AKTU

GATEWAY CLASSES

Digital System Design

B.Tech. 3rd Sem

EC & Allied

Exam/Result Oriented Content

- ✓ Recorded Video Lectures
- ✓ Pdf Notes
- ✓ PYQs



DIGITAL SYSTEM DESIGN

UNIT 4 : Logic families and semiconductor memories

Lec 1



Today's Target

- Integrated Circuits ✓
- Integration Levels ✓
- Characteristics of digital circuits ✓
- Logic Families ✓
- Digital IC Terminology ✓
- University Questions ✓

INTEGRATED CIRCUITS

- Integrated circuits (ICs) are chips, pieces of semiconductor material, that contain all of the transistors, resistors, and capacitors necessary to create a digital circuit or system.
- The first ICs were fabricated using Ge BJTs in 1958.
- Jack Kirby of Texas Instruments, Nobel Prize in 2000
- Robert Noyes of Fairchild Semiconductors fabricated the first Si ICs in 1959.

GW
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Integration Levels:

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- SSI Small scale integration [12 gates/chip]
- MSI Medium scale integration [100 gates/chip]
- LSI Large scale integration [1K gates/chip]
- VLSI Very large scale integration [10K gates/chip]
- ULSI Ultra large scale integration [100K gates/chip]

Characteristics of digital circuits

Fan in:

- Fan in is the number of inputs connected to the gate without any degradation in the voltage level.

Fan out:



- Fan out specifies the number of standard loads that the output of the gate can drive without impairment of its normal operation

Power dissipation:



- Power dissipation is a measure of power consumed by the gate when fully driven by all its inputs.

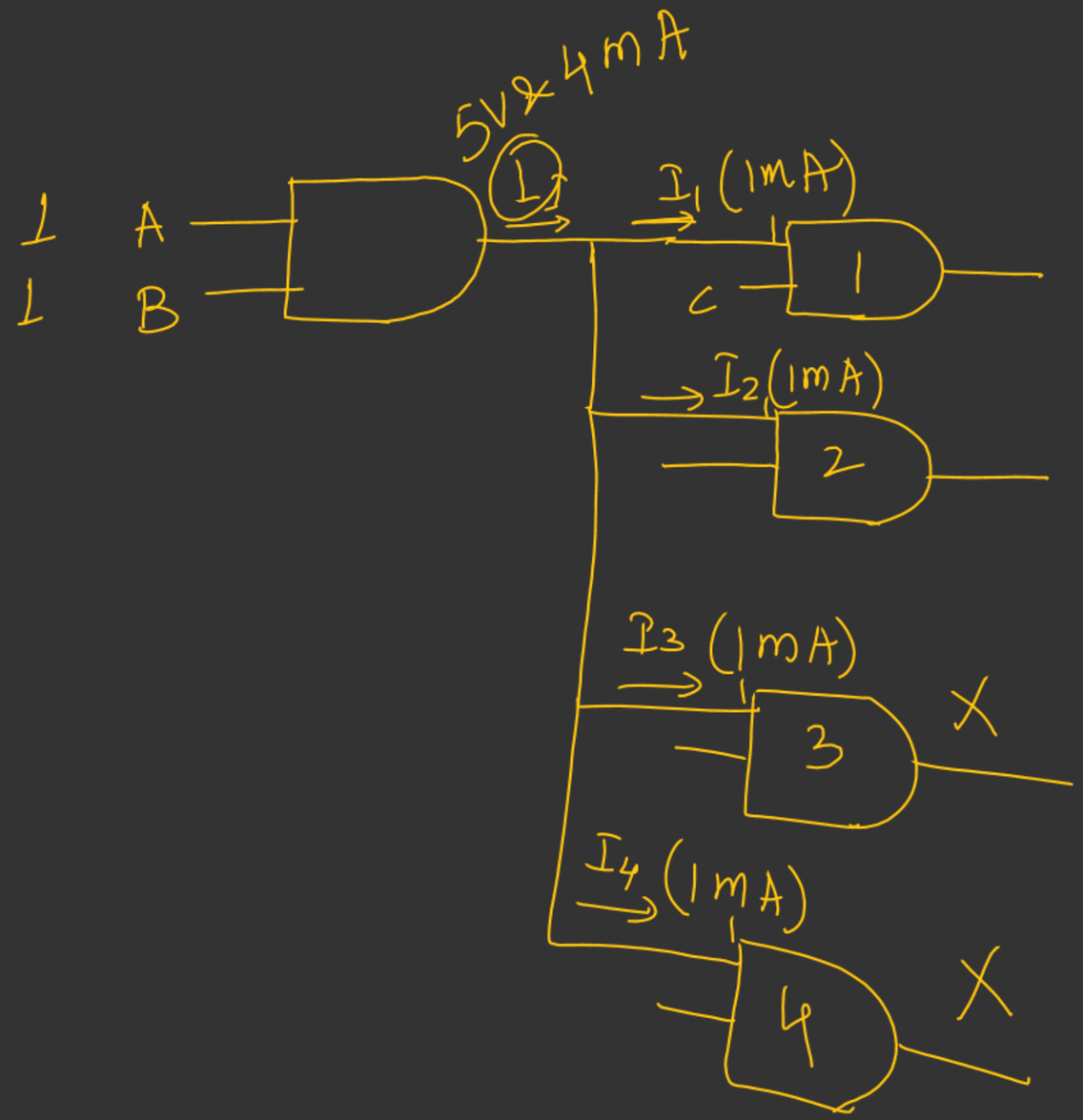
Propagation delay:

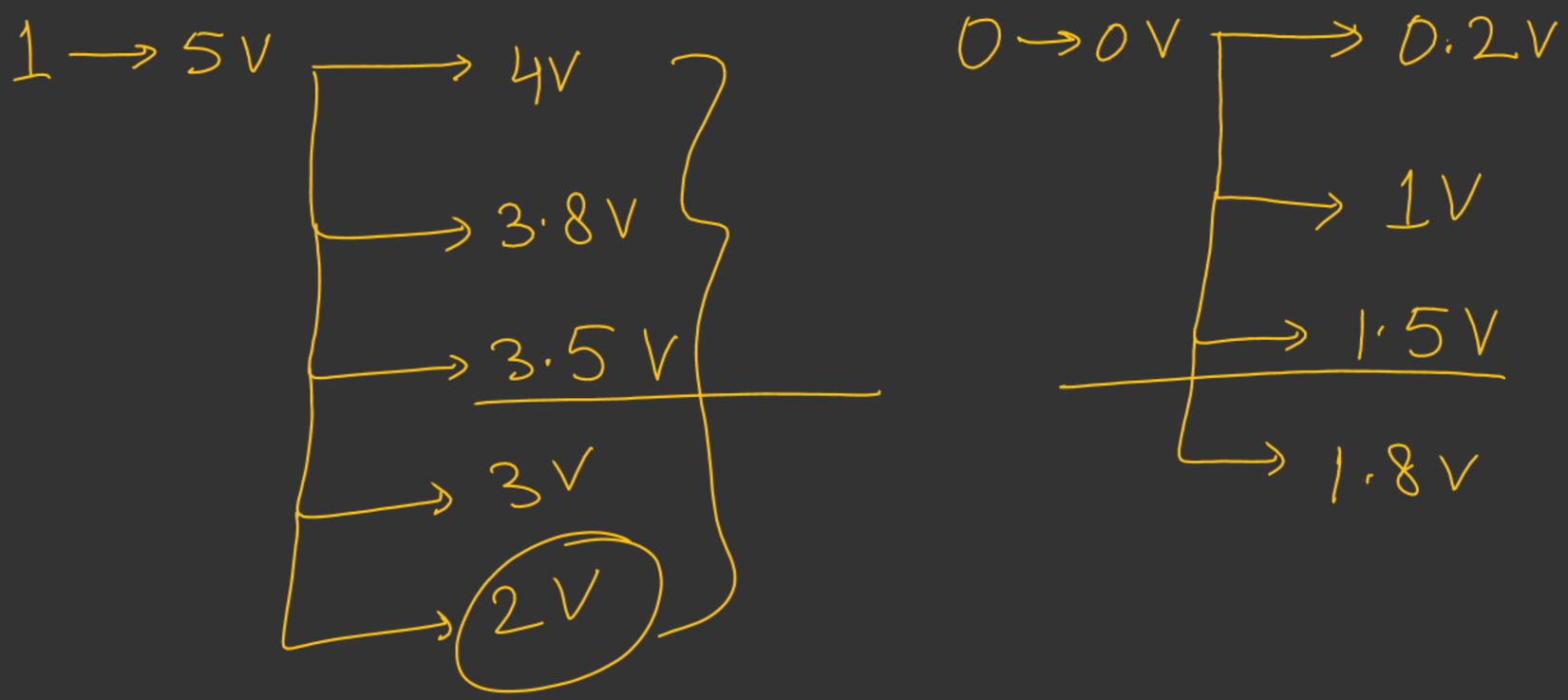
- Propagation delay is the average transition delay time for the signal to propagate from input to output when the signals change in value. It is expressed in ns.

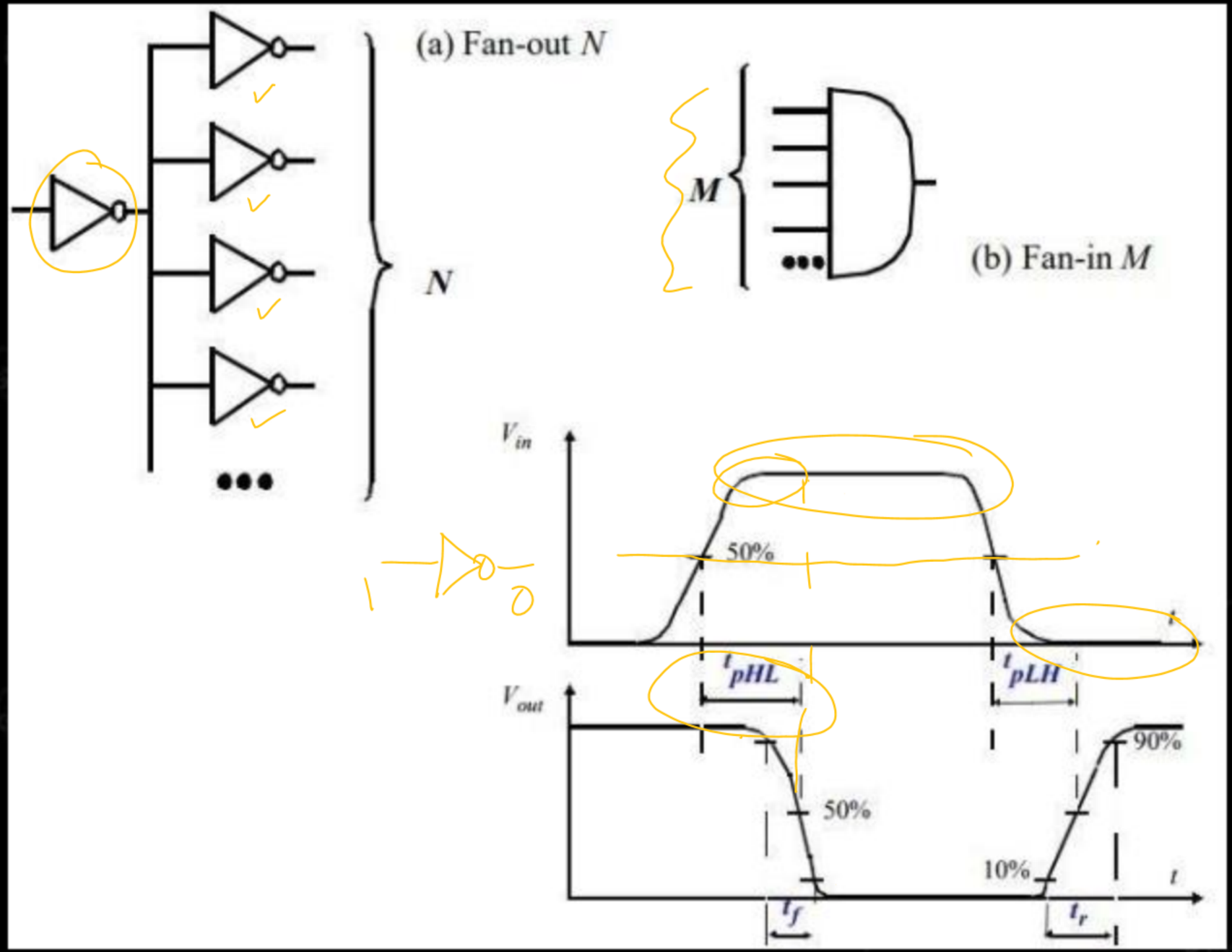
10^{-9} sec

Noise margin:

- It is the maximum noise voltage added to an input signal of a digital circuit that does not cause an undesirable change in the circuit output. It is expressed in volts.


5V & 4mA
1
A
1
B
1
I_1 (1mA)
C
1
I_2 (1mA)
2
I_3 (1mA)
3
X
I_4 (1mA)
4
X


1 → 5V
4V
3.8V
3.5V
3V
2V
0 → 0V
0.2V
1V
1.5V
1.8V


(a) Fan-out N
N
M
(b) Fan-in M
V_{in}
50%
t_{pHL}
t_{pLH}
V_{out}
90%
50%
10%
t
t_f
t_r

Logic Families

- Logic families are sets of chips that may implement different logical functions but use the same type of transistors and voltage levels for logical levels and for the power supplies.
- These families vary by speed, power consumption, cost, voltage & current levels.
- The most widely used families are:
- DL (Diode- logic)
- DTL （Diode-transistor logic）
- RTL （Resistor-transistor logic）
- TTL （Transistor -transistor logic）
- ECL （Emitter-coupled logic）
- MOS （Metal-oxide semiconductor）
- CMOS (Complementary Metal-oxide semiconductor）

Digital IC Terminology

Voltage Parameters:

- V_{IH}(min): high-level input voltage, the minimum voltage level required for a logic 1 at an input.
- V_{IL}(max): low-level input voltage
- V_{OH}(min): high-level output voltage
- V_{OL}(max): low-level output voltage
- For proper operation, the input voltage levels to a logic must be kept outside the indeterminate range. Lower than VIL(max) and higher than VIH(min).

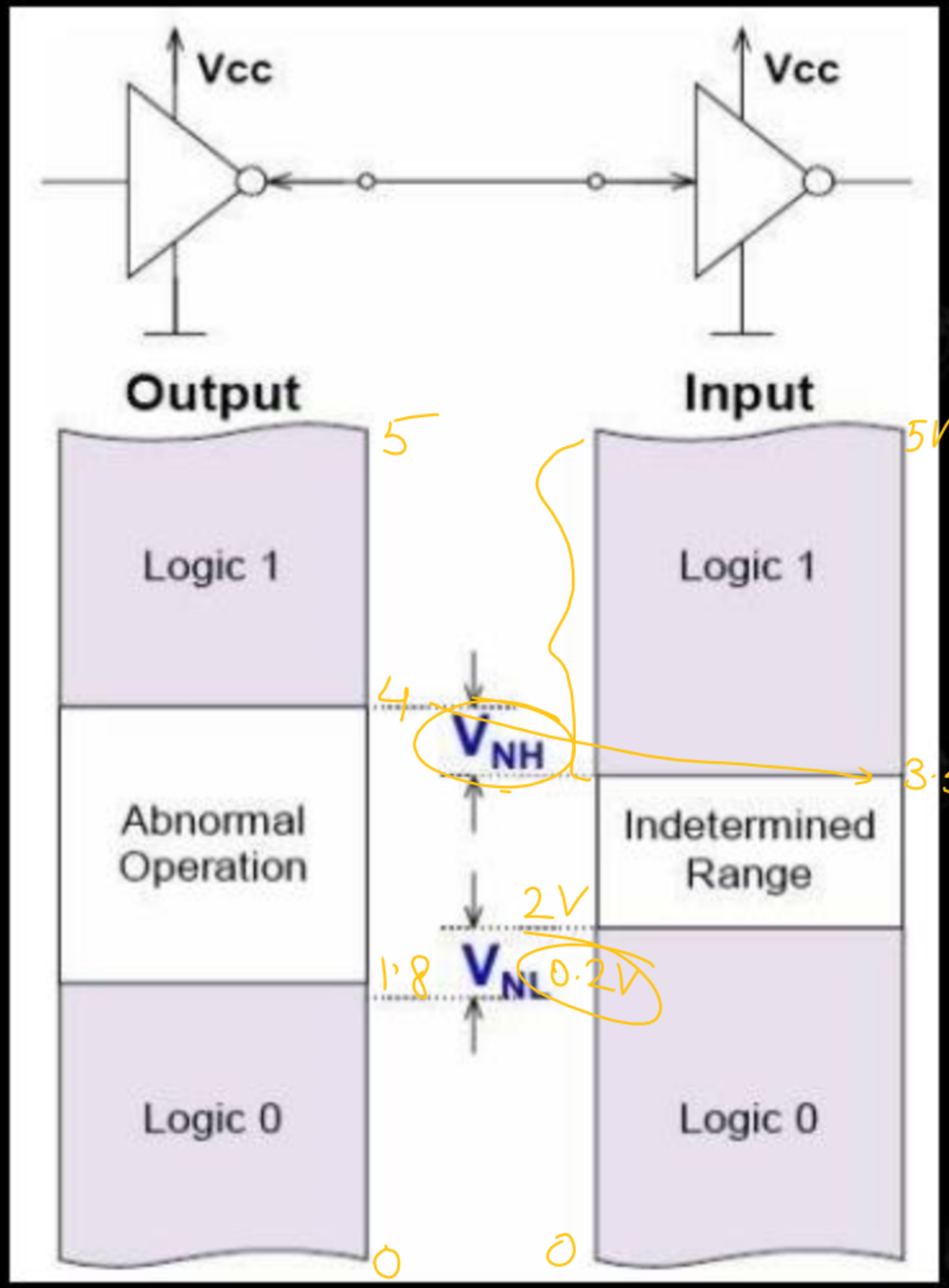


Noise Margin:

- The maximum noise voltage that can be tolerated by a circuit is termed its noise immunity (noise Margin)

Current Parameters:

- I_{OH} – Current flowing into an output in the logical "1" state under specified load conditions
- I_{OL} – Current flowing into an output in the logical "0" state under specified load conditions
- I_{IH} – Current flowing into an input when a specified HI level is applied to that input
- I_{IL} – Current flowing into an input when a specified LO level is applied to that input


Vcc
Vcc
Output
Input
Logic 1
Logic 1
Abnormal Operation
Indetermined Range
Logic 0
Logic 0
V_{NH}
V_{NL}
5
5V
4
3.5V
2V
1.8
0.2V
0
0

University Questions

Year	Questions	Marks
22-23 21-22 18-19	Explain FAN-IN and FAN-OUT.	2 Marks
22-23	Describe figure of merit & noise immunity of TTL & CMOS ICs	2 Marks
20-21	Define the following terms I. threshold voltage II. propagation delay III. power dissipation IV. fan-in V. fan-out	10 Marks
19-20	What is logic family? Give the classification of logic families in brief	2 Marks

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