SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB201-ANALOG ELECTRONIC CIRCUITS

II YEAR/ III SEMESTER

UNIT 5 – IC MOSFET AMPLIFIERS

TOPIC – Amplifier with active loads: Enhancement load

Amplifiers with Active Load

* When MOSFET itself is used as a load device, it's referred to as active load.

* There are 3 types of load devices

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1. n-channel enhancement mode device
2. n-channel depletion-mode device
3. p-channel enhancement mode device

1. NMOS Amplifier with Enhancement Load

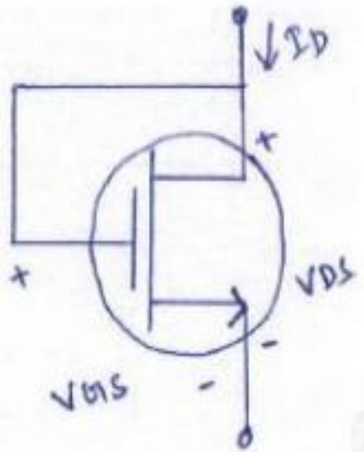

Fig: N-channel enhancement mode MOSFET with gate & drain shorted

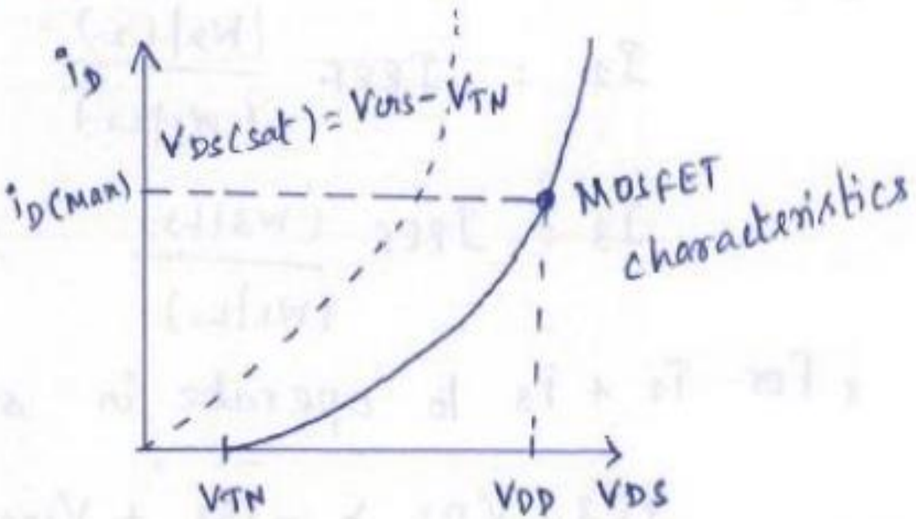

Fig: current - voltage characteristics for n-channel enhancement load device

* In this, the MOSFET act as a non-linear resistor & is called enhancement load device.

* Since MOSFET is in enhancement mode $V_T > 0$.

* For this circuit $V_{DS}(sat) = V_{GS} - V_T$ which means that the MOSFET is always in the saturation region.

* The I-V characteristics is a plot of equation

$$i_D = K_n (V_{GS} - V_T)^2$$

* The enhancement load circuit alone can't be used as an amplifier, however, if it's connected in a circuit with another MOSFET. This circuit can be used as an amplifier (or) as an inverter in a digital circuit.

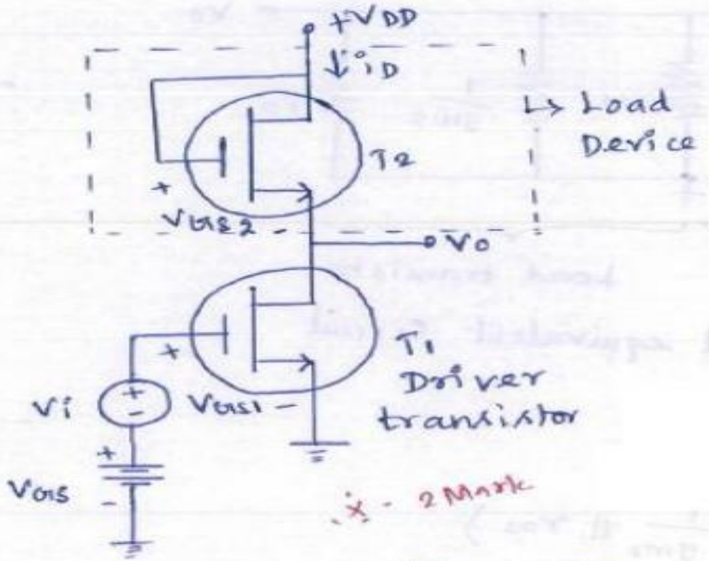

Fig: NMOS amplifier with enhancement load device

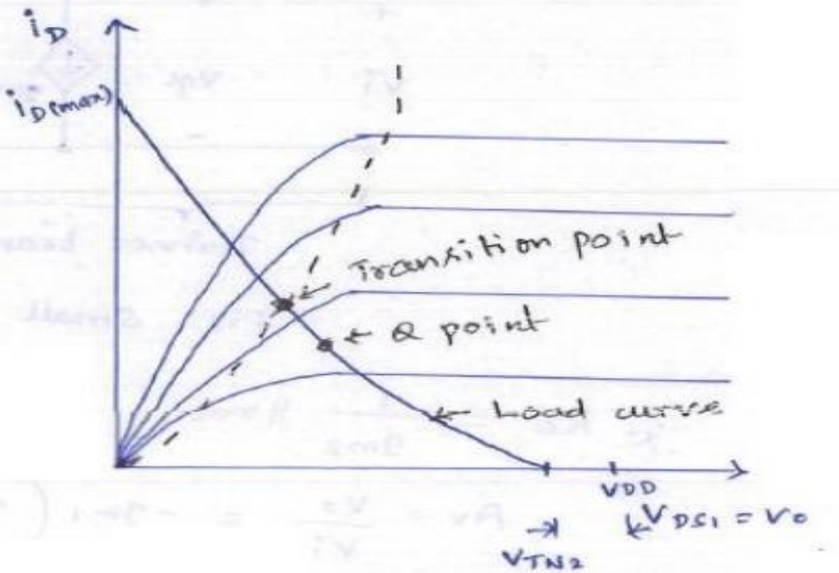

Fig: V-I characteristics

* Here The MOSFET T_2 is used as a load & MOSFET 'T_1' is used as a driver transistor.
* The load device T_2 is always biased in the saturation region.
* The V-I characteristics of the load device is non-linear. The load curve is also non-linear.

* At $V_{DD} - V_{TN2}$, the load curve intersects the voltage axis & the current in the enhancement load goes to zero.

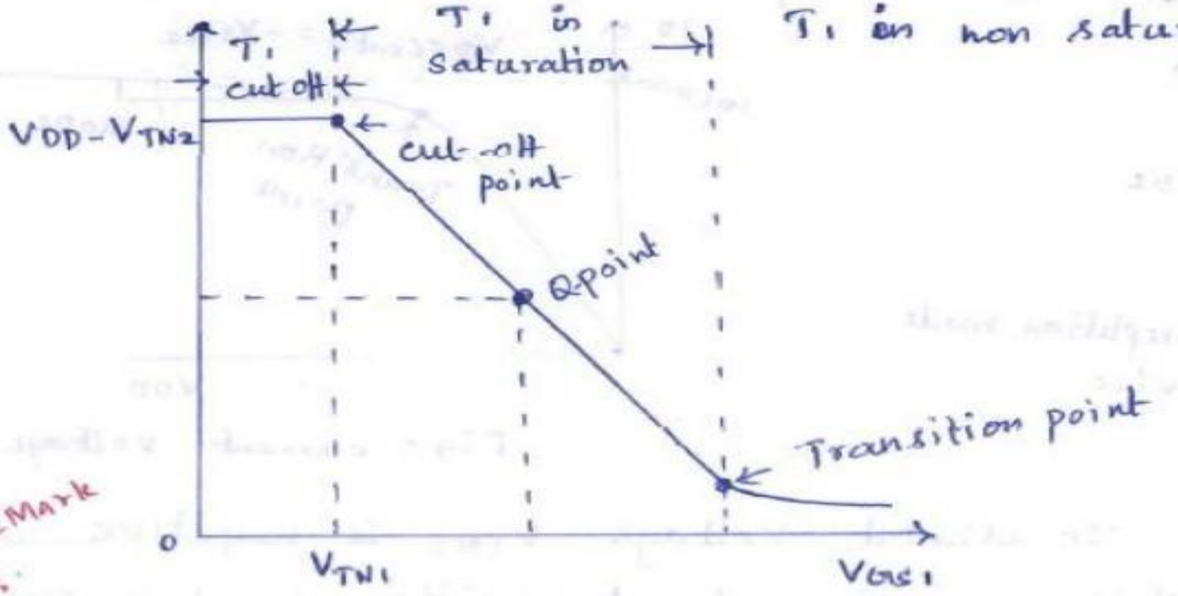

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Fig: Voltage Transfer characteristics

* In the characteristics fig: the Q-point should be in the Saturation region to use circuit as an amplifier.

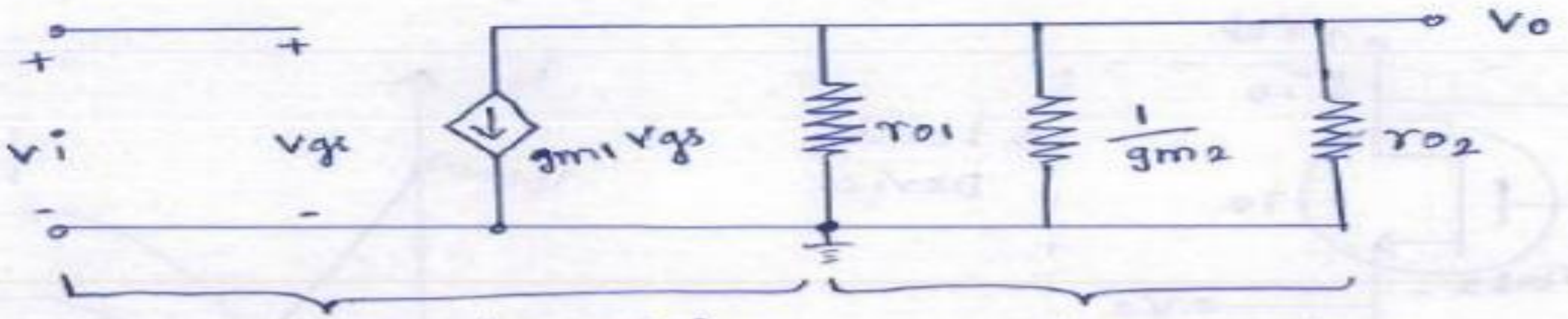

Fig: Small signal equivalent circuit

$$R_o = \frac{1}{g_{m2}} \parallel r_{o2}$$

$$A_v = \frac{v_o}{v_i} = -g_{m1}\left(r_{o1} \parallel \frac{1}{g_{m2}} \parallel r_{o2} \right)$$

Since $\frac{1}{g_{m2}} << r_{o2}$ & $\frac{1}{g_{m1}} << r_{o1}$, the A_v can be approximated as

$$A_v = \frac{-g_{m1}}{g_{m2}} = -\sqrt{\frac{K_{n1}}{K_{n2}}} = -\sqrt{\frac{(W_1/L_1)}{(W_2/L_2)}}$$

⇒ * This is related to the size of the transistor. (2 Mark)

* To obtain larger voltage gain we can use depletion-mode MOSFET.

THANK YOU