SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

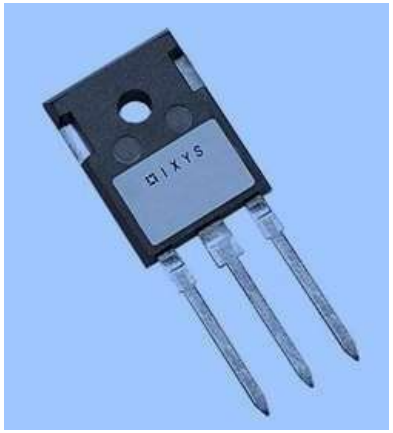
COURSE NAME : 23EEB202-Electron Devices and Circuits

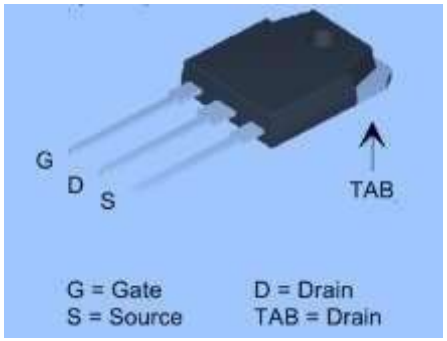
II YEAR /III SEMESTER

Topic : **IGBT**

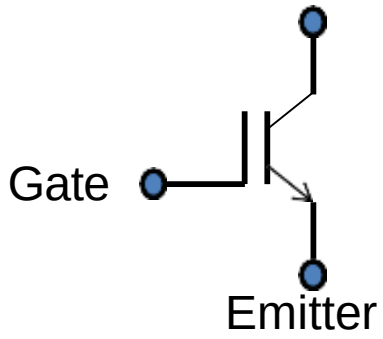
Contents

- Basic structure,
- I-V Characteristics,
- Switching characteristics
- Device limitations and
- Safe operating area (SOA).





- Combination of BJT & PMOSFET
- High Input Impedance like a PMOSFET.
- Low on state power loss like a BJT.
- In IGBT second breakdown problem is not present.
- Voltage controlled device.
- Three terminal device.



Symbol of IGBT

SOME OTHERS NAME OF IGBT:

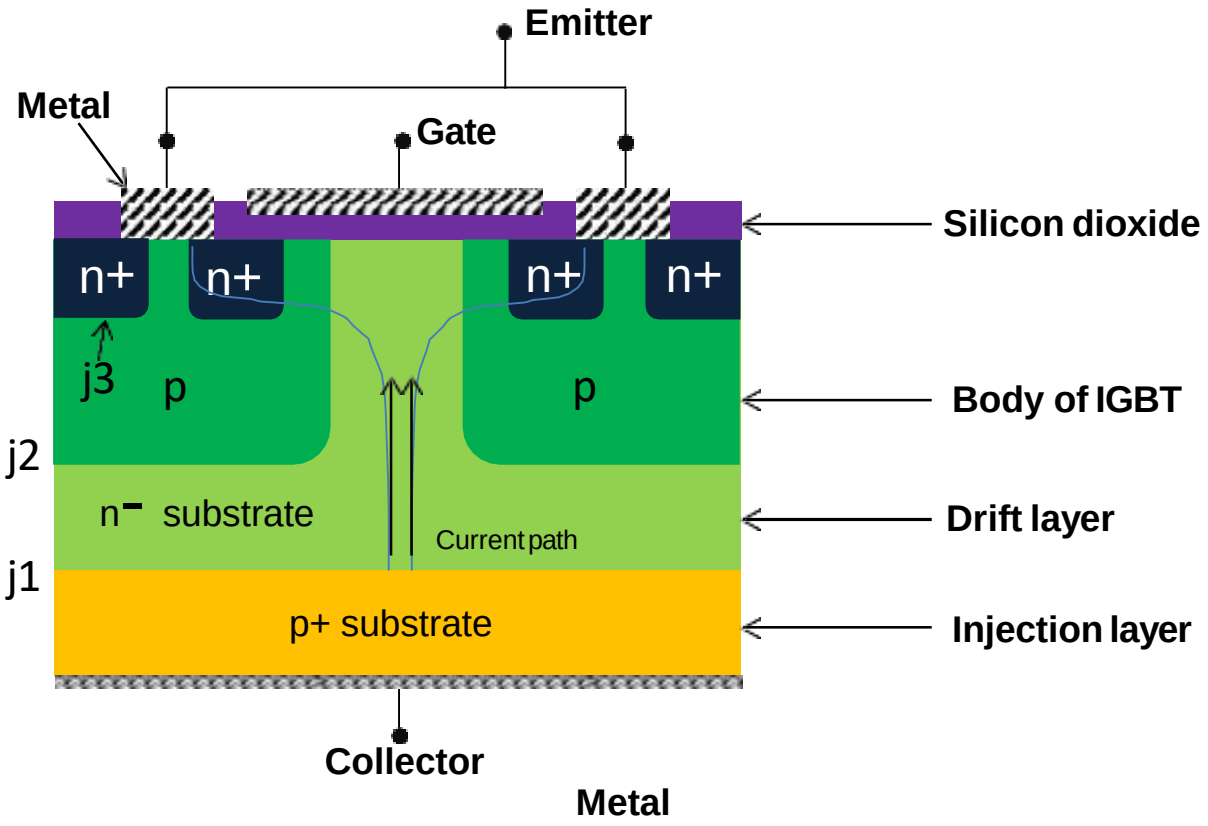
- MOSIGT - metal oxide gate bipolar junction transistor
- COMFET - conductively modulated field effect transistor
- GEMFET – gate modulated field effect transistor

- The IGT device has undergone many improvement cycles to result in the modern Insulated Gate Bipolar Transistor (IGBT).
- These devices have near ideal characteristics for high voltage (> 100V) medium frequency (< 20 kHZ) applications.
- This device along with the MOSFET (at low voltage high frequency applications) have the potential to replace the BJT completely

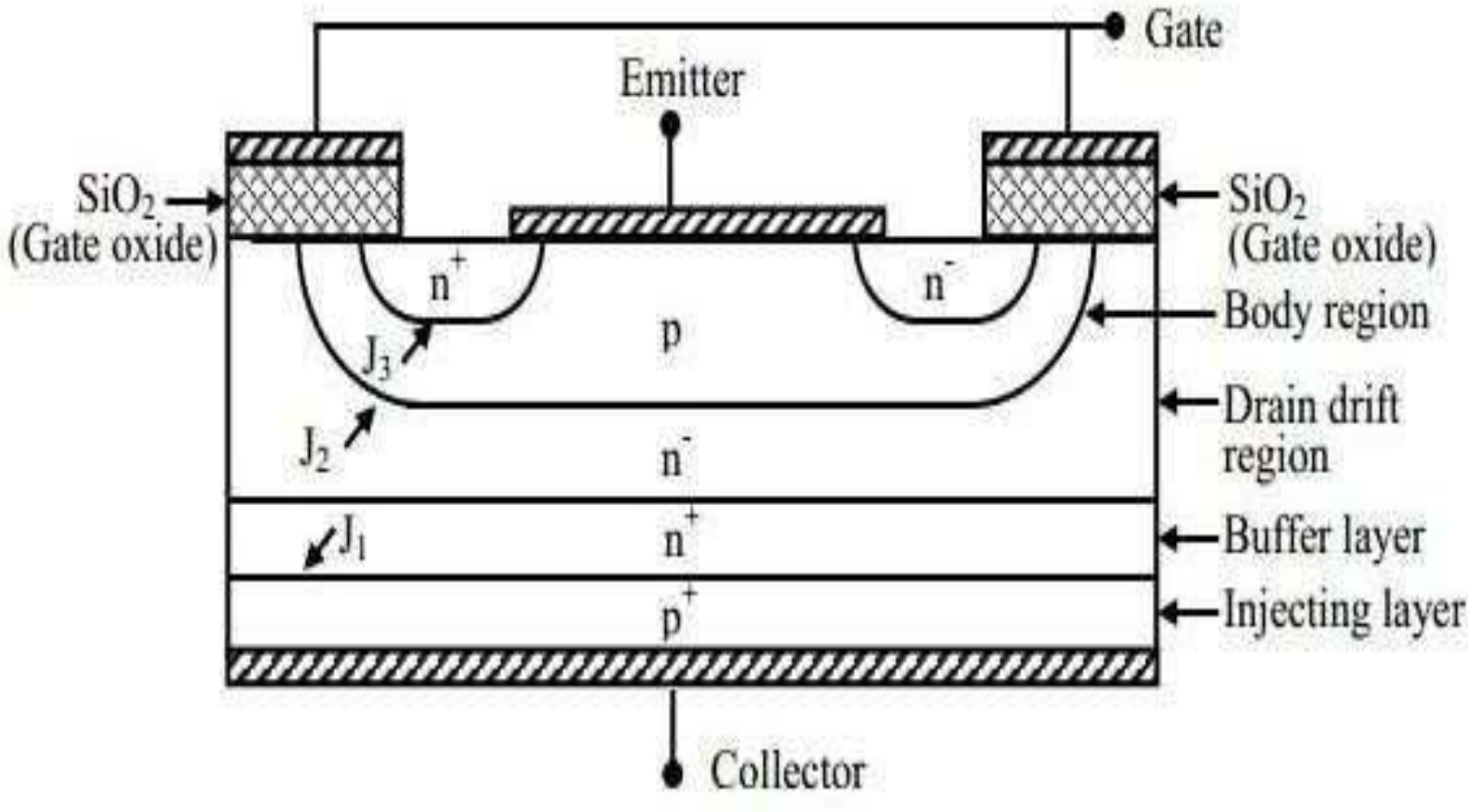
Basic Structure of IGBT

Do You Know?

- The p+ layer is called injection layer because it inject holes in to n- layer.
- The thickness of n- layer determine voltage blocking capability of IGBT.

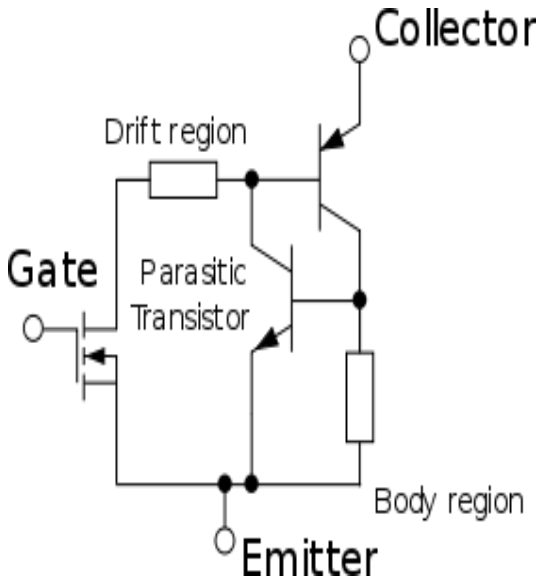


Construction of IGBT



- IGBT & PMOSFET are same in structure but main difference between in the substrate.
- The n+ layer substrate at the drain in PMOSFET is now substitute in the IGBT by a p+ layer substrate is called collector C.
- The p layer is called body of IGBT.

Equivalent & Working circuit of IGBT



Equivalent circuit of IGBT

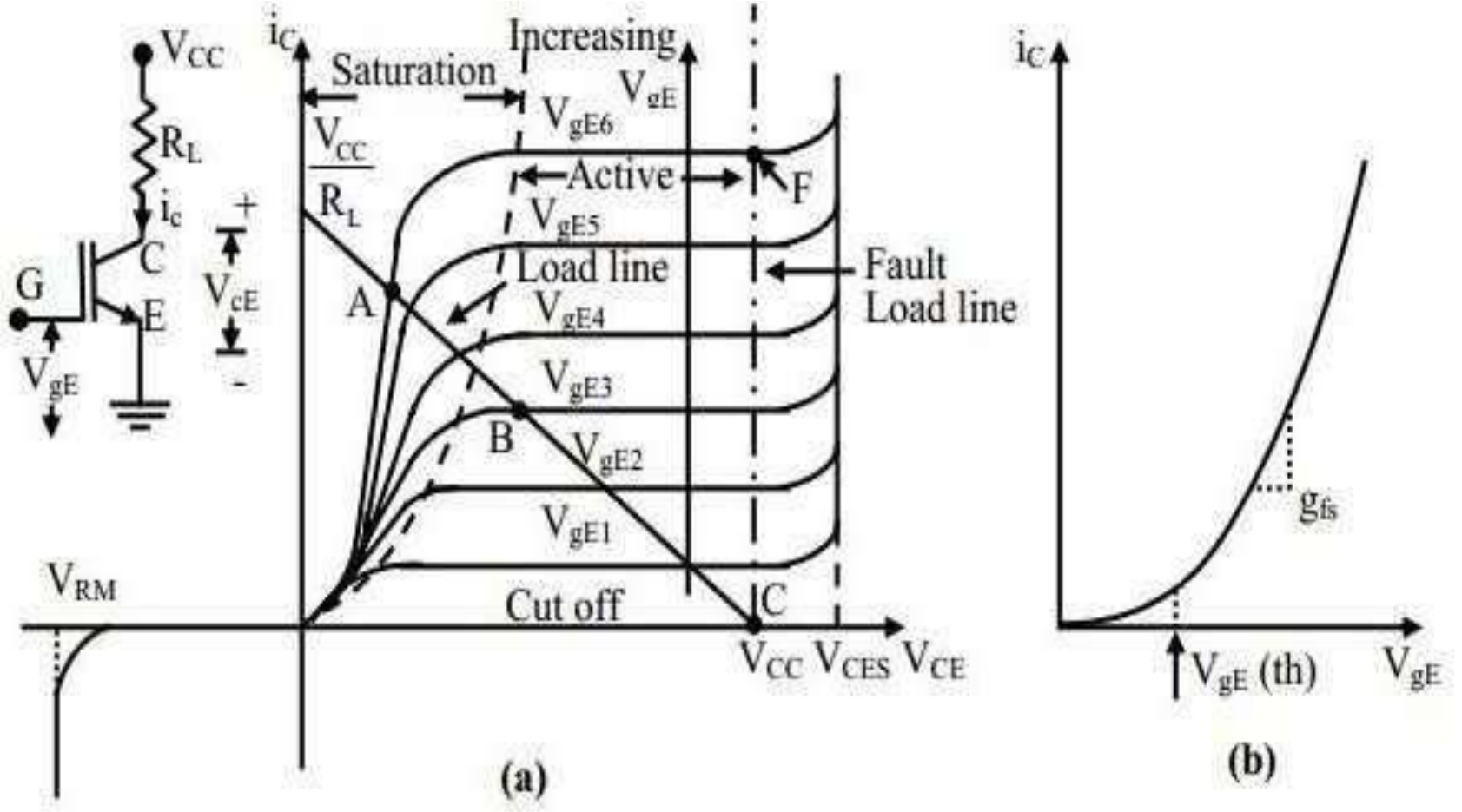
Operating principle of IGBT

- Operating principle of an IGBT can be explained in terms of the schematic cell structure and equivalent circuit of Fig.2(a) and (c).
- From the input side the IGBT behaves essentially as a MOSFET.
- Therefore, when the gate emitter voltage is less then the threshold voltage no inversion layer is formed in the p type body region and the device is in the off state.
- The forward voltage applied between the collector and the emitter drops almost entirely across the junction J2.

- Very small leakage current flows through the device under this condition.
- In terms of the equivalent current of Fig.2(c), when the gate emitter voltage is lower than the threshold voltage the driving MOSFET of the Darlington configuration remains off and hence the output **p-n-p** transistor also remains off.
- When the gate emitter voltage exceeds the threshold, an inversion layer forms in the **p** type body region under the gate.

- This inversion layer (channel) shorts the emitter and the drain drift layer and an electron current flows from the emitter through this channel to the drain drift region.
- This in turn causes substantial hole injection from the p+ type collector to the drain drift region.
- A portion of these holes recombine with the electrons arriving at the drain drift region through the channel.
- The rest of the holes cross the drift region to reach the p type body where they are collected by the source metallization.

I-V Characteristics of IGBT



- They appear qualitatively similar to those of a logic level BJT except that the controlling parameter is not a base current but the gate-emitter voltage.
- When the gate emitter voltage is below the threshold voltage only a very small leakage current flows though the device while the collector – emitter voltage almost equals the supply voltage (point C in Fig).
- The device, under this condition is said to be operating in the cut off region.

Thank You