المكتبة التي سيتم اعتمادها لمادة Power Electronics في الفصل الدراسي

1. Cyril W. Lander "Power Electronics"
   McGraw-Hill Book company, 1987

2. B. W. Williams "Power Electronics, Devices, Drivers, and Applica
   Macmillan Edcation Ltd., 1988

3. M. H. Rashid, "Power Electronic Circuits Devices and Applications"
   Prentice-Hall Inc., 1994

4. P. C. Sen "Principles of Electric Machines and Power Electronics"
   John Wiley & Sons, 1997

1.1 Power diode

Power diode is a two-terminal p-n junction device. When the anode potential is positive with respect to the cathode, the diode is said to be forward biased and the diode conducts as shown in figure (1.1).

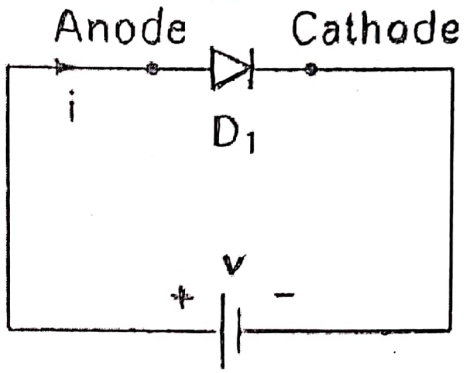

Figure (1.1)

A conducting diode has a relatively small forward voltage drop across it (about 0.7 V); and the magnitude of this drop would depend on the manufacturing process and junction temperature.

When the cathode potential is positive with respect to the anode, the diode is said to be reversed biased. Under reverse-biased conditions, a small reverse current (also known as leakage current) in the range of micro- or milliamper flows and this leakage current increases slowly in magnitude with the reverse voltage until the avalanche or zener voltage is reached as shown in figure (1.2).

The forward conducting voltage decreases with increased junction temperature T_j. That is, the on-state voltage has a negative temperature coefficient. At higher currents the coefficient becomes positive as shown dotted. The temperature coefficient for avalanche is positive. The reverse bias current increases with increased junction temperature.

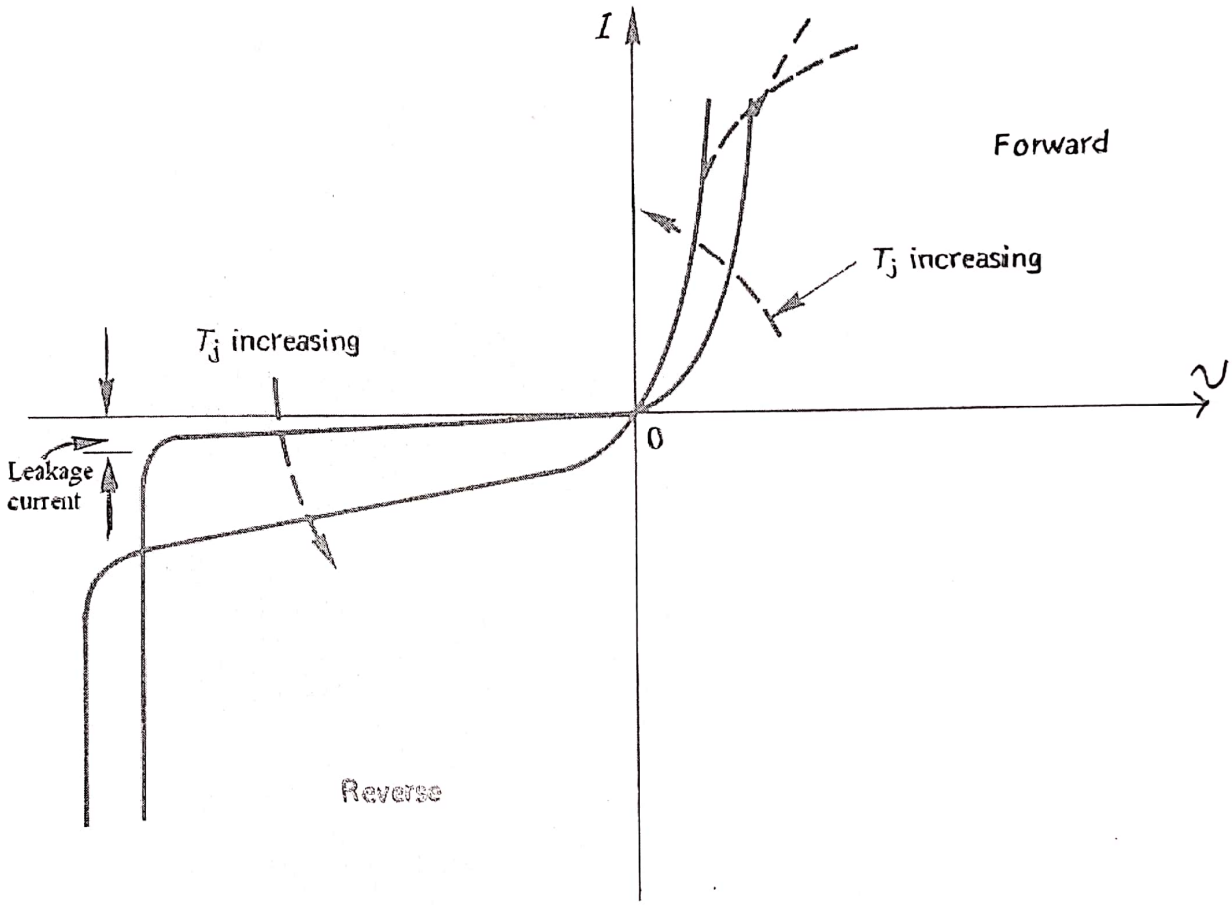
I
Forward
T_j increasing
T_j increasing
V
0
Leakage current
Reverse

Figure (1.2)

1.2 Power transistor (BJT)

This transistor is a three-layer p-n-p or n-p-n semiconductor device having two junctions. This type of transistors is known as a bipolar junction transistor (BJT). The structure and the symbol of npn transistor are shown in figure (1.3).

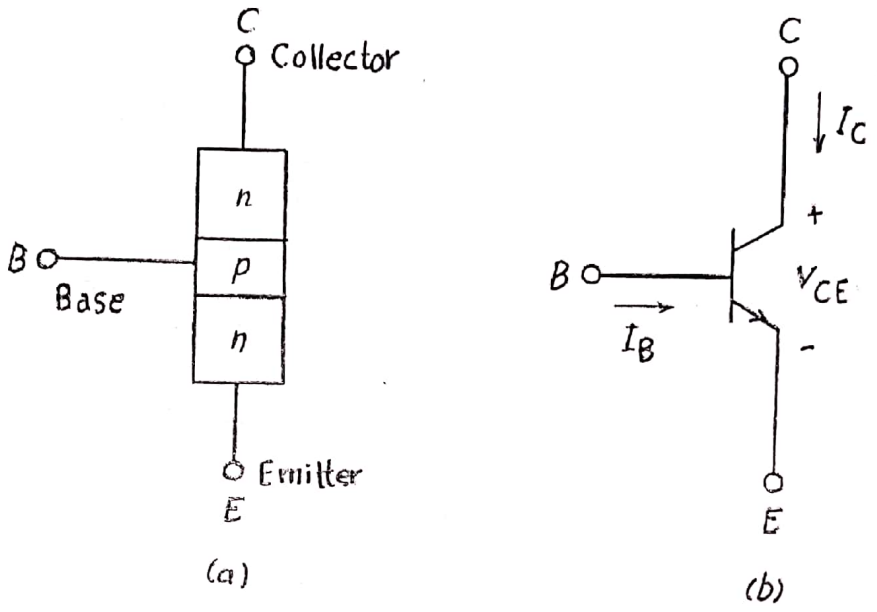

Figure (1.3)

The power transistors which are used as a switching element are operating in either cut-off region or in the saturation region, resulting in a low on-state voltage drop.

If the base current I_B is zero, the transistor is in an off-state and behaves as an open switch. On the other hand if the base is driven hard, that is if the base current is sufficient to drive the transistor into saturation, then the transistor behaves as a closed switch.

(a) Cut-off region with $V_{be} \leq 0$, $V_{cb} > 0$.

(b) Saturation region with $V_{be} > 0$, $V_{bc} > 0$,

Over saturation with $i_b > i_c / \beta$.

The typical BJT collector output characteristics are shown in figure (1.4).

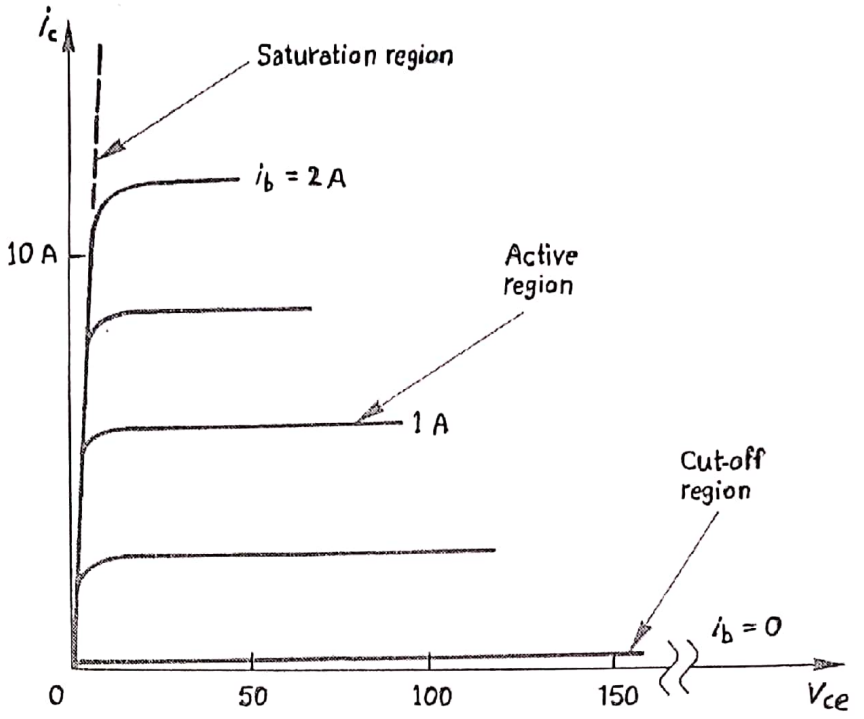

Figure (1.4) Output characteristics of the bipolar transistor in the common emitter configuration

Power transistors switch on and off much faster than thyristors. They may switch on in less than 1μs and turn off in less than 2μs. Therefore, power transistors can be used in applications where the frequency is as high as 50 kHz. These devices are however, very delicate. They fail under certain high voltage and high current conditions. They should be operated within specified limits, known as the safe operating area (SOA).

The SOA is partitioned into four regions as shown in figure (1.5), defined by the following limits:

- Peak current limit (ab).
- Power dissipation limit (bc).
- Secondary breakdown limit (cd).
- Peak voltage limit (de).