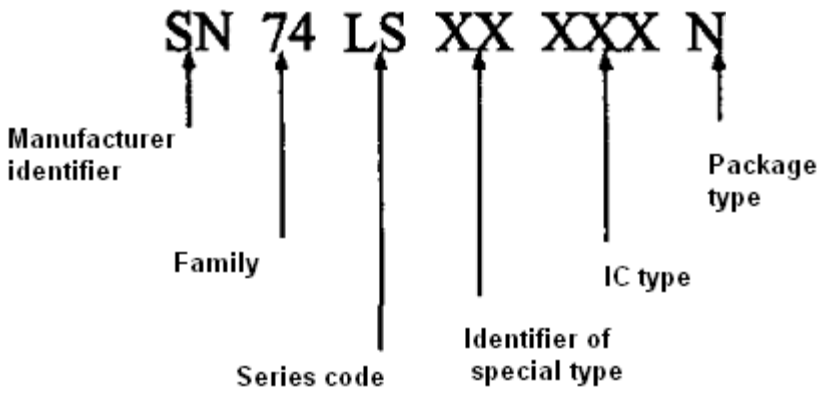
Tutorial 2
Digital Logic

CO 2206 Computer Organization

Digital IC Identifier

- There are huge amounts of different digital IC chips available in the market starting from simplest logical elements and ending with processors and gate arrays (FPGA)
  - lots of IC manufacturers offering IC's too
- There is no standard marking (identifier) system, although there are similar patterns to observe
- Lets look at the common marking of general digital chips for TTL 74 series:



TTL IC Marking - 1

- **Manufacturer identifier** indicates the manufacturer name, e.g.
  - AD Analog Devices
  - DS Dallas Semiconductor
  - DM National Semiconductor (digital)
  - HD Hitachi (digital)
  - HI Harris
  - LM National
  - MC Motorola
  - SN Texas Instruments, TI (Standard)
- **Family** – also indicates a temperature range:
  - 74 - commercial (0…70° C), while CMOS chips has a range of (-40…+85° C)
  - 54 – military where working temperature range is (-55…+125° C)

TTL IC Marking - 2

- **Series code** – up to three symbols:
  - none – standard TTL
  - LS – Low power Schottky
  - S – Schottky TTL
  - ALS – Advanced Schottky TTL (one of the most widely used)
  - F – Tast TTL
  - HC- high speed CMOS
  - HCT – High speed CMOS with TTL inputs
  - AC – Advanced CMOS
  - ACT – Advanced CMOS with TTL inputs
  - BCT – BiCMOS technology
  - ABT- Advanced BiCMOS Technology
  - LVT – Low Voltage Technology with low voltage power source
- **Identifier of special type** – two symbols that can be excluded

TTL IC Marking - 3

- **IC type** – IC type describing its function;
- **Package type**:
  - N – plastic DIL (DIP)
  - J – ceramic DIP
  - T – flat metal
- **Examples**:
  - SN74ALS32N - Quad 2-input OR Gate from Texas Instruments
  - SN74ALS08N - Quad 2-input AND Gate from Texas Instruments

Logic Gate ICs

- **Task 1:** Determine (research) a part number of the IC for the following logic gates:
  - 2-input NAND gates
  - 3-input NAND gates
  - 2-input NOR gates
  - 3-input NOR gates
  - NOT gates
  - OR gates
  - AND gates
  - XOR gates

Boolean Algebra - 1

- **Task 2**: Solve the following problems
  - Prove the *absorption law* using *Boolean Algebra:* $x \cdot (x+y) = x$
  - Prove the implementations of *AND*, *OR* and *NOT* using *NAND*
    - Prove above using *Truth Table* and *Boolean Algebra*
  - Prove the implementations of *AND*, *OR* and *NOT* using *NOR*
    - Prove above using *Truth Table* and *Boolean Algebra*
  - Prove equivalence, $(xyz)' = x' + y' + z'$ by means of *truth table*
  - Prove equivalence by means of *Boolean algebra:*
    - $(x+y)' \cdot (x'+y')' = 0$
    - $xy = (x+y)(x+y')(x'+y)$
    - $xy + x'z = xy + x'z + yz$

Boolean Algebra - 2

- **Task 3**: Solve the following problems
  - Demonstrate by means of truth tables the validity of the following identity:
    - XOR's inverse: $(x \oplus y)' = x \oplus y'$
  - Prove the identity of each of the following *Boolean equations*, using algebraic manipulation:
    - Prove A'B' + AB = (A ⊕ B)'. Hint: use double negation
    - $(a \oplus b)' \oplus c = a'b'c' + abc' + a'bc + ab'c$
  - Simplify the following logic functions using *Boolean algebra* rules:
    - ab + ab'
    - xyz + x'y +xyz'x' + xy + xz' + xy'z'
  - Obtain the truth table of the function (xy + z)(y + xz) and express the function in *sum-of-minterms* and *product-of-maxterms*