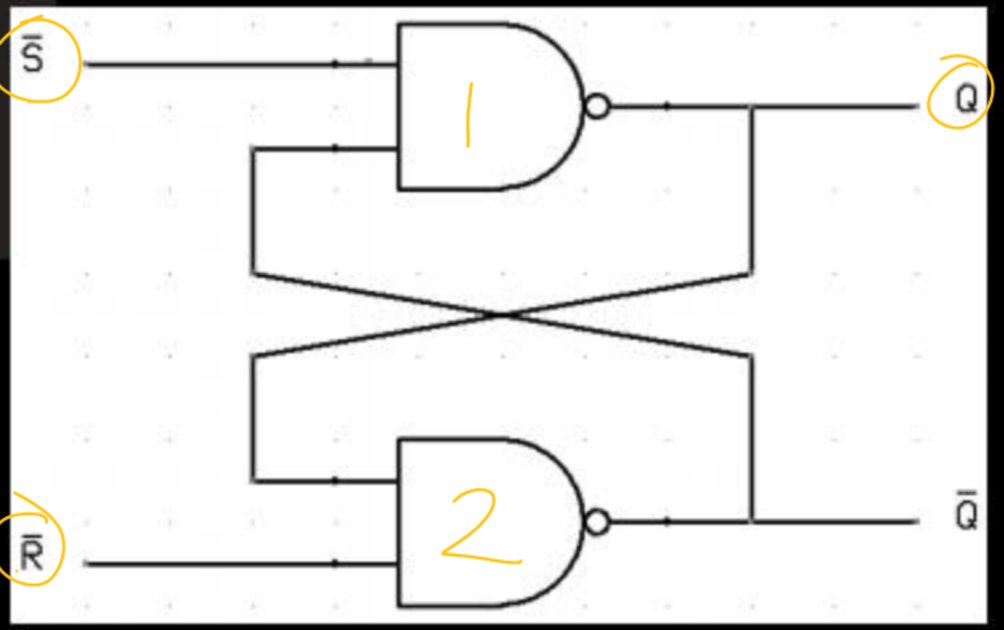
Latches

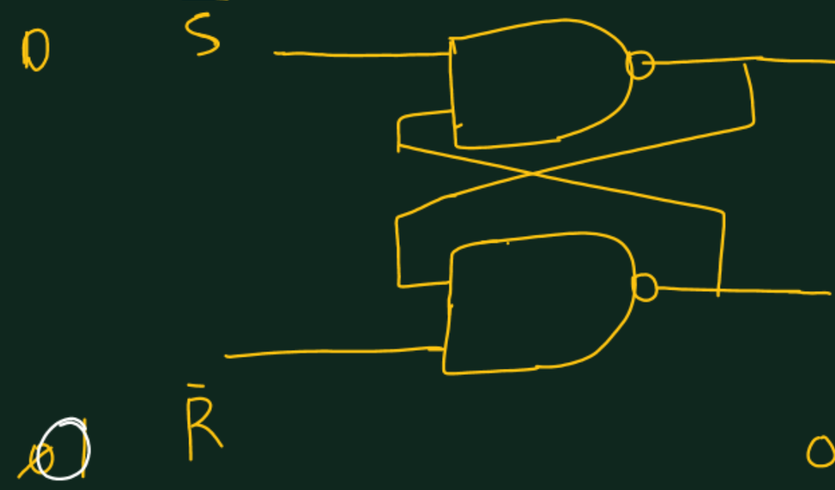
- The circuit shown below is a basic NAND latch.
- The inputs are generally designated "S" and "R" for "Set" and "Reset" respectively.
- The outputs of any single-bit latch or memory are traditionally designated Q and Q'.



NAND & NOR LATCH







$0 \to 1$

$1 \to 1$

$1 \to 1 \to 0$

$1 \to 0$

$0 \to 0$

	$\bar{S}$	$\bar{R}$	S	R	Q_n	$\bar{Q}_n$	Q_{n+1}	$\bar{Q}_{n+1}$
Memory	1	1	0	0	0	1	0	1
	1	1	0	0	1	0	1	0
Reset	1	0	0	1	0	1	0	1
	1	0	0	1	1	0	0	1
Set	0	1	1	0	0	1	1	0
	0	1	1	0	1	0	1	0
Invalid	0	0	1	1	0	1	1	1
	0	0	1	1	1	0	1	1

UNIVERSITY QUESTIONS

YEAR	QUESTION	MARKS
21-22 20-21	Write the differences between combinational and sequential circuits.	10 Marks 2 Marks
20-21 19-20	What is difference between flip flop and latches?	2 Marks

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Thank You

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