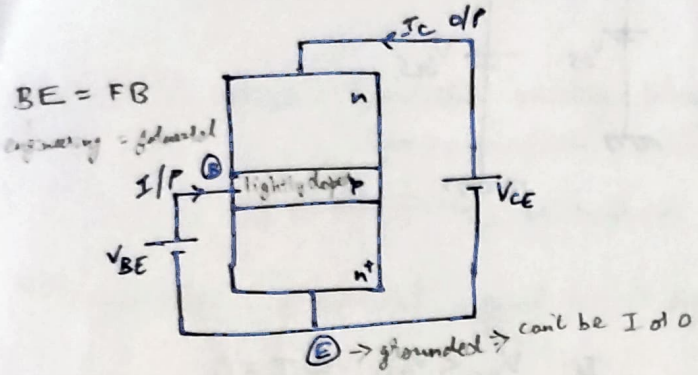
BJT - current controlled

→ Characteristics

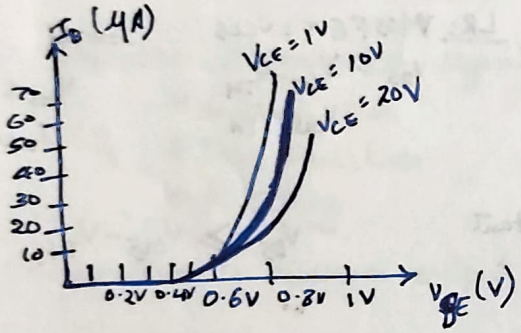
Common Emitter



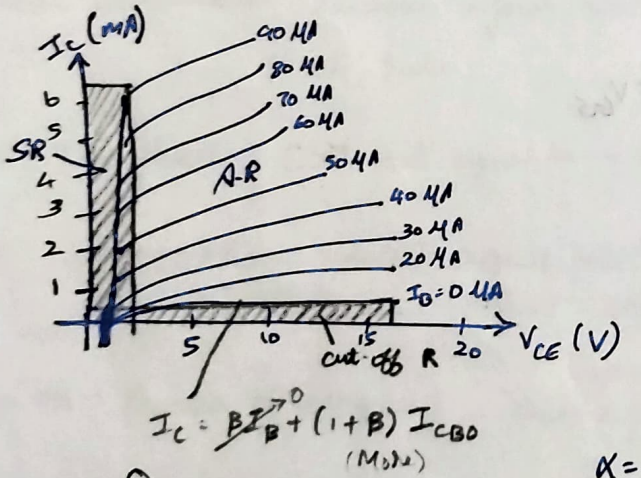
I/p : V_{BE} vs I_B (V_{CE} const.)

o/p : V_{CE} vs I_C (I_B const.)

I/p:



o/p :



$I_C = \beta I_B + (1+\beta) I_{CBO}$ (Mostly)

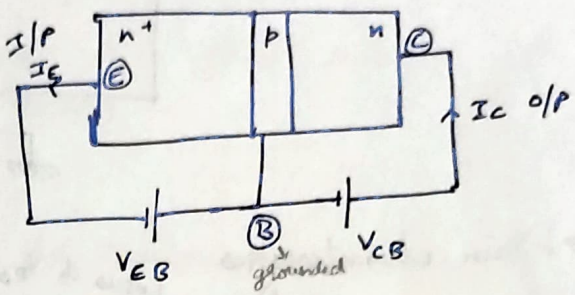
$\beta = \frac{I_C}{I_B}$

50 - 400

$\alpha = \frac{\beta}{1+\beta}$

$\beta = \frac{\alpha}{1-\alpha}$

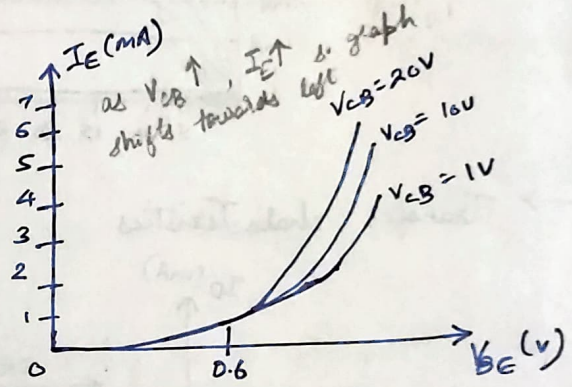
Common Base



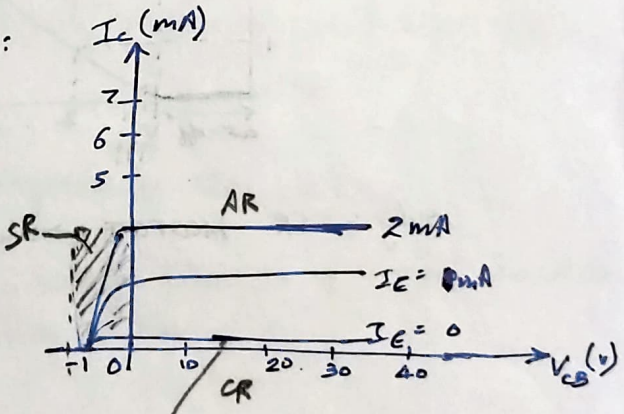
I/p : V_{EB} vs I_E (V_{CB} const)

o/p : V_{CB} vs I_C (I_E const.)

I/p:



o/p:

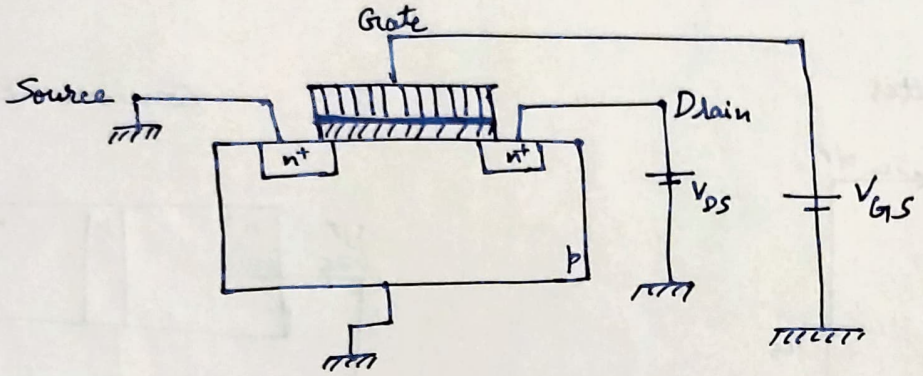


$I_C = \alpha I_E + I_{CBO}$ (Very less)

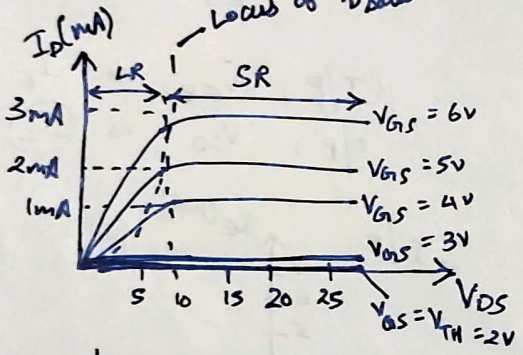
$\alpha = \frac{I_C}{I_E} < 1$

MOSFET - Metal Oxide Semiconductor Field Effect Transistor

VCCS - Voltage Controlled current source



→ Drain characteristics



If $V_{GS} < V_{TH} \Rightarrow I_D = 0$

cond. for SR

$V_{DS} \geq V_{GS} - V_{TH}$

LR: MOSFET : VCCS

$V_{DS} = V_{GS} - V_{TH}$

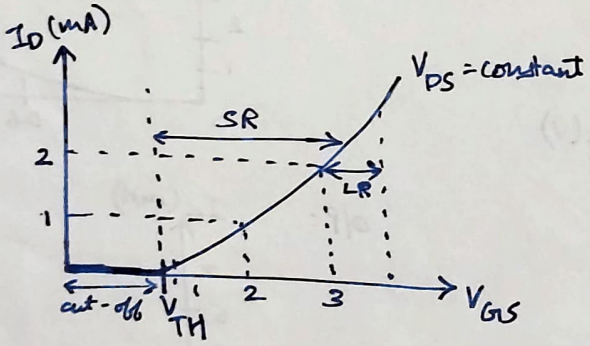
$V_{GS} > V_{TH}$

cut-off

$V_{GS} < V_{TH}$

$I_D = 0$

→ Transfer characteristics



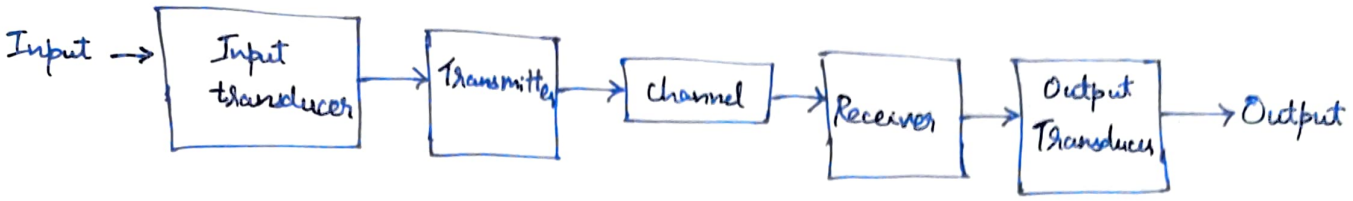
$V_{DS} \geq V_{GS} - V_{TH}$

only in SR MOSFET → amplifier

COMMUNICATION SYSTEMS

22nd December 2022
8th January, 2023

Block diagram :



→ Input Transducer : Converts message produced by source to a form suitable for communication system (electrical signal)
eg: Speech waves, microphone voltage

→ Transmitter : Electrical signal ⟶ signal suitable for transmission over a given medium (Modulation)

→ Transmission channel : Physical medium on which signal is carried.
Every channel introduces some amount of distortion, noise & interference.
eg: Air, wires, coaxial cable

→ Receiver : Recovers transmitted signal from channel
* Amplification
* Demodulation
* Filtering

ideal transmission : Receiver output is scaled and possibly it is delayed version of message signal.

practical transmission : received signal will have signal component disturbed by noise.
eg: TV set, radio

→ Output Transducer : Electrical signal ⟶ desired form by the system
- Active : doesn't require power source, work on principle of energy conversion
- Passive : does require external power source

#Modulation : Process of changing carrier signal characteristics acc. to message signal.
- Analog → AM, FM
- Digital → ASK, PSK, FSK

→ Need for Modulation

i) ↑ distance over which signal can be transmitted faithfully
ii) reduces height of antenna
iii) avoids mixing of signals
iv) reduce noise and interference
v) for multiplexing
vi) helps to adjust bandwidth

Demodulation : Process of recovering massage from modulated signal

→ Coherent : Local oscillator is tuned to freq. of carrier to get back message
→ Non-coherent : does not use local oscillator.

Fundamental concepts of cellular Telephone

→ Cellular Concept System Design Fundamentals

- Goals of cellular system
  * High capacity
  * Large coverage area
  * Efficient use of limited spectrum

- For large coverage area single transmission requires high power, tall towers
- Single transmission can provide service to small no. of users only.

Poor spectrum utilization

→ Cellular concept & Frequency Reuse Pattern

* Each cellular base station is allocated a group of radio channels within a small geographic area called a cell
* Neighbouring cells are assigned different channel groups.
* By limiting the coverage area to within the boundaries of the cell, the channel groups may be reused to cover different cells.
* Keep interference levels within tolerable limits.
* Freq. reuse / Freq. planning seven groups of channel from A to G
  footprint of each cell is actual radio coverage.
* Each cell uses omni-directional antenna.

→ Uses of Cellular concept

* Solves the problem of spectral congestion and user capacity
* Offers very high capacity in a limited spectrum
* Helps in reuse of radio channel in different cells.

→ Cells

* Base station antennas designed to cover specific cell area
* Hexagonal cell shape assumed for planning
  - Simple model for easy analysis → circles leave gaps
  - actual cell footprint is amorphous (no specific shape) where Tx successfully serves mobile unit.
* Base station location
  - cell centre → omni directional antenna not necessarily in the exact center
* cell corners → sectored (directional) antennas on 3 corners with 120° coverage
  - very commonly used in BTS (Base Transceiver Station)
  - one can define cell as having 3 antennas at centre / antennas at 3 corners

Handoff Strategies

MSC - Mobile Switching Centres

* Handoff: When a mobile unit moves from one cell to another while a call is in progress, the MSC must transfer (handoff) the call to a new channel belonging to a new base station.
  - new voice and control channel frequencies
  - very important task → often given higher priority than new call.
    * it is worse to drop an in-progress call than to deny a new one.
* choose a (handoff threshold) > (min usage signal level)
  - so there is time to switch channels before level becomes too low.
  - as mobile moves away from base station and towards another base station.

Roaming

* Mobile may move into different system controlled by a different MSC called an intersystem handoff

Issues involved in roaming

1. Prioritizing Handoffs:

   * Issue: Perceived Grade of service (GOS) - service quality as viewed by user, "quality" in terms of dropped or blocked calls (not voice quality)
   assign higher priority to handoff vs new call request.

2. Guard channels

   * Percentage of total available cell channels exclusively set aside for handoff requests makes fewer channels available for new call requests
   * a good strategy is dynamic channel allocation (not fixed)
     - adjust no. of guard cells as needed by demand
     - so channels are not wasted in cells with low traffic

3. Queuing Handoff requests

   * Use time delay b/w handoff threshold and minimum useable signal level to place a blocked handoff request in queue.
   * a handoff request can keep trying during that time period, instead of having a single block/no block decision.
   * prioritize requests (based on mobile speed) and handoff as needed.
   * calls will still be dropped if time period expires.

Practical Handoff considerations

* Problems occur because of large range of mobile velocities
* small cell sizes/micro cells leads to large no. of handoffs
* MSC load is heavy when high speed users are passed b/w very small cells.

Umbrella Cells

* Use of different antenna heights and Tx power levels to provide large and small cell coverage
* multiple antennas and Tx can be co-located at single location if necessary.
* Large cell → high speed traffic → fewer handoffs
* Small cell → Low speed traffic → more handoffs

Benifits of small handoff time

i) greater flexibility in handling high/low speed users

ii) queing handoffs and prioritizing

iii) more time to "rescue" calls needing urgent handoff

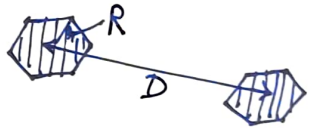
iv) fewer dropped calls → GOS increased

→ can make decisions based on wide range of metrics other than signal strength
  * such as measure interference levels
  * can have multidimensional algorithm for making decisions.

→ MSC dynamically decides which signal is best and listens to that one
  * soft handoff
  * passes data from that base station onto PSTN (Public switched Telephone Network)

Co-channel Interference (CCI)

* During freq. reuse there are several cells that use the same set of freq. which leads to co-channel interference.
* To reduce CCI, co-channel cell must be seperated by a min. distance.
* when size of the cell is approximately same



CCI is a func. of : *R : Radius of cell.
*D : dist. of centre of nearest co channel cell
* $Q = \frac{D}{R}$

co channel reuse ratio

as Q↑ interference is reduced, improves transmission quality.