Introduction to Power Electronics

Comprehensive Course on Power Electronics

Ankit Goyal • Lesson 1 • Nov 20, 2020

Syllabus

1. Power semiconductor devices
   - a. switches
   - b. power diode
   - c. power Tx → BJT, MOSFET, IGBT
   - d. SCR
   - e. Thyristors
2. Phase controlled converters
   - a. 1-ϕ → HW, FW
   - b. 3-ϕ → HW, FW
   - c. Source Inductance
   - d. Dual converter (ESE)

③ Choppers

ⓐ Buck ⓑ Boost ⓒ Buck - Boost

ⓓ Thyristor commutation

④ Inverters

ⓐ 1-ϕ ⓑ 3-ϕ ⓒ PWM

⑤ Resonance converter

⑥ AC & DC Drive

⑦ SMPS

⑧ AC Voltage controller

} ESE

GATE: 8-10 marks

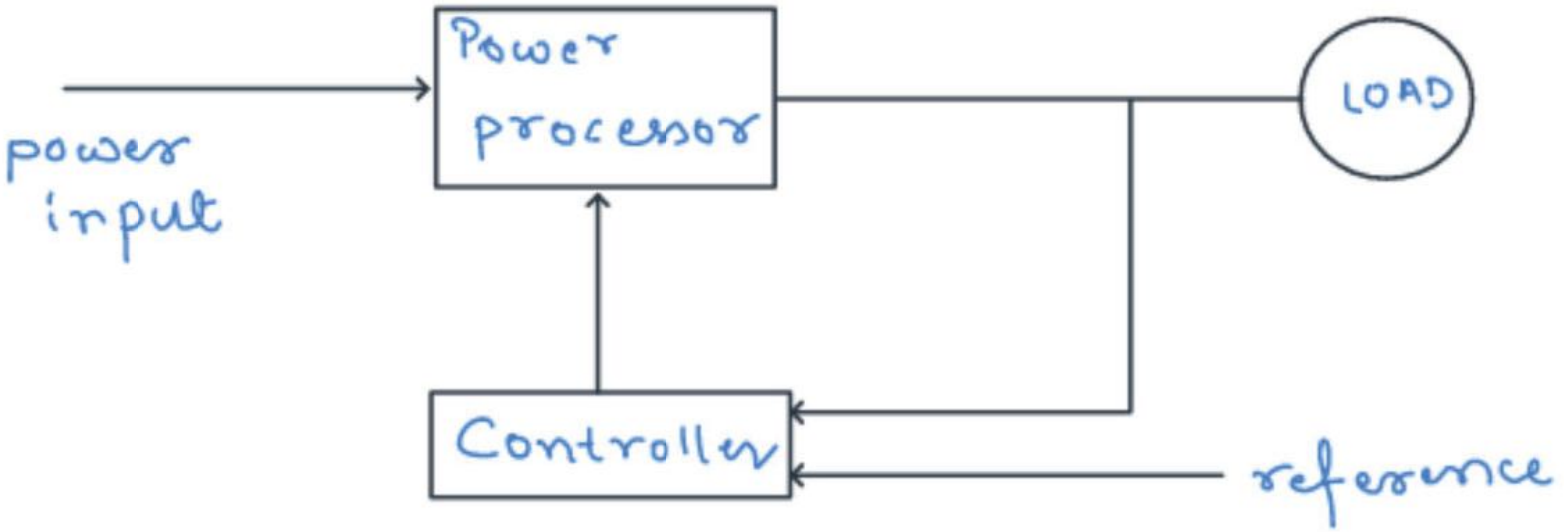
Syllabus: 1st week of Jan

ESE syllabus: last week of Jan

Book: MH Rashid, PS Bimbhra

Introduction

- The task of power electronics is to transform the power in a form required by load.

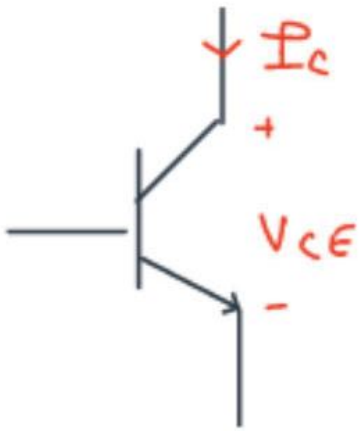


- Controller controls triggering of power switches to achieve desired output.

Power Electronics Vs Analog Electronics

- In power conversion process, a small power loss & a high energy efficiency is required.
  - ↳ cost of wasted energy
  - ↳ difficult to remove dissipated heat from device
- The other consideration are reduction in size, weight & cost.
- The above objectives cannot be met by linear power supply.

  In analog electronics semiconductor devices work in active region whereas in power electronics they work in cut off or saturation.



- region of operation is defined by I_C & V_{CE}
- active region : $V_{CE} \neq 0$ $I_C \neq 0$ ← AE

$$P_D = V_{CE} I_C \neq 0$$

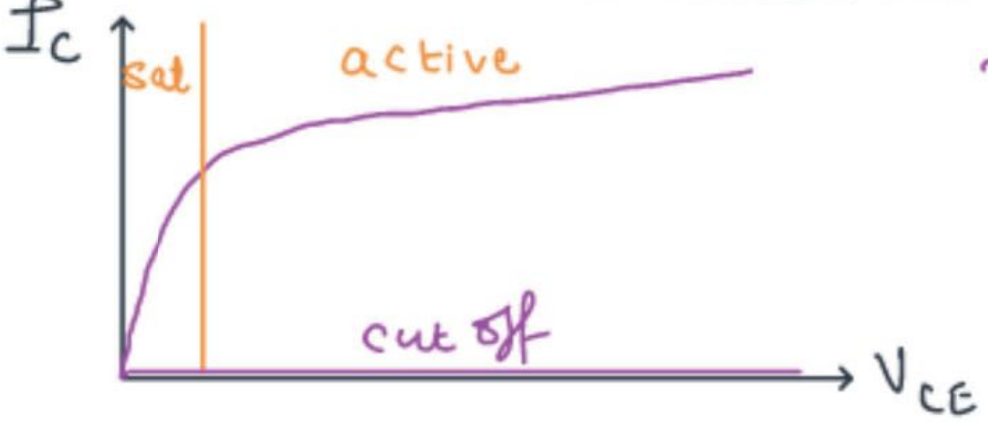
- cut-off region: $I_C = 0$ V_{CE} = high

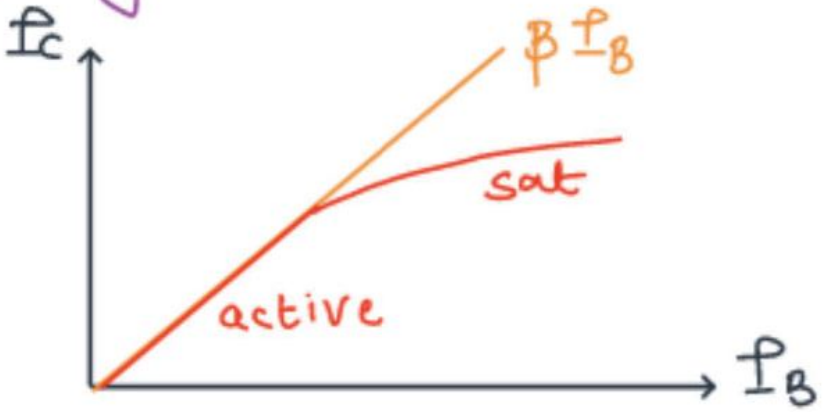
$$P_D = 0$$

PE

- saturation: I_C = high $V_{CE} \simeq 0$

$$P_D \simeq 0$$





- In power electronics, device operates in cut off & saturation region at very high frequency so that size & weight of transformer is reduced.

- Major differences

① region of operation

② rating of power electronic devices is high

③ In analog electronics shape of signal matters but in power electronics efficiency of conversion matters.

Applications of Power Electronics

1. Switch mode Power Supply (SMPS)
2. Energy conversion
3. Process control & factory automation
4. Transportation : electric vehicles used power electronic converters.
5. Welding, electroplating & Induction heating
6. HVDC
7. AC & DC Drives

Advantages & Disadvantages

Advantages

(i) High η due to low power loss

(ii) High reliability

(iii) Long life & less maintenance

(iv) Fast dynamic response

(v) Small size & less weight

Drawbacks

(i) Harmonics due to switching action

(ii) high cost

Harmonics in Power Electronics

Harmonics: Any non-sinusoidal periodic function can be expressed as fourier Series. The terms that are having frequency as a multiple of fundamental frequency are called as harmonics.

⇒ In power electronics, switches are always operated in periodic manner.

Drawbacks:

(i) Harmonics degrade the quality of ac supply

(ii) Increased losses

(iii) overload in neutral condr ($I_n = 3I_{a0}$: 3rd harmonic = 0 sequence)