2

Exp. No. 6(ECS51)

Introduction to TTL 74 series basic logic gates

Digital Integrated Circuits (ICs) and the TTL 74 series.

Digital Integrated Circuits (ICs). : Digital ICs are a collection of resistors, diodes and transistors fabricated on a single piece of semiconductor material usually silicon and referred to as "chip". The chip is enclosed in a protective plastic or ceramic package with pins extended out for connecting the IC to other devices. The most common type of package is a dual-in-line package (DIP) as shown in figure 1.1. The pins are numbered counterclockwise when viewed from the top of the package with respect to an identifying notch or dot at one end of the chip. The DIP below is a 14-pin package. 16, 20, 24, 28, 40 and 64 pin packages are also available. The fabricated resistors, diodes and transistors reside in the chip are called logic gates. Different chip may contain different amount of these logic gates. Digital ICs are often categorized according to their circuit complexity as measured by the number of equivalent logic gates in an IC. There are currently
five standard levels of complexity as in Table 1.1.

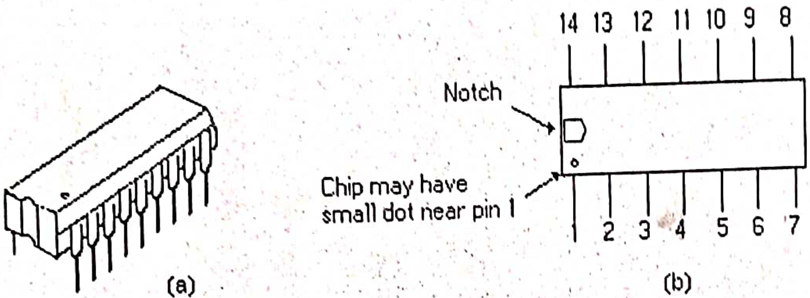


Figure 1.1 (a) Dual-in-line package.
(b) Top view showing pin numbers.

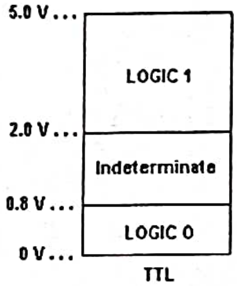
Complexity	Approximate number of gates per chip in commercial products.	Typical products
Small-scale integration (SSI).	Less than 12.	Logic gates, flip-flops.
Medium-scale integration (MSI).	12 to 99.	Counters, multiplexers, adders.
Large-scale integration (LSI).	100 to 9999.	8 bit microprocessors, ROM, RAM.
Very large-scale integration (VLSI)	10,000 to 99,999	16 and 32 bit microprocessors, sophisticated peripherals.
Ultra large-scale integration (ULSI)	100,000 or more.	64 bit microprocessors, special processors, real time image processing.

Table 1.1

All the ICs that will be used in Laboratory 6 are ICs of the SSI category. With ICs, electronic circuits become much smaller and less expensive. This expanded the uses of electronics to various sectors such as industrial, telecommunication, aerospace, computers, calculators and home appliances. Modern electronics using ICs is rapidly becoming the "brains and nerves" of our complex society.

TTL 74 series :
The TTL 74 series is the most widely used family of digital ICs in the SSI and MSI categories. Figure 1.2 shows a standard TTL inverter circuit. Notice that it contains several bipolar transistors and this is how the name TTL (transistor-transistor logic) comes.

TTL Inputs : Power and Ground
Refering to Figure 1.1, all TTL ICs have a dc power supply voltage connected to one of their pins labeled Vcc and ground to another which is labeled as GND. VCC in the range of 4.5V to 5.5V is required. Typically 5V power supplies are used. TTL ICs will not work reliably with dc supply voltages outside of this recommended range and will likely be destroyed if the recommended maximum of 5.5v is exceeded. Logic level voltage ranges Figure 1.3 shows the logic-level voltage ranges for TTL ICs. A logic is any voltage in the range from 0 to 0.8V and a logic 1 is any voltage from 2V to 5V. Voltages that are not in either of these ranges are said to be indeterminate and should not be used as inputs to any TTL device.



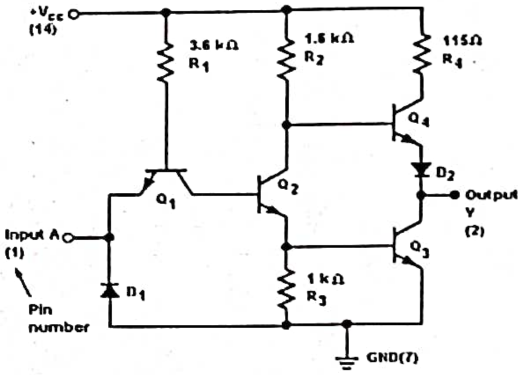


Fig 1.2 TTL inverter circuit

Unconnected (floating) Inputs : If a TTL input is left unconnected, the gate generally reacts as though the input was high. However, an open TTL input is noise-prone. So the high state is not reliable. If only one gate is being used on a multiple gate chip, the inputs to the unused gates may be left open in the breadboard construction in the lab.

Basic logic gates : A logic gate is the simplest device used to construct digital circuits. Logic gates basically have one or more inputs and only one output. The circuits respond to various input combinations and a truth table shows this relationship between the input combinations and its output. Familiarization with a logic circuit's truth table is essential to the technologist or technician before the person can design with or troubleshoot the circuit. Various types of logic gates are available such as inverters (NOT), AND, OR, NAND, NOR, EXOR and EXNOR, each with its own unique logic function.

I. STEPWISE PROCEDURE:

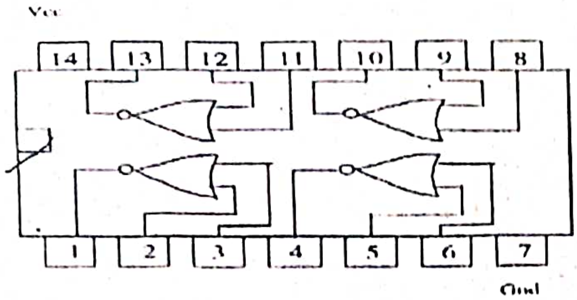
1. Connect +5v to pin 14 and ground to pin 7 of IC.
2. Make the connections as per circuit diagram.
3. Give the logic level inputs according to truth table shown for each gate.
4. Write down the output logic level.
5. Put logic 1 for ON state of LED and logic 0 for OFF state of LED in the observation table.

II. To verify NAND and NOR gates as universal logic gate.

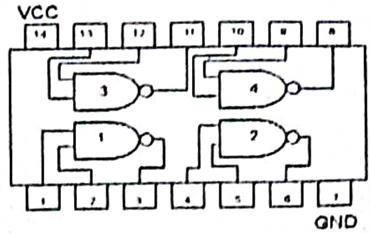
LEARNING OBJECTIVES :

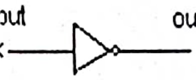
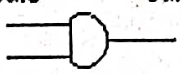
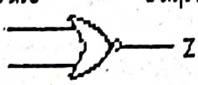
1. To understand the working of NAND and NOR gates.
2. To know the concept of realization of AND, OR, NOT gates by using NAND and NOR gate.

Pin configuration of IC 7402



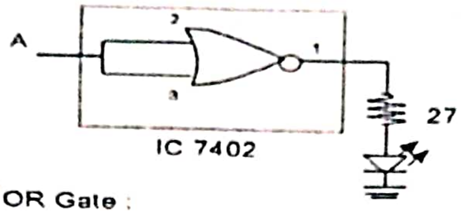
PIN Configuration of IC 7400



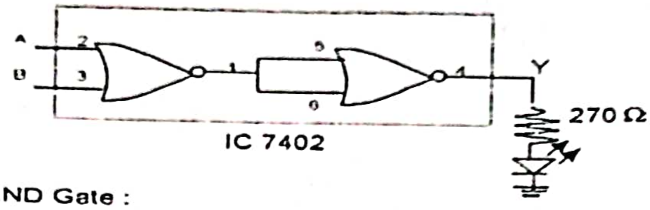
Gate Name	Gate symbol and Boolean equation		Truth Table	
NOT	input x  output y	Boolean equation: $y = \bar{x}$	input, x 0 1	output, y 1 0
OR	inputs x y  output z	Boolean equation: $z = x + y$	input, x y 0 0 0 1 1 0 1 1	output, z 0 1 1 1
AND	inputs x y  output z	Boolean equation: $z = x.y$	input, x y 0 0 0 1 1 0 1 1	output, z 0 0 0 1
NAND	inputs x y  output z	Boolean equation: $z = \overline{x.y}$	input, x y 0 0 0 1 1 0 1 1	output, z 1 1 1 0
NOR	inputs x y  output z	Boolean equation: $z = \overline{x+y}$	inputs x y 0 0 0 1 1 0 1 1	output, z 1 0 0 0
EXOR	inputs x y  output z	Boolean equation: $z = x \oplus y$ $= \bar{x}y + x\bar{y}$	Inputs x y 0 0 0 1 1 0 1 1	output z 0 1 1 0

Circuit diagram using IC 7402

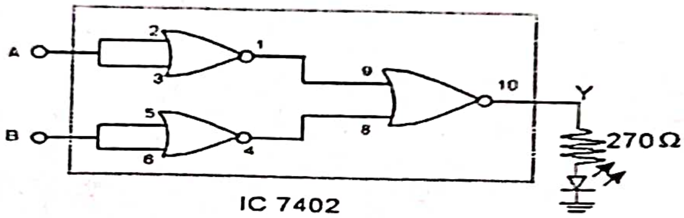
i. NOT Gate :



ii. OR Gate :

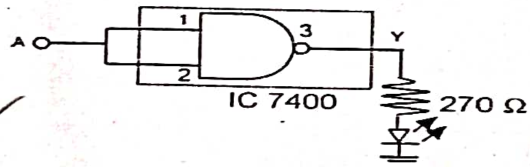


iii. AND Gate :

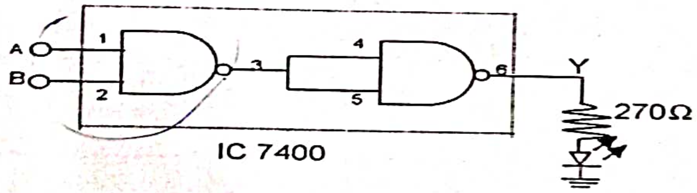


Circuit diagram using 7400.

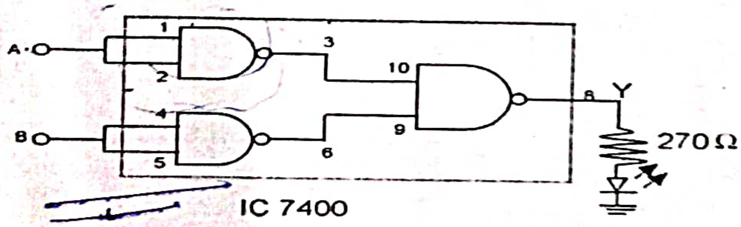
i. NOT Gate :



ii. AND Gate :



iii. OR Gate :



QUESTIONS :

1. Draw EX-OR gate using NAND and NOR gate.
2. Why NOR gate and NAND gate called "Universal logic gate"?
3. Draw the symbol and truth table of following gates.
   1. NOT 2. AND 3. OR 4. NAND 5. Ex-OR .
4. Draw circuit diagram of EX NOR gate using NOR gate.
5. Draw circuit diagram of Ex-NOR gate using NAND gate.