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Menu

- Available ICs in TTL
- See also web-site
  - >Pinouts on the Software/Docs page
- TTL Gates
- Positive-Logic & "N-" Logic

See software/docs on web:
Hardware_Get_Started.pdf, Pinouts

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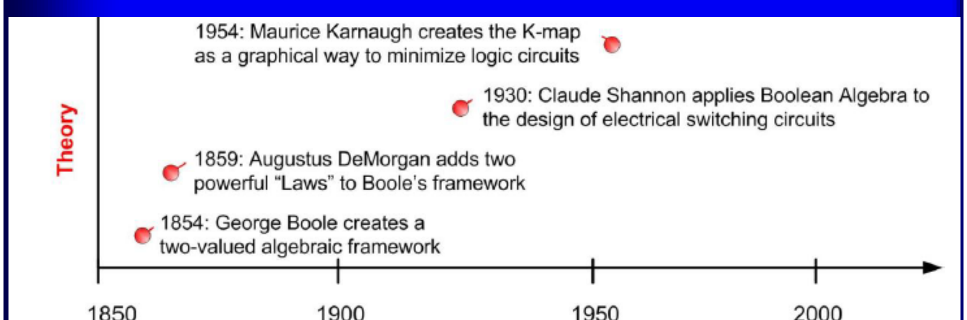
Milestones in Logic and HDL: Theory



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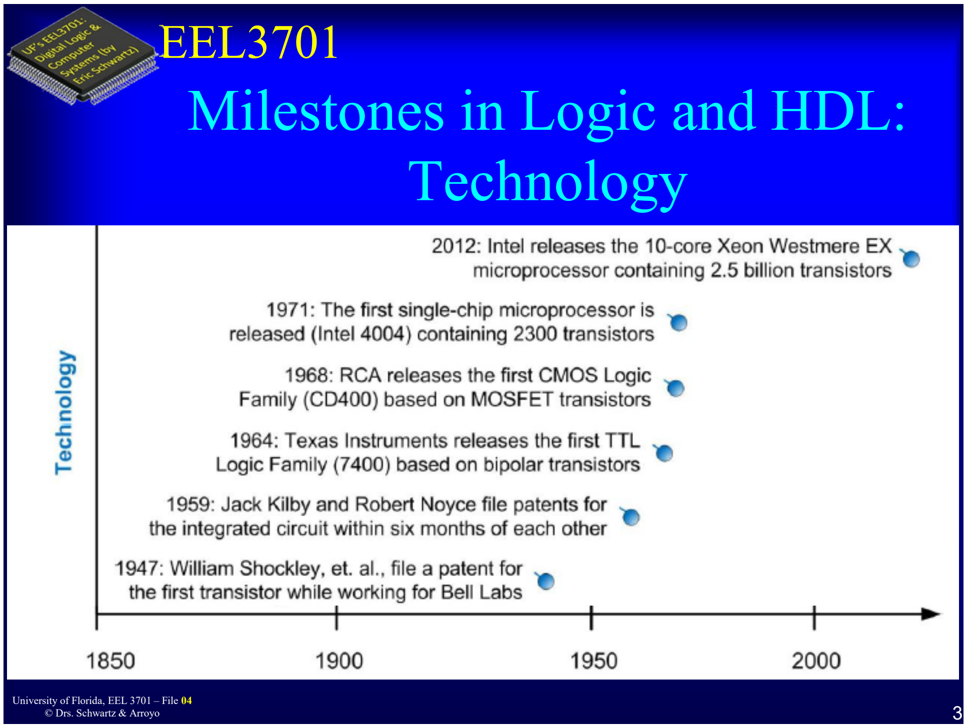
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Milestones in Logic and HDL: Technology
Technology
2012: Intel releases the 10-core Xeon Westmere EX microprocessor containing 2.5 billion transistors
1971: The first single-chip microprocessor is released (Intel 4004) containing 2300 transistors
1968: RCA releases the first CMOS Logic Family (CD400) based on MOSFET transistors
1964: Texas Instruments releases the first TTL Logic Family (7400) based on bipolar transistors
1959: Jack Kilby and Robert Noyce file patents for the integrated circuit within six months of each other
1947: William Shockley, et. al., file a patent for the first transistor while working for Bell Labs
1850
1900
1950
2000
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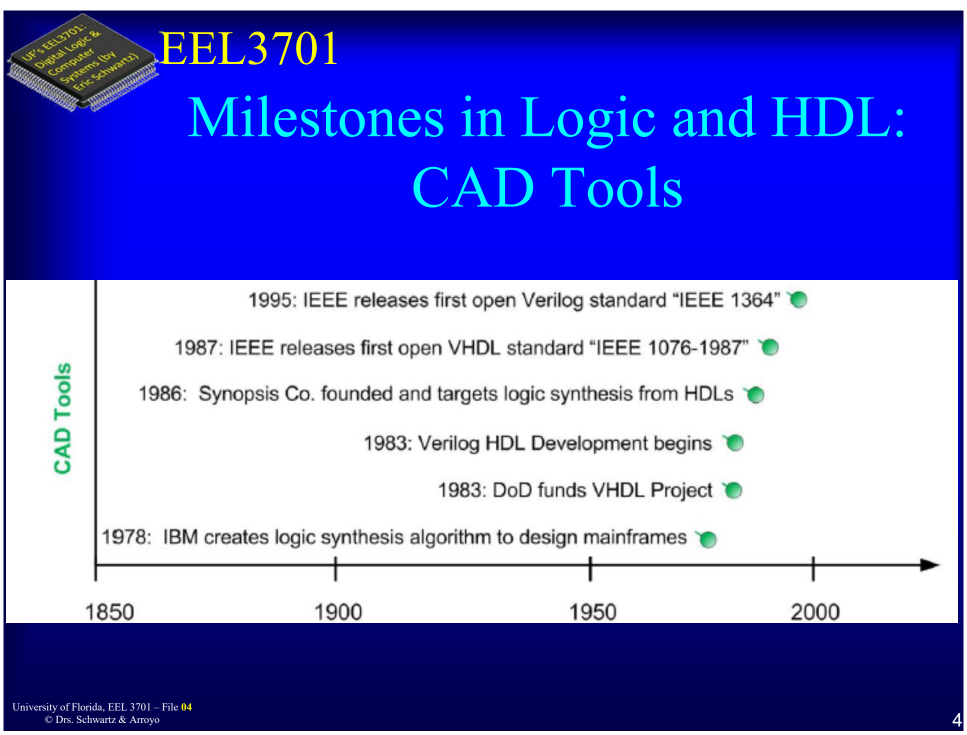
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Milestones in Logic and HDL: CAD Tools
CAD Tools
1995: IEEE releases first open Verilog standard "IEEE 1364"
1987: IEEE releases first open VHDL standard "IEEE 1076-1987"
1986: Synopsis Co. founded and targets logic synthesis from HDLs
1983: Verilog HDL Development begins
1983: DoD funds VHDL Project
1978: IBM creates logic synthesis algorithm to design mainframes
1850
1900
1950
2000
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Integrated Circuits

- Available Integrated Circuits (ICs or Chips) in Transistor-Transistor-Logic (TTL) include:
  - > Standard TTL = TTL
  - > Low Power TTL = L-TTL
  - > High Speed TTL = H-TTL
  - > Schottky TTL = S-TTL
  - > Low Power S-TTL = LS-TTL
  - > Advanced S-TTL = AS-TTL
  - > Advanced LS-TTL = ALS-TTL
- The data sheets use 74XY or 54XY to represent commercial grade IC's:
  - X = Series of TTL   Y = 2, 3, or 4 digits
  - <Examples> 74LS00, 7400, 74ALS00, 74LS153, etc.
- High speed CMOS = **HC** ; Ex: 74HC00, 74HC02, etc.
- HC CMOS is not TTL but uses the same numbering system
- TTL uses bipolar transistors. CMOS uses complementary MOS (metal-oxide semiconductor) transistors

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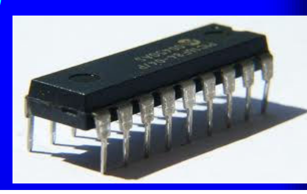
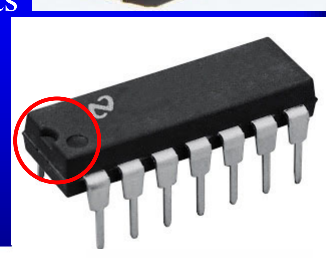
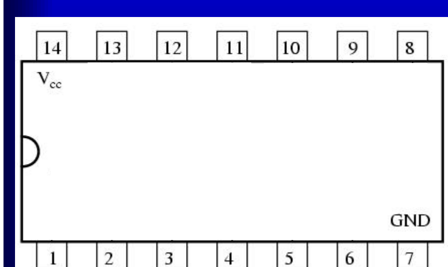
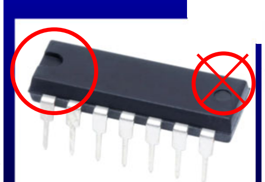
IC's (Chips)

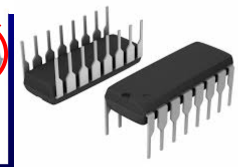
- **DIP** = Dual In-line Package
  - >Two parallel rows of pins
  - >Common for students and hobbyists
  - >Pins go through a board or into sockets
  - >Notch and/or dot denotes pin 1











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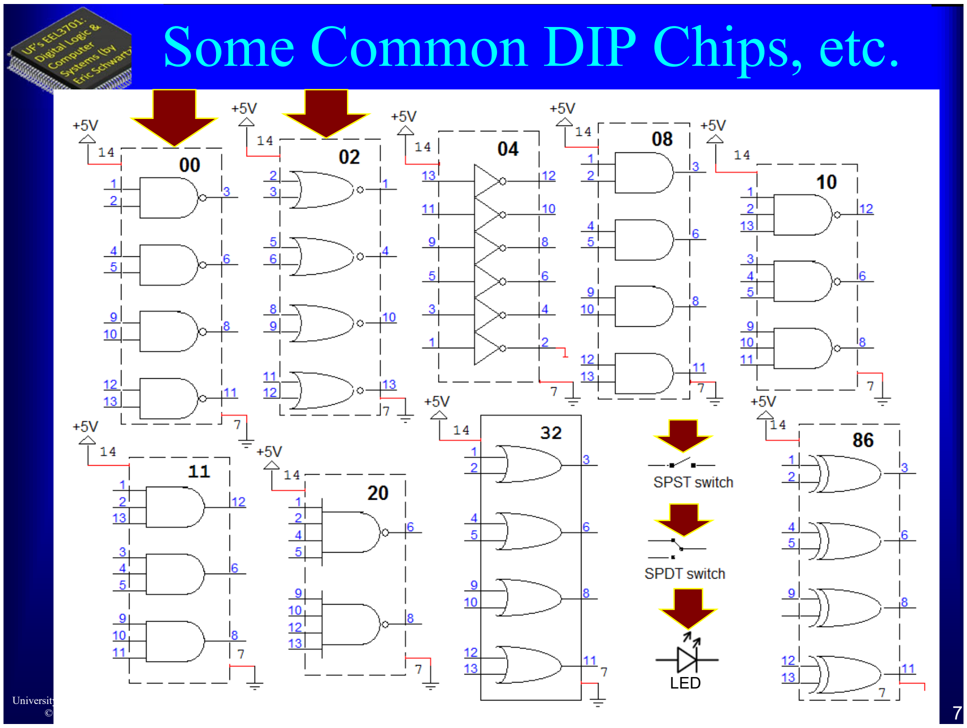

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Available ICs

- Check out the **software/docs** page under heading **pinouts** on the class web site
  - >Various versions of pinouts for common chips

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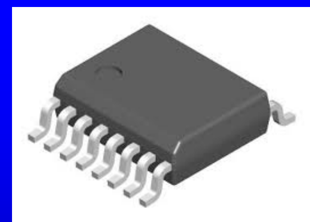
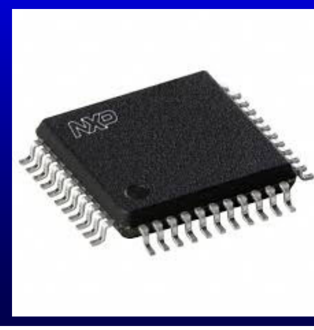
More Chip Types

- **SOIC** = Small Outline IC
  - >For surface mounting on one side of PCB
- **SOP** = Small Outline Package
  - >Similar to SOIC, but with smaller pin spacing
- **QFP** = Quad Flat Package
  - >For surface mounting on one all four sides of PCB





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More Chip Types

- **PLCC** = Plastic leaded (or leadless) chip carrier
  - >Pins on side and underneath chip
  - >Very hard to solder pins
  - >Often used with PLCC socket
- **PLCC Socket** = Receptacle for PLCC
  - >Socket for PLCC

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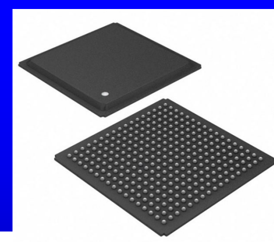
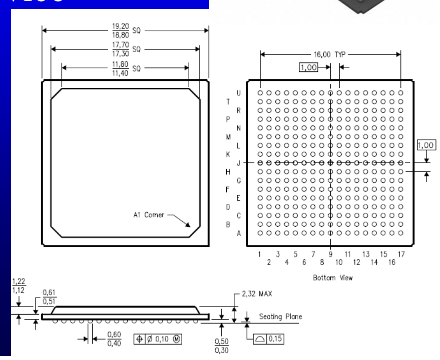
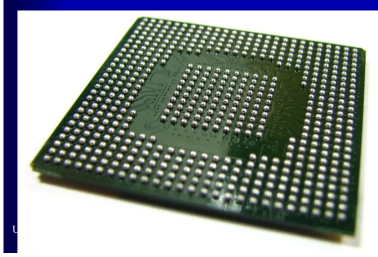
More Chip Types

- **BGA** = Ball Grid Array package
  - >Pins underneath chip
  - >For surface mounting on one side of PCB with very high pin density
  - >Bottom view of BGA device shown below







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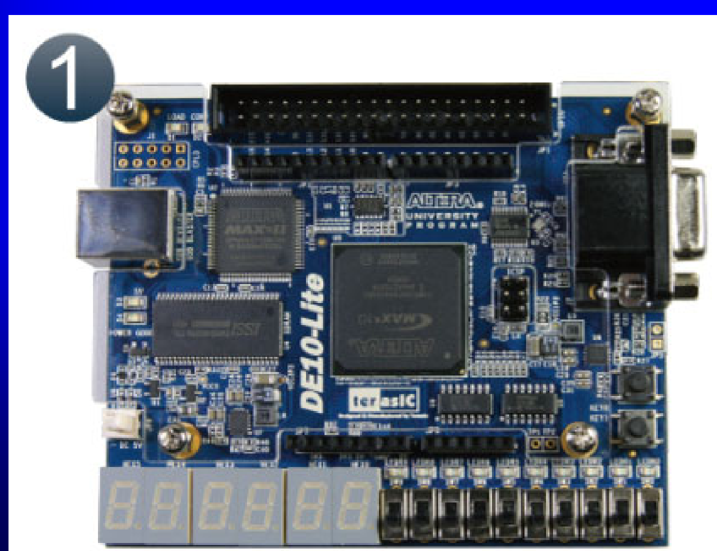
DE10-lite (3701 PCB starting in Fall 23) w/ Max10



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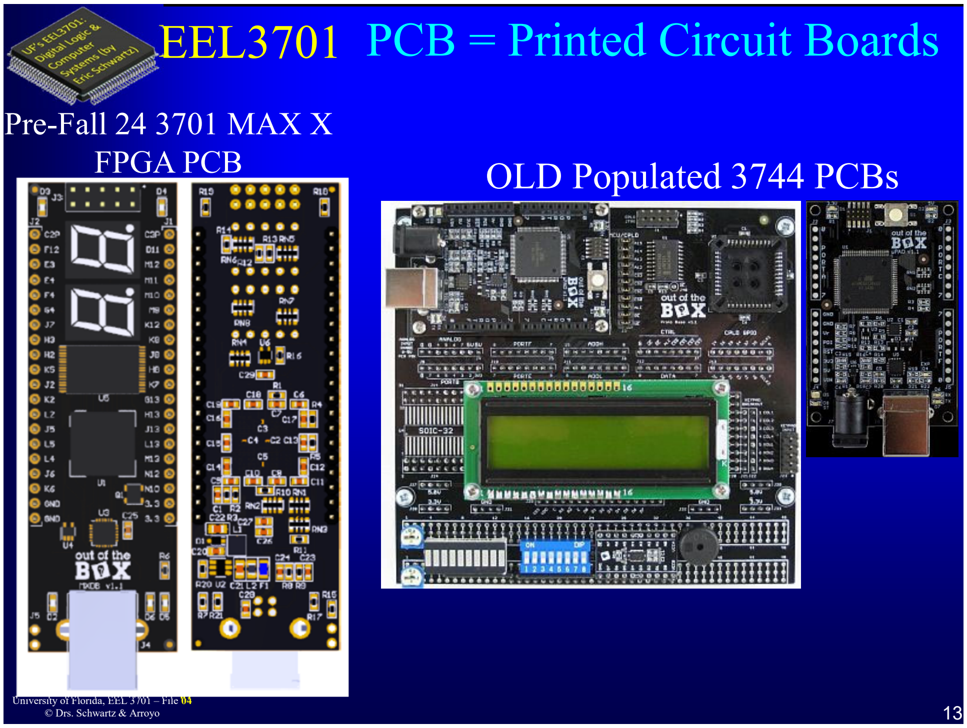
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PCB = Printed Circuit Boards
Pre-Fall 24 3701 MAX X
FPGA PCB
OLD Populated 3744 PCBs
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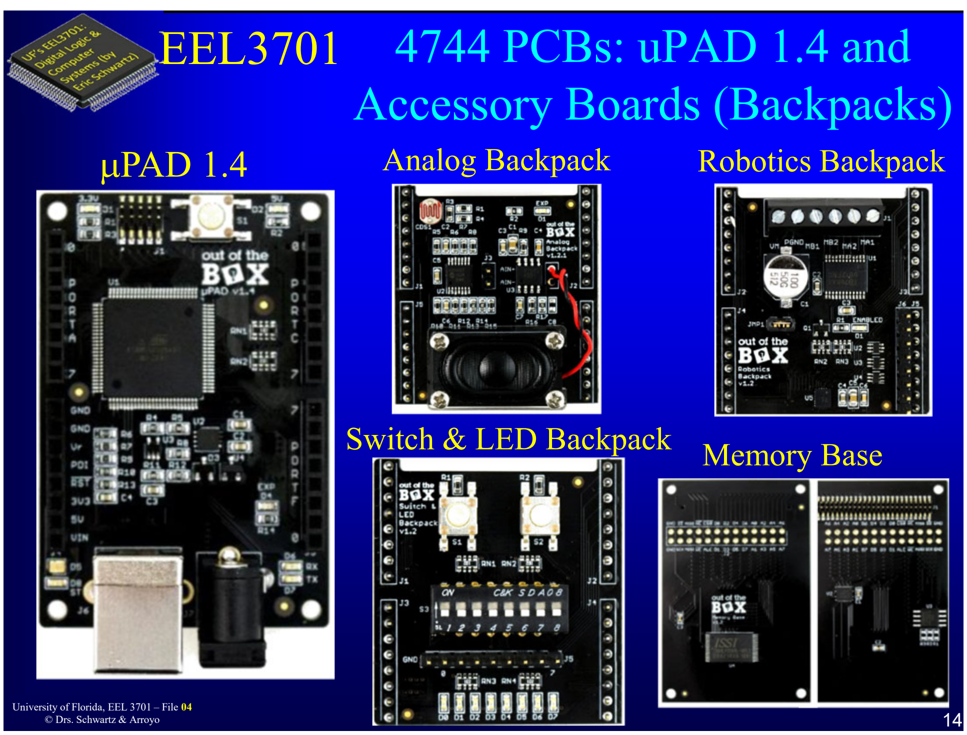
EEL3701
4744 PCBs: uPAD 1.4 and
Accessory Boards (Backpacks)
μPAD 1.4
Analog Backpack
Robotics Backpack
Switch & LED Backpack
Memory Base
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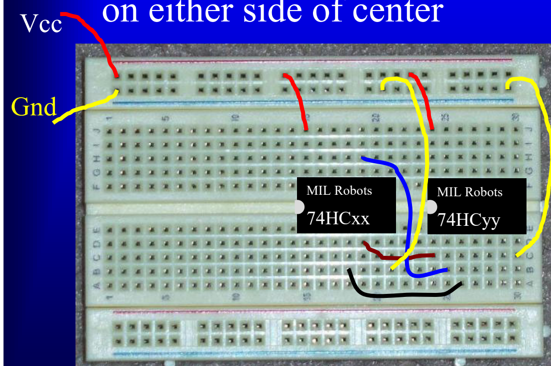
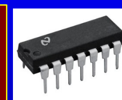
Breadboard (Protoboard) and Building Circuits

- Used for quick circuit assembly using DIP chips, switches, LEDs, and resistors (also SIP resistors)
  - >Chips are inserted in holes with pins going on either side of center



Then add switch and LED circuits for Input/Output



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Resistors

- Ohm's Law: V = I R
  - >V is voltage
  - >I is current
  - >R is resistance
- For a fixed voltage (common in digital circuits), as R ↑, I ↓
- "Resistors resist!"
  - >The higher the resistance, the more they resist

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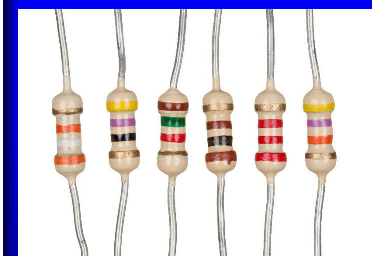
Axial Resistors



How to Read Resistor Color Codes

6-Band: 2 7 $4 \cdot 10^0$ ± 2 = 274 Ω ± 2%, 250 ppm/K

Color	1st Digit	2nd Digit	3rd Digit		Multiplier	Tolerance	Temperature Coefficient
Black	0	0	0		1 Ω		250 ppm/K
Brown	1	1	1		10 Ω	± 1%	100 ppm/K
Red	2	2	2		100 Ω	± 2%	50 ppm/K
Orange	3	3	3	×	1k Ω		15 ppm/K
Yellow	4	4	4		10k Ω		25 ppm/K
Green	5	5	5		100k Ω	± 0.5%	20 ppm/K
Blue	6	6	6		1M Ω	± 0.25%	10 ppm/K
Violet	7	7	7			± 0.1%	5 ppm/K
Grey	8	8	8				1 ppm/K
White	9	9	9				
Gold					0.1 Ω	± 5%	
Silver					0.01 Ω	± 10%	

4-Band: 12×10^5 ±5% = 1,200 kΩ ± 5%

5-Band: 100×10^2 ±1% = 10,000 Ω ± 1%

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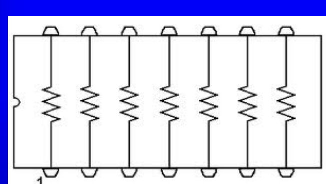
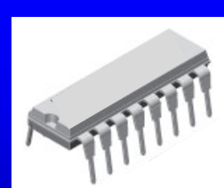
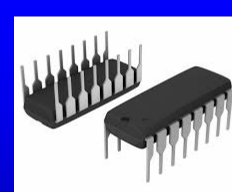
Resistor Packs

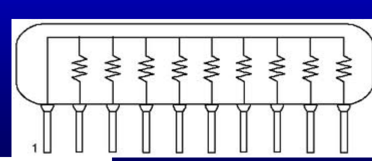
- DIP resistor pack







- SIP resistor pack
  - > **SIP** = Single Inline Package



Vcc or Gnd

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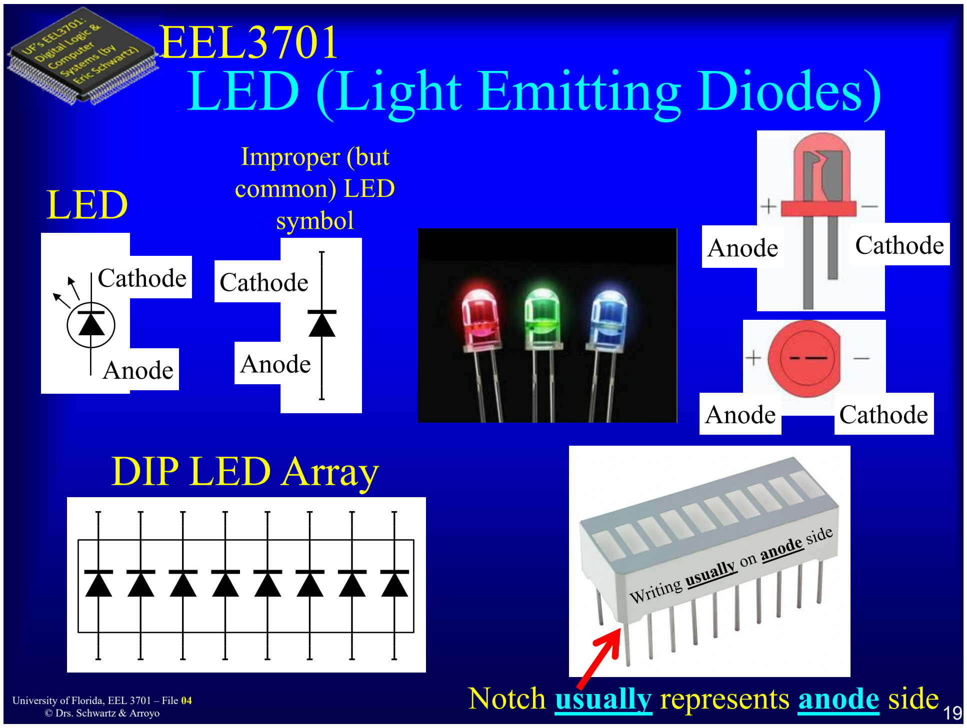
EEL3701
LED (Light Emitting Diodes)
LED
Cathode
Anode
Improper (but common) LED symbol
Cathode
Anode
Anode
Cathode
Anode
Cathode
DIP LED Array
Writing usually on anode side
Notch usually represents anode side
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Switches: SPST, SPDT, Array
• SPST = Single-Pole. Single-Throw
Open Circuit
Short Circuit
• SPST Arrays
>On = closed
• SPDT = Single-Pole, Double-Throw
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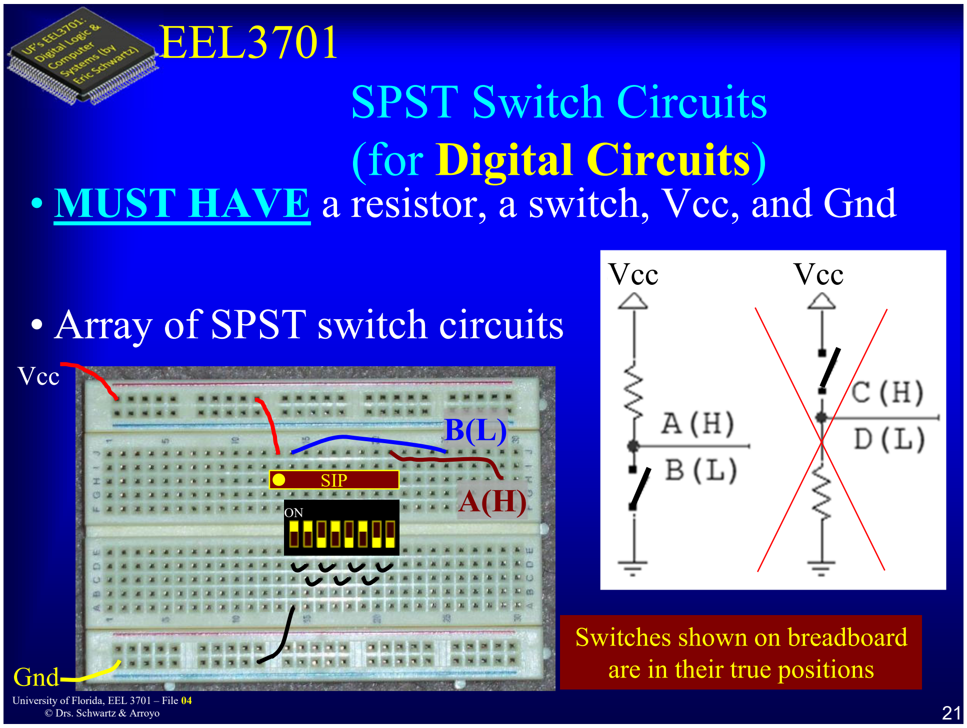
EEL3701
SPST Switch Circuits
(for Digital Circuits)
• MUST HAVE a resistor, a switch, Vcc, and Gnd
• Array of SPST switch circuits
Vcc
B(L)
SIP
A(H)
ON
Gnd
Vcc
Vcc
A (H)
B (L)
C (H)
D (L)
Switches shown on breadboard are in their true positions
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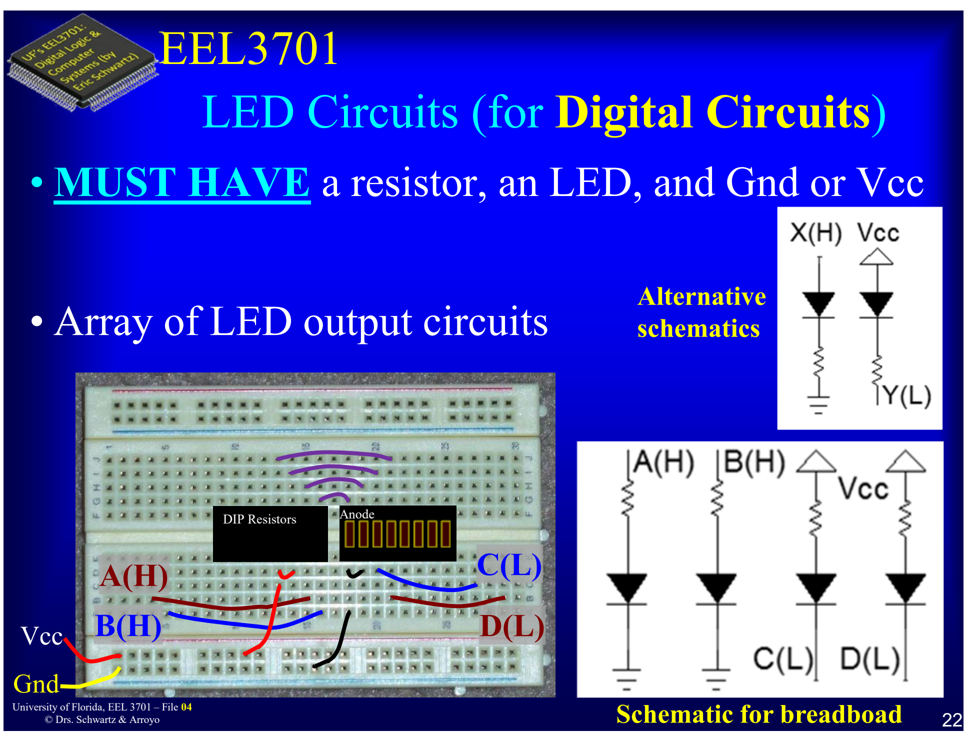
EEL3701
LED Circuits (for Digital Circuits)
• MUST HAVE a resistor, an LED, and Gnd or Vcc
• Array of LED output circuits
Alternative schematics
X(H)
Vcc
Y(L)
DIP Resistors
Anode
A(H)
B(H)
C(L)
D(L)
Vcc
Gnd
A(H)
B(H)
Vcc
C(L)
D(L)
Schematic for breadboad
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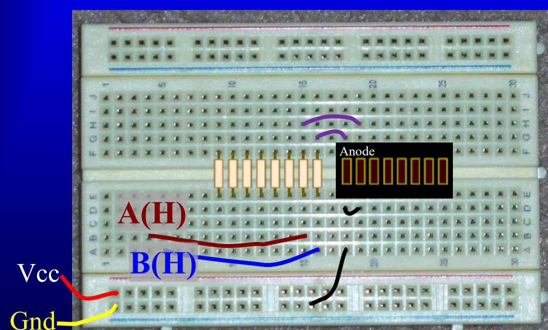
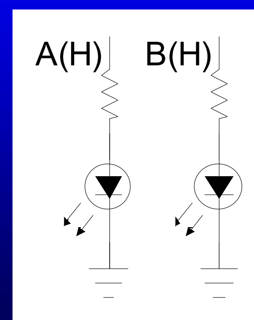
LED Circuits (for **Digital Circuits**)

- **MUST HAVE** a resistor, an LED, and Gnd or Vcc
- Array of LED output circuits with axial resistors





Schematic for breadboad

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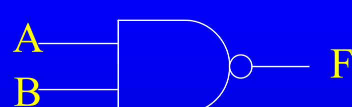
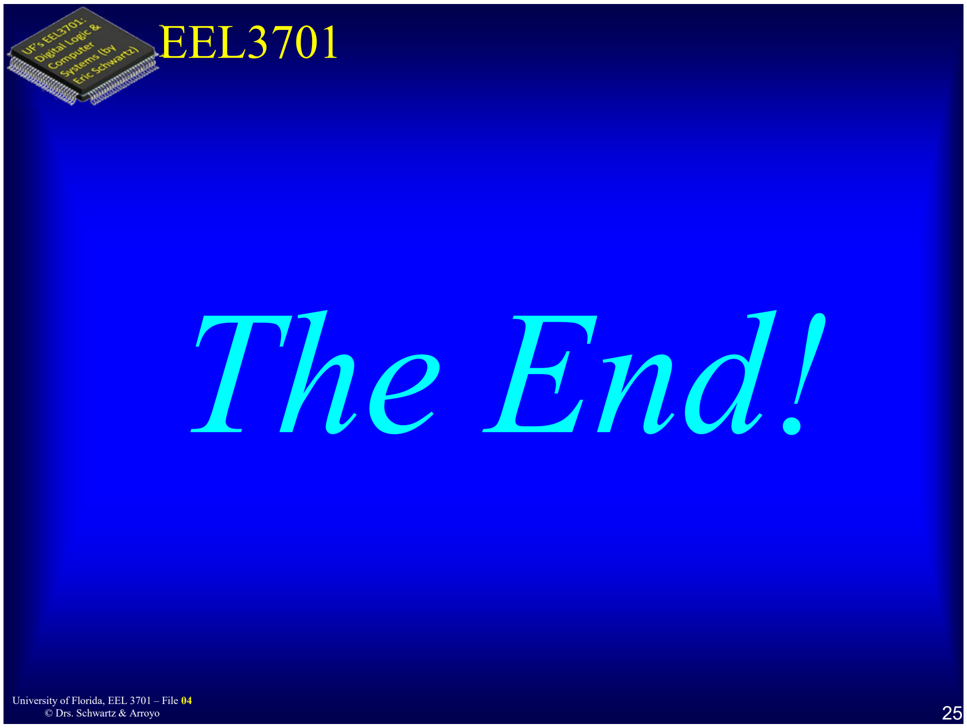
Integrated Circuits

- Look at 74'00 where ' is {null, H, L, S, LS, AS, ALS, HC, etc.}
  - >They are ALL equal to:



- What is ***F*** ?
- Input
  - A wire (no bubble) means it responds to H voltage. (Active-High)
  - A bubble in a wire means it responds to L Voltage. (Active-Low)
- Output
  - A wire (no bubble) means it produces H voltage. (Active-High)
  - A bubble in a wire means it produces L Voltage. (Active-Low)


UF's EEL3701: Digital Logic & Computer Systems (by Eric Schwartz)
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The End!
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