# COMPUTER LOGIC AND DIGITAL CIRCUIT DESIGN (PHYS306/COSC330): UNIT 2.2

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# SUMMARY

**Reading: DF Chapter 3-4 (Moodle)**

1. Logic Gates
   - Circuit diagram
   - Truth table
   - Timing diagram
   - Boolean logic
2. Boolean algebra I
3. IC Circuits, **data sheets**
4. Boolean algebra II

**Homework: Chapter 3, ex. 1-22 (two weeks)**

# FIXED-FUNCTION LOGIC: IC GATES

IC Gates are an interesting but fading topic.

1. Some basic realities
2. Notions of power and time
3. Fun with part numbers and data-sheets
    - *This may not seem as important, but it is*

## FIXED-FUNCTION LOGIC: IC GATES

*Switching time - $t_s$, Power dissipation - $P_d = V^2/R$*

CMOS

- Complementary Metal-Oxide Semiconductor
- MOSFETs
- Lower *power dissipation*
- 3.3V and 5V type (voltage that represents HIGH)

TTL

- Transistor-Transistor Logic
- BJTs
- Faster *switching speeds*
- 5V type (voltage that represents HIGH)

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Chapter 3 examines 54/74 series IC gates.

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`www.digikey.com`

Sample part number: **74***A*LV**C**20

- **74** Mil-spec or military specification. 54 is commerical specification
- *A* “Advanced”
- LV low-voltage (3.3 V type), could also be HV or high-voltage (5.0 V type)
- **C** CMOS, could also be CT for TTL compatibility
- 20: specific gates inside. In this case we have two NAND gates with 4-inputs each

| End code | IC contents |
| --- | --- |
| 00 | Quad 2-input NAND |
| 02 | Quad 2-input NOR |
| 04 | Hex inverter |
| 08 | Quad 2-input AND |
| 10 | Triple 3-input NAND |
| 11 | Triple 3-input AND |
| 20 | Dual 4-input NAND |
| 21 | Dual 2-input AND |
| 27 | Triple 3-input NOR |
| 30 | Single 8-input NAND |
| 32 | Quad 2-input OR |
| 86 | Quad 2-input XOR |

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Sample part number: **74***A*LV**C**20

1. Look up power dissipation. Can't find it? Then find $I_{CCL}$ and/or $I_{CCH}$.
2. Look up propagation delay time $t_d$. Usually it is in nanoseconds.
3. Look up voltage type (*does it match*?)
4. $P_D = V_{cc}\left(\frac{I_{CCL}+I_{CCH}}{2}\right)$
5. Compute the speed-power product (SPP) (product of the delay time and $P_D$)
6. Repeat (6) for a variety of part numbers, and plot (SPP) versus $t_d$ and $P_D$.

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Sample part number: 74*A*LVC20

1. Compute fan-out:
$$UL = \frac{I_{OH}}{I_{IH}} = \frac{I_{OL}}{I_{IL}} \tag{1}$$
This is the ratio of input and output currents in the low and high states. Represents the maximum number of down-stream gates a given gate can handle.
2. CMOS systems are "high-impedance" (high-resistance) so the fan-out should be high. Think about this in terms of Ohm's law ($V = iR$).
3. Compute fan-out for a variety of part numbers

The key to this lesson is that data sheets and part numbers matter. It's not just gibberish.

Imagine buying 54-series parts, because that's what they last guy did, building a unit, and deploying it in...Antarctica. What's the temperature in Antarctica? Yeah...you needed to buy 74-series.

Also, an important feature of any IC/digital component data sheet is the **pin-out.**

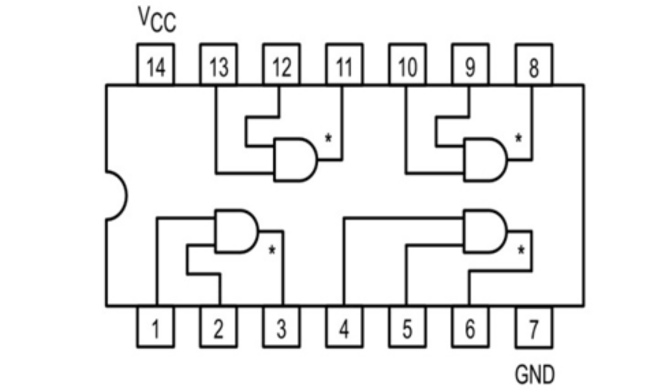


**Figure 1:** Example of IC *pinout*, which displays **which pins mean what.**

Vocabulary recap:

1. Pinout
2. Ohm's Law
3. SPP
4. $t_d$
5. $P_d$
6. $I_{IH}$, $I_{OH}$
7. $I_{IL}$, $I_{OL}$
8. $V_{CC}$, $I_{CCL}$, $I_{CCH}$ (which current is higher?)
9. CMOS, TTL, MOSFET

# CONCLUSION

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