Experiment No : 2 : Construction of Bipolar Transistor Logic Gate.

Introduction: A bipolar transistor is a three terminal semiconductor device. Under the control of one of the terminals, called the base, current can flow selectively from the collector terminal of the emitter terminal.

NPN Transistor
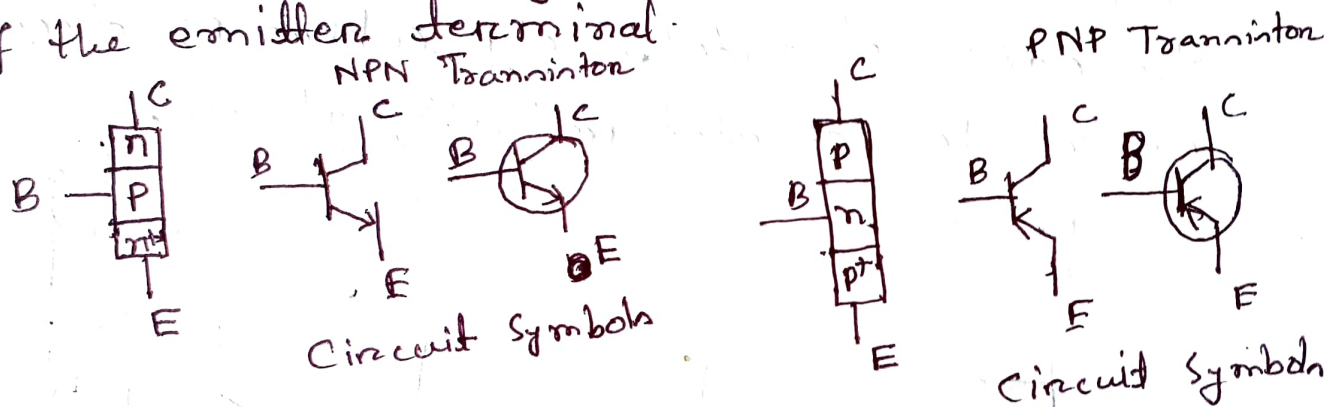
PNP Transistor

Circuit Symbols

Circuit Symbols

Fig 2.1: Bipolar junction transistor circuit symbols.

In this experiment we examine how to build logic gates from bipolar transistor using the RTL, DTL and TTL dg design.

Theory and Mathodology : Register-Transistor Logic (RTL): Register Transistor Logic (RTL) is a large step beyond Diode Logic (DL). Basically, RTL replaces the diode switch with a transistor switch. If a +5V signal (logic 1) is applied to the base of the transistor, the transistor turns fully on and grounds the output signal.

If the input is grounded, the transistor is off and the output signal is allowed to rise to +5 volts. In this way, the transistor not only inverts the logic sense of the signal, but it also ensures that the output voltage will always be a valid logic level under all circumstances. Because of this, RTL circuits can be cascaded indefinitely, where DL circuits can not be cascaded reliably at all.
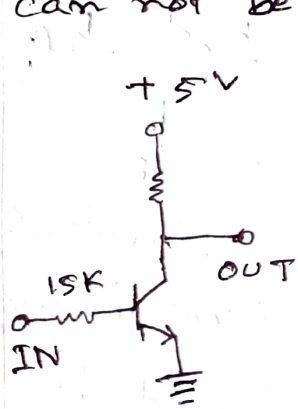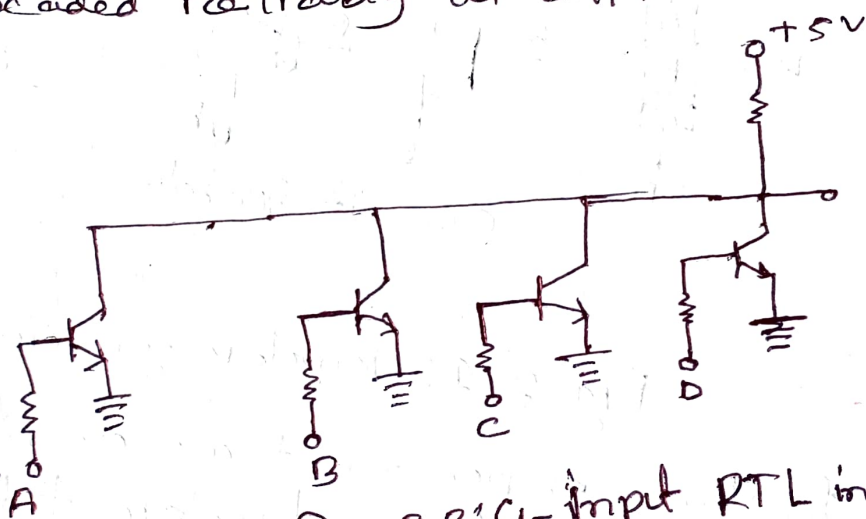
Fig. 2.2: RTL Inverter

Fig 2.3: 4-input RTL inverter

Diode-Transistor Logic (DTL): Diode transistor Logic (DTL) is a class of digital circuits built from bipolar junction transistor (BJT), diodes and registors; it is the direct ancestor of transistor transistor Logic (TTL).

DTL offers better noise margins and greater fan outs than RTL, but suffers from low speed.

RTL allows the construction of NOR gate easily, but NAND gates are relatively more difficult to get from RTL. DTL, however, allows the construction of simple NAND gates from a single transistor, with the help of several diodes and registers.
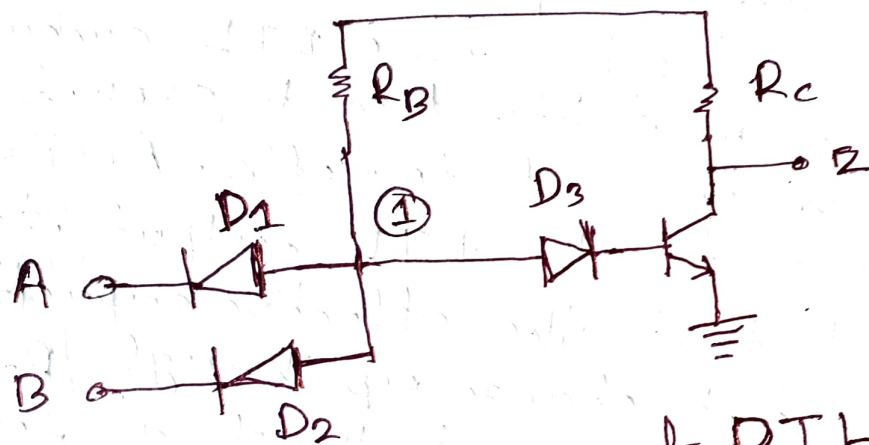

Fig 2.4: 2-input DTL NAND Gate.

Transistor-Transistor Logic: We can think of a bipolar transistor as two diodes placed very close together, with the point between the diode being the transistor base. Thus, we can use transistor in place of diodes to obtain logic gates that can be implemented with transistors and resistors only: this is called transistor-transistor logic (TTL).

one problem that DTL does not solve its low speed, especially when the transistor is being turned off. Turning off a saturated transistor

in a DTL gate requires it to first pass through the active region before going into cut-off. Cut-off, however, will not be reached until the stored charge in its base has been removed. The dissipation of the base charge takes time if there is no available path from the base to ground. This is why some DTL circuits have a base resistor that is tied to ground, but even this requires some trade-offs. Another problem with turning off the DTL output transistor is the fact that the effective capacitance of the output need to charge up through Rc before the output voltage rises to the final logic '1' level, which also consumes a relatively large amount of time. TTL, however, solves the speed problem of DTL elegantly.
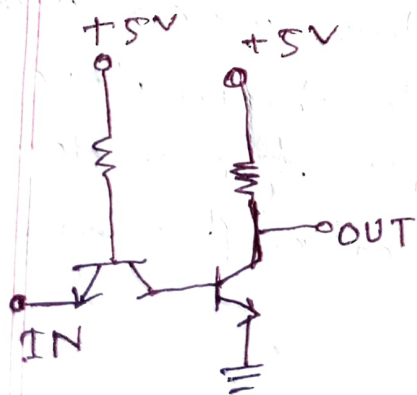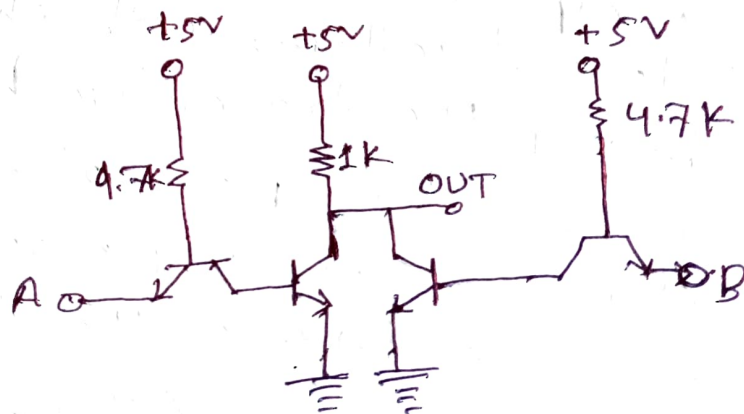

Fig 2·5: TTL Inverter

Fig 2·6: 2-input TTL NOR gate.