EE1212-

Electronic System I

Logic Families

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Logic Families

- There are various ways in which a logic gate can be implemented using electronic components. [Diodes, Transistors & Resistors].
- These are known as logic families.
- Examples

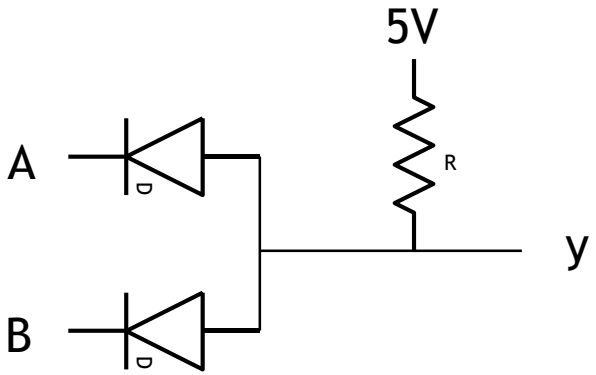
  Resistor-Transistor Logic (RTL)

  Diode-Transistor Logic (DTL)

  Transistor-Transistor Logic (TTL)

Diode Logic

- Uses Diode and Resistors



Voltage Table

A	B	y
0V	0V	0.6V
0V	5V	0.6V
5V	0V	0.6V
5V	5V	5V

Positive Logic Truth Table

A	B	y
0	0	0
0	1	0
1	0	0
1	1	1

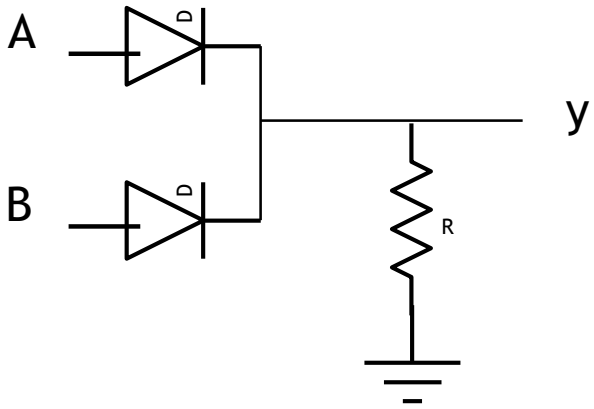
AND Gate

Negative Logic Truth Table

A	B	y
1	1	1
1	0	1
0	1	1
0	0	0

OR Gate

Diode Logic



Voltage Table

A	B	y
0V	0V	0V
0V	5V	4.4V
5V	0V	4.4V
5V	5V	4.4V

Positive Logic Truth Table

A	B	y
0	0	0
0	1	1
1	0	1
1	1	1

OR Gate

Negative Logic Truth Table

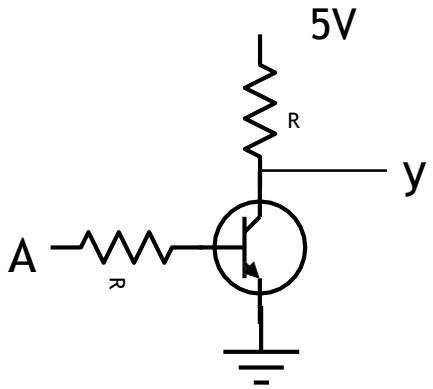
A	B	y
1	1	1
1	0	0
0	1	0
0	0	0

AND Gate

Resistor Transistor Logic (RTL)

- These use Transistors to combine multiple input signals, which also amplify and invert the resulting combined signal.
- Often an additional transistor is included to re-invert the output signal.
- This combination provides clean output signals that are either inverted or non-inverted.
- RTL gates are simple and inexpensive.
- Limitations
- *Draw a lot of current from the power supply for each gate.*
- *The RTL gate cannot switch at high speeds due to the transistor.*
- No longer used in the fabrication of gates.

Resistor Transistor Logic (RTL)



Voltage Table

A	y
0V	5V
5V	0.2V

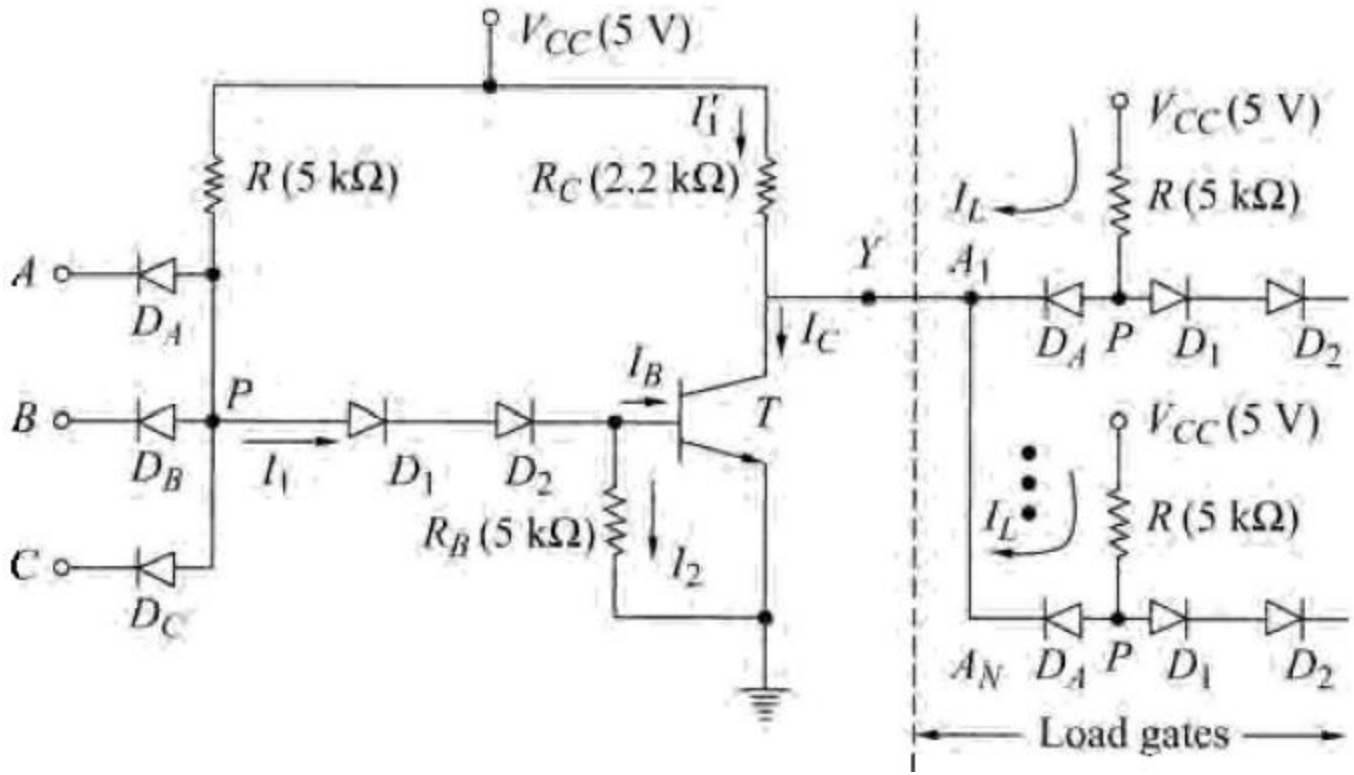
Positive Logic Truth Table

A	y
0	1
1	0

NOT Gate

Diode Transistor Logic (DTL)

- Combination of Diode logic and RTL Logic.
- DTL circuit using discrete components was made using input diodes and a transistor inverter (NOT), which was modified for IC design implementation as shown in figure.



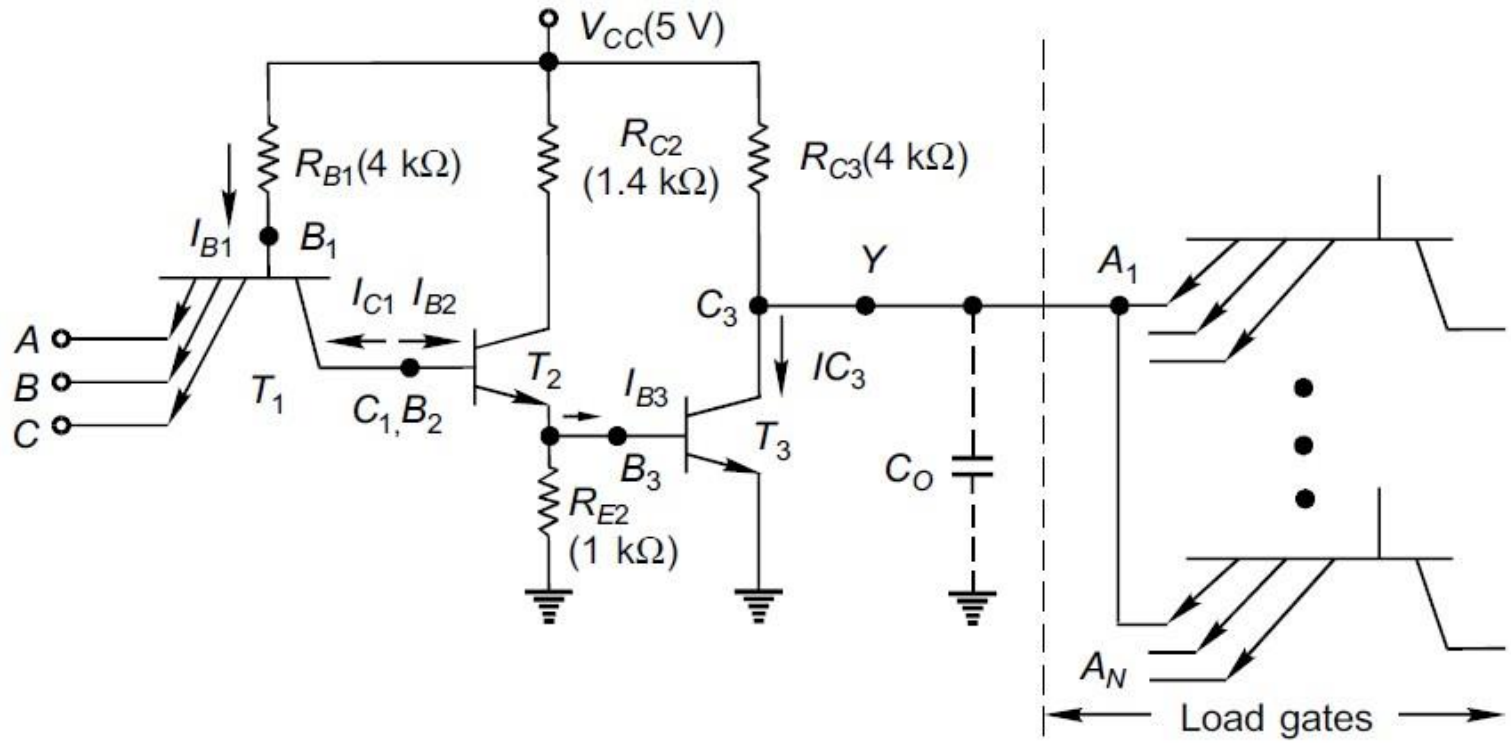
3-input DTL NAND gate driving N similar gates

Transistor-Transistor Logic (TTL)

- DTL has become outdated and is completely replaced by TTL because of speed limitations
- The main cause for the speed limitation in DTL is the slow process of removal of stored base charge of the output transistor.
- Uses multiple Emitter Transistors
- This is an extension of DTL family with diodes replaced by multiple emitter transistors. (Multiple emitter transistors are used to get the internal diodes)

Transistor-Transistor Logic (TTL)

- The physical construction of integrated circuits made it more effective to replace all the input diodes in a DTL gate with transistors built with multiple emitters.
- The result is transistor-transistor logic, which became the standard logic circuit in most applications for a number of years.
- These devices comprise the 7400 family of digital ICs.



3-input TTL NAND gate driving N similar gates

Unconnected Inputs in TTL

- If any input of a TTL gate is left disconnected (open or floating) the corresponding E–B junction of T1 will not be forward-biased.
- Hence, it acts exactly in the same way as if a logical 1 is applied to that input.
- Therefore, in TTL ICs, all unconnected inputs are treated as logical 1s.
- The unused inputs should either be connected to some used input(s) or returned to VCC through a resistor

Emitter Coupled Logic (ECL)

- Emitter-coupled logic (ECL) is the fastest of all logic families.
- Used in applications where very high speed is essential.
- High speeds have become possible in ECL because the transistors are used in difference amplifier configuration, in which they are never driven into saturation and thereby the storage time is eliminated.
- Propagation delays of less than 1 ns per gate have become possible in ECL.

CMOS Logic

- All logic families use significant amounts of electrical power.
- Many applications, especially portable, battery-powered ones, require that the use of power be absolutely minimized.
- To accomplish this, the CMOS (Complementary Metal- Oxide-Semiconductor) logic family was developed.
- This family uses enhancement-mode MOSFETs as its transistors and is so designed that it requires almost no current to operate.
- Highly useful and effective in a wide range of battery- powered applications.

Characteristics of Digital ICs

- Characteristics can be used to compare its performance
  1. *Speed of operation*
  2. *Power dissipation*
  3. *Figure of merit*
  4. *Fan-out*
  5. *Current and voltage parameters*
  6. *Noise immunity*
  7. *Operating temperature range*

Assignment 2

1. Explain the operation of
   a) 3-input DTL NAND gate driving N similar gates
   b) 3-input TTL NAND gate driving N similar gates
2. Write short notes on the 7 Characteristics of Digital ICs (Explain each characteristic separately)

- Reference : Modern Digital Electronics by RP Jain (Chapter 4)
- **Note : Marks will be deducted for plagiarizing**
- Submission deadline : 19.10.2022