IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

MICRORLECTRONICS: DEVICES TO CIRCUITS

JFET, Structure and operation

SUDEB DASGUPTA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



Outline

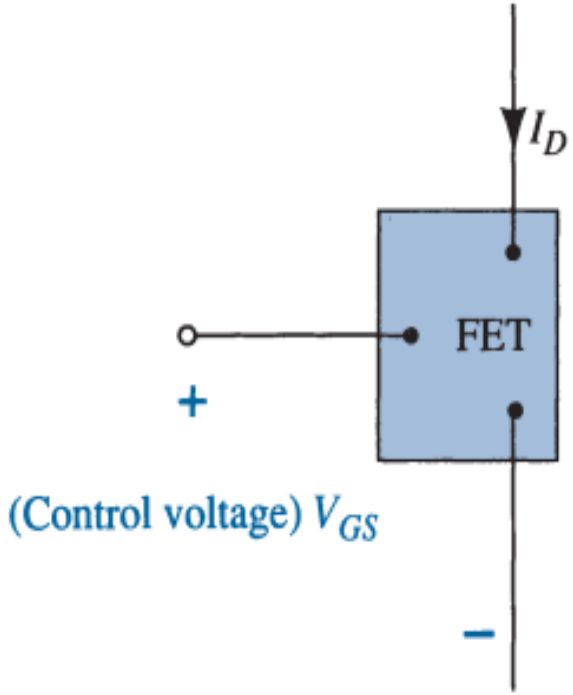
- Junction Field Effect Transistor(JFET)
- Structure of JFET
- Operation of JFET for small Vds
- Operation of JFET for Vgs=0 V
- Current –Voltage Characteristics
- Recapitulation

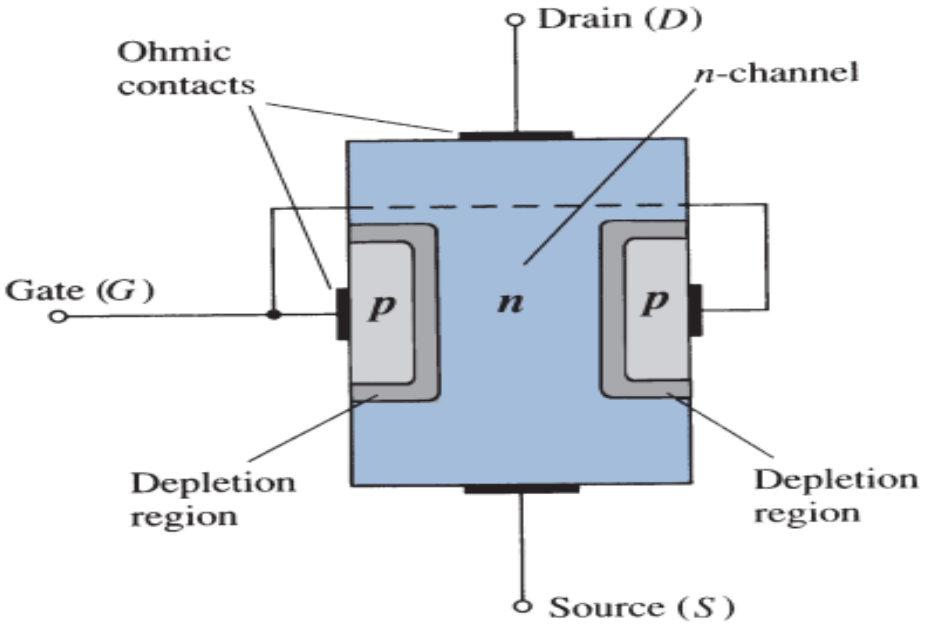
Junction Field Effect Transistor(JFET)

- JFET is a voltage controlled device.
- The current in a JFET is through a semiconductor region known as the channel, with ohmic contacts at each end.
- The basic transistor action is modulation of the channel conductance by an electric field perpendicular to the channel.
- The modulating electric field is induced in the space charge region of a reverse –biased pn junction or schottky barrier junction, the field is the function of the gate voltage.

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

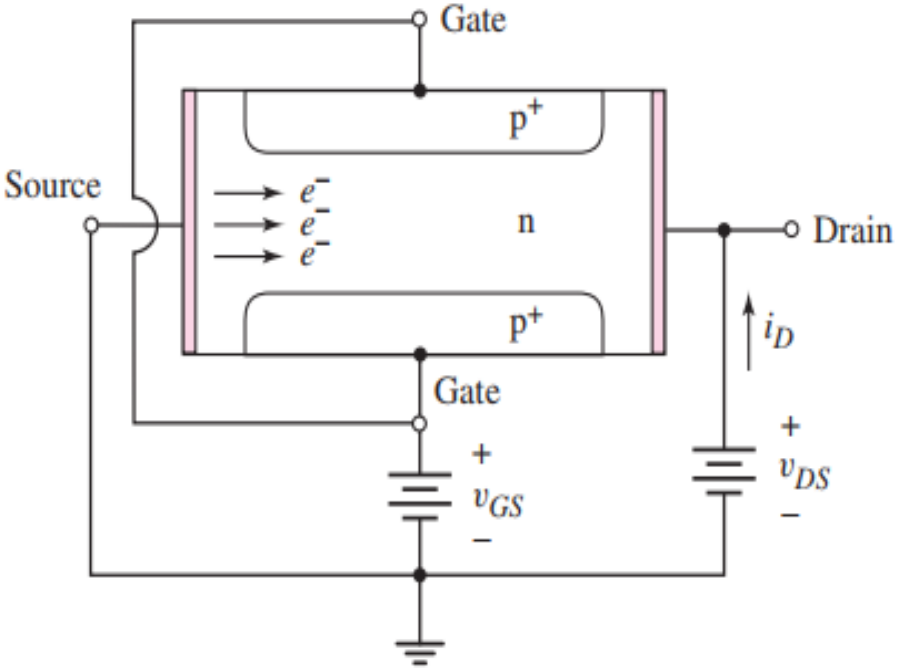
Structure of JFET

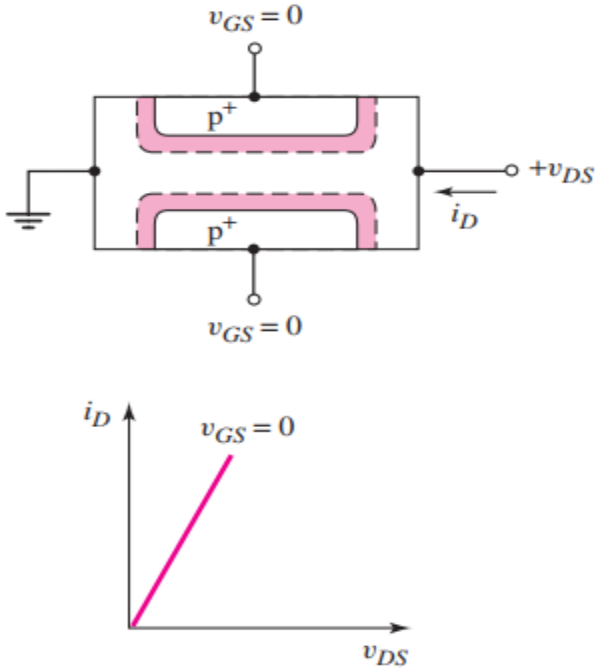




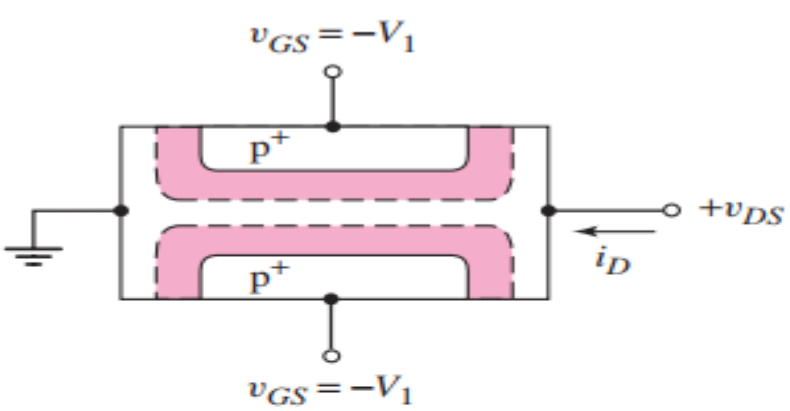
Source: Electronics devices and circuit theory, Robert L. Boylestad, Eleventh Edition

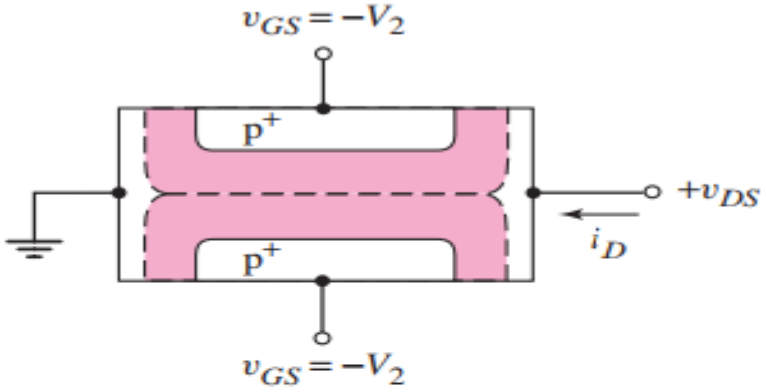
Operation of JFET for small Vds

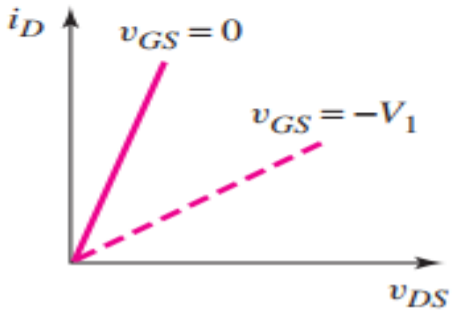


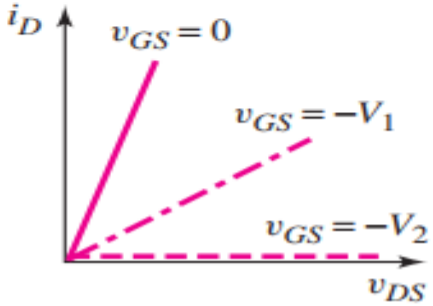


Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition



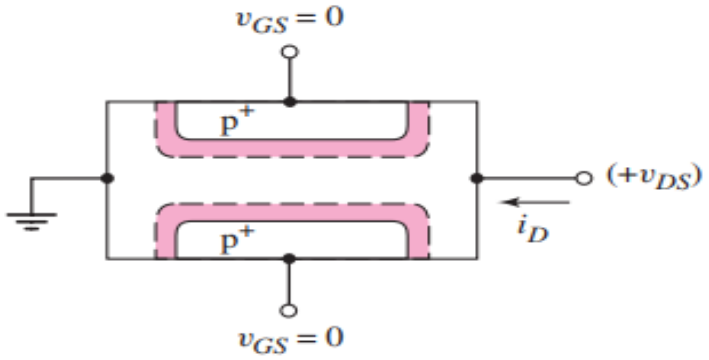


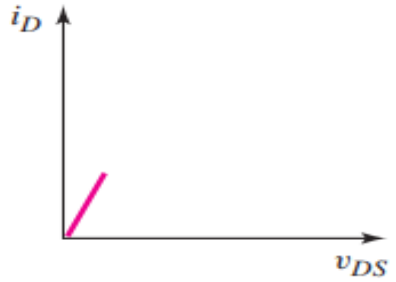


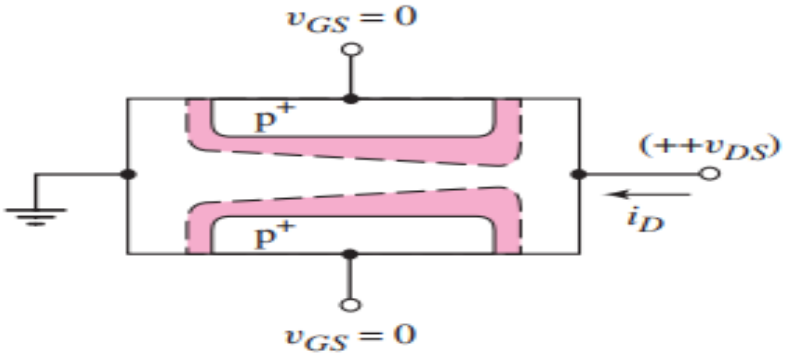


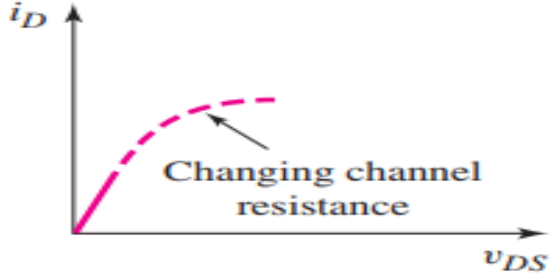
Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Operation of JFET for Vgs=0 V

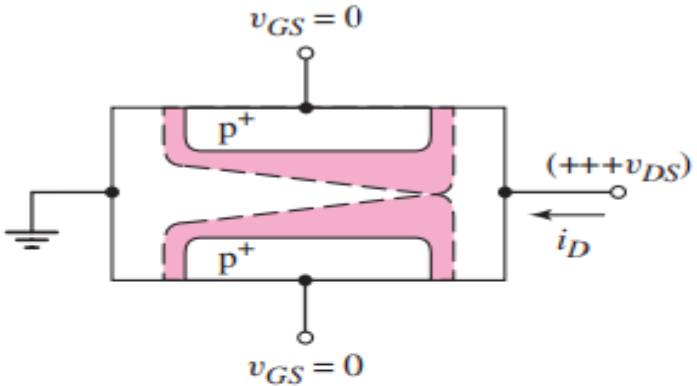


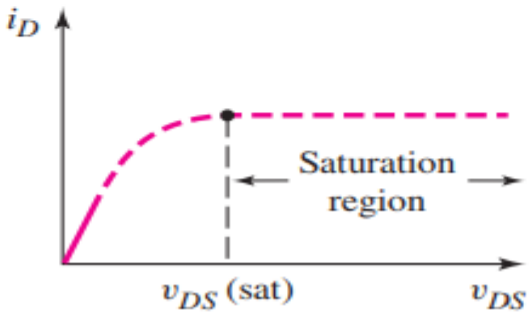


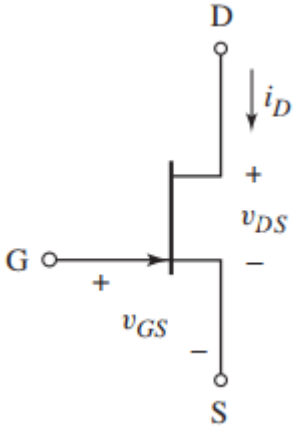




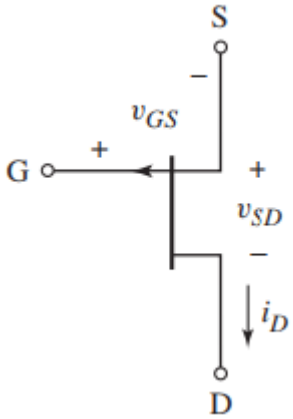
Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition







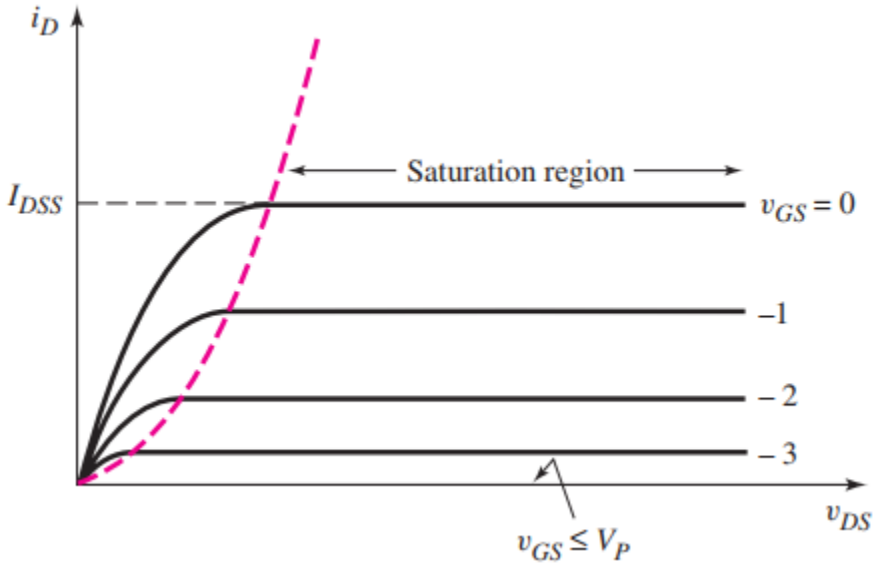
N-channel JFET

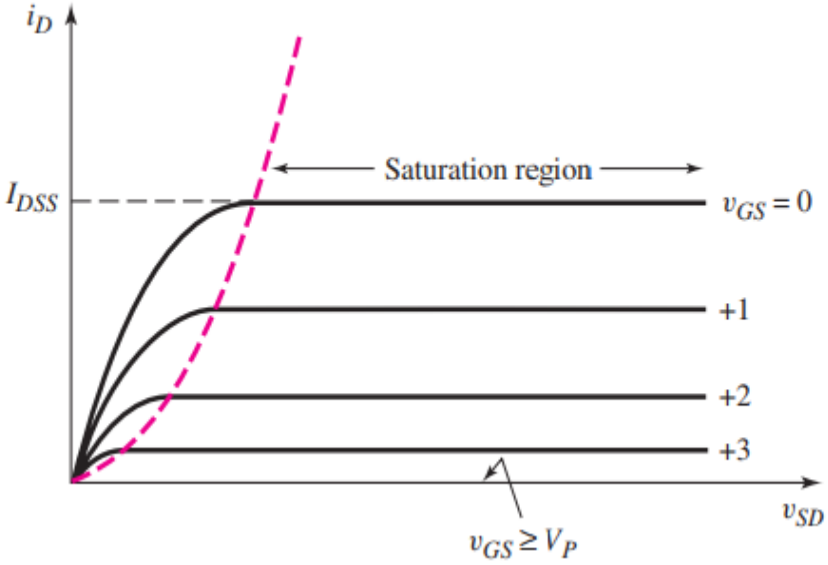


P-channel JFET

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Current –Voltage Characteristics





N-channel JFET

P-channel JFET

V_P Pinch-off Voltage

$$i_D = I_{DSS}\left(1 - \frac{v_{GS}}{V_P}\right)^2$$

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

- n-Channel device, the saturation region occur when $v_{DS} \geq v_{DS(sat)}$.
- P-channel device, the saturation region occur when $v_{SD} \geq v_{SD(sat)}$.
- The current capability of a JFET can be increased by increasing the value of Idss, which is the function of transistor width.

$$v_{SD(sat)} = V_P - v_{GS}$$

$$v_{DS(sat)} = v_{GS} - V_P$$

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Recapitulation

- JFET is a voltage controlled device.
- One of the most important characteristics of JFET is high input impedance.
- The current capability of a JFET can be increased by increasing the value of Idss, which is the function of transistor width.
- The maximum current is defined as Idss and occurs when VGS = 0 V and VDS >|VP|.

Source: Microelectronics Circuit Analysis and Design Donald A. Neamen, Fourth edition

Thank You