Lecture 13

MOSFET

4.4 The MOSFET as an Amplifier and as a Switch

- **We use MOSFET in the design of amplifier circuits since they act as a voltage-controlled current source in the Saturation region**
  - i.e. Changes in v_{GS} gives rise to changes in i_D
- **How to achieve Linear Amplification? i.e. an amplifier whose output signal (i.e. the Drain current i_D) is linearly related to the input signal (i.e v_{GS})**
  - We'll have to find a way around the highly non-linear (square-law) relationship of i_D to v_{GS}:

$$i_D = \frac{1}{2} k_n' \frac{W}{L} \left[(v_{GS} - V_t)^2 \right]$$

DC Biasing is a Fundamental Step towards designing a Linear MOSFET Amplifier

- **The technique we use to obtain linear amplification out of a fundamentally non-linear device is called DC biasing**
  - Two Steps:
    1. Bias the MOSFET to operate at a certain DC voltage V_{GS} and corresponding I_D and then,
    2. Superimpose a small AC signal to be amplified v_{gs}, on top of the DC bias voltage V_{GS}

Large-Signal Operation

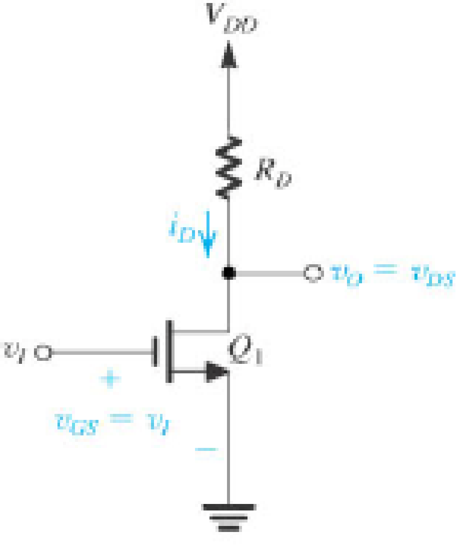
Common Source (CS) (grounded source) Amplifier

- Called *Common Source* since the grounded source is common to both the input port (between G and S) and the output port (between D and S)

- Changes in $v_I = v_{GS}$, causes changes in i_D and we use a resistor R_D to get an output voltage v_o:

$$v_o = v_{DS} = V_{DD} - R_D\, i_D$$

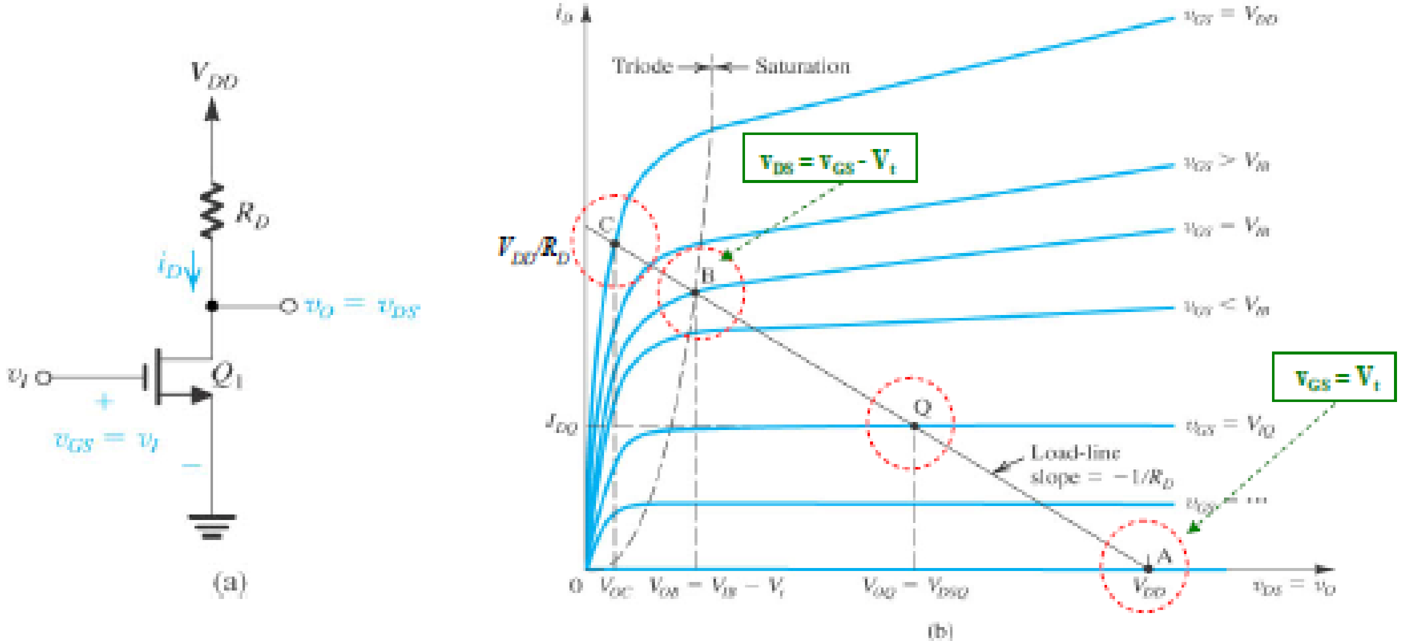
- A DC power supply V_{DD} is needed to turn the MOSFET on and to supply the necessary power for its operation



(a)

Voltage Amplifier

Large-Signal Operation *cont.*



- Governed by the *intersection* of the MOSFET i_D-v_{DS} characteristic and the **Load Line** imposed by connecting the drain to V_{DD} via R_D
- For any given v_I (=v_{GS}), we locate the corresponding i_D-v_{DS} curve and find v_o from the point of intersection of this curve with the load line
- As v_I=v_{GS} is increased, the operating point slides on the load line from point A (cutoff), through Saturation, to point C (Triode)