Electronic Devices

Final Term
Lecture - 03

Reference book:

Electronic Devices and Circuit Theory (Chapter-6)

Robert L. Boylestad and L. Nashelsky , (11th Edition)

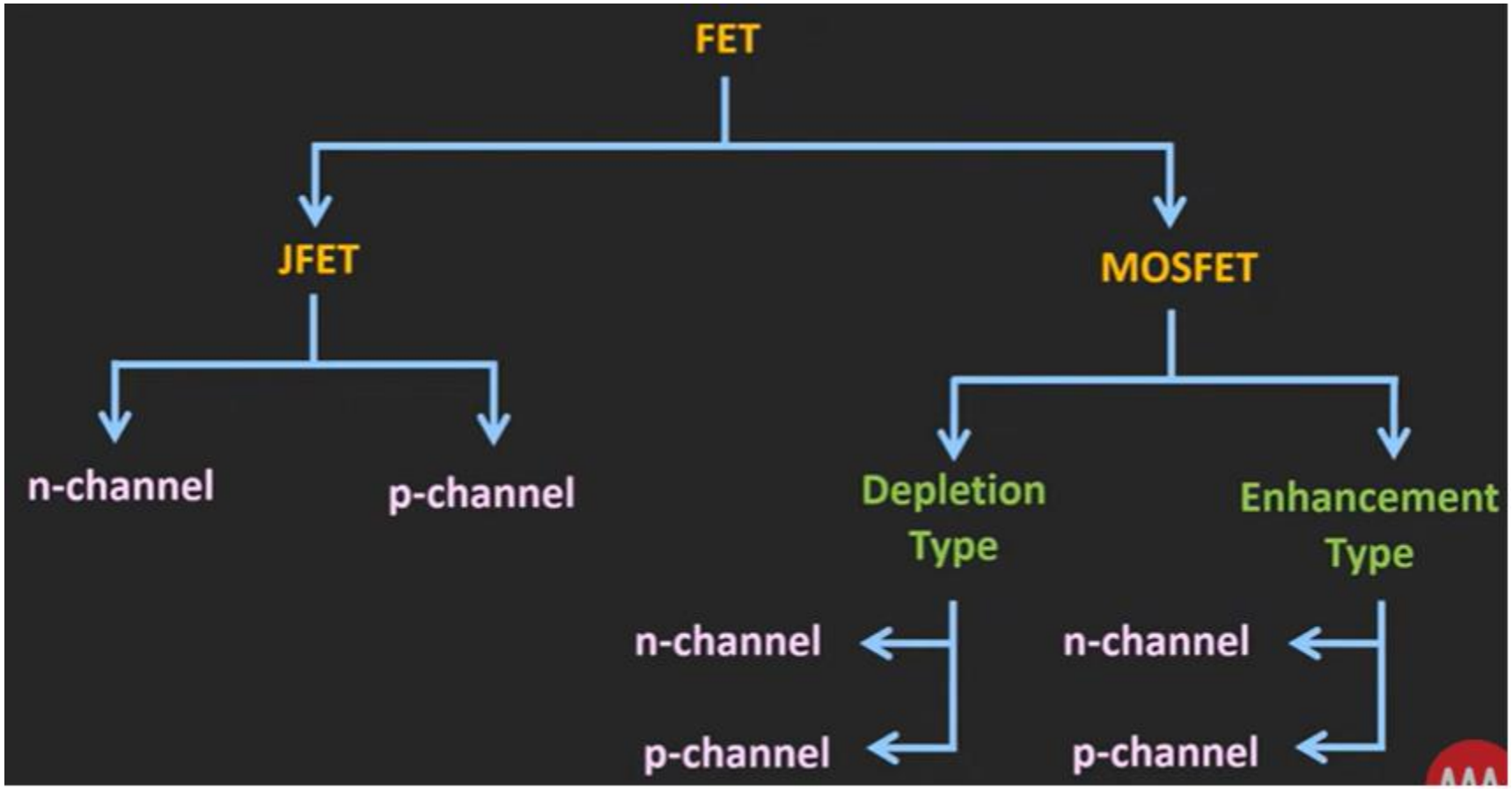
OBJECTIVES

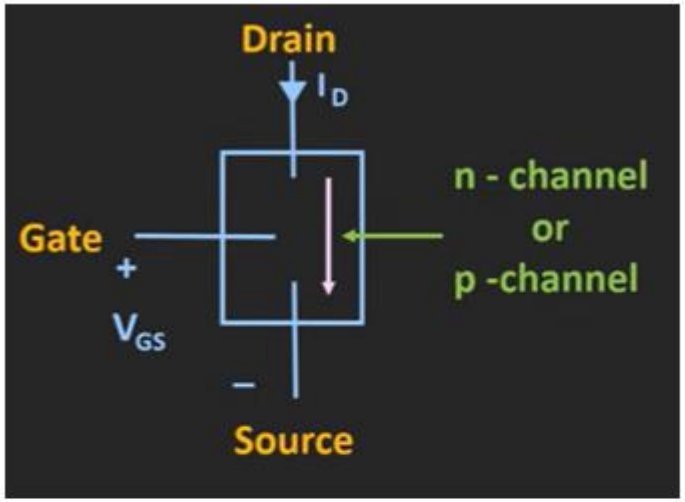
- Become familiar with the construction and operating characteristics of Junction Field Effect (JFET), Metal-Oxide Semiconductor FET (MOSFET), and Metal-Semiconductor FET (MESFET) transistors.
- Be able to sketch the transfer characteristics from the drain characteristics of a JFET, MOSFET, and MESFET transistor.
- Understand the vast amount of information provided on the specification sheet for each type of FET.
- Be aware of the differences between the dc analysis of the various types of FETs.

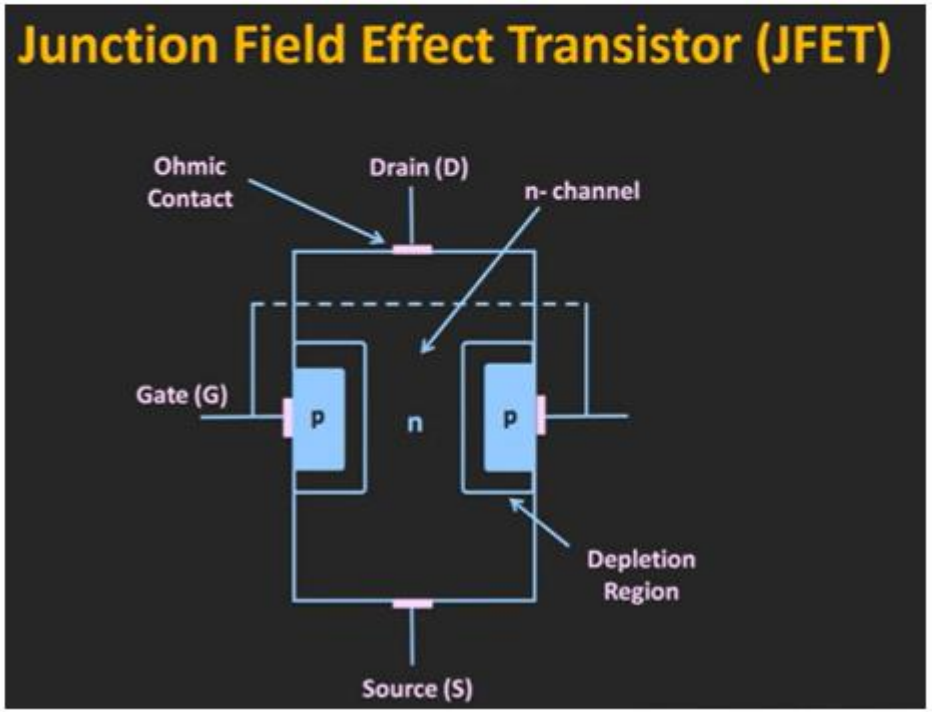
FETs vs BJTs

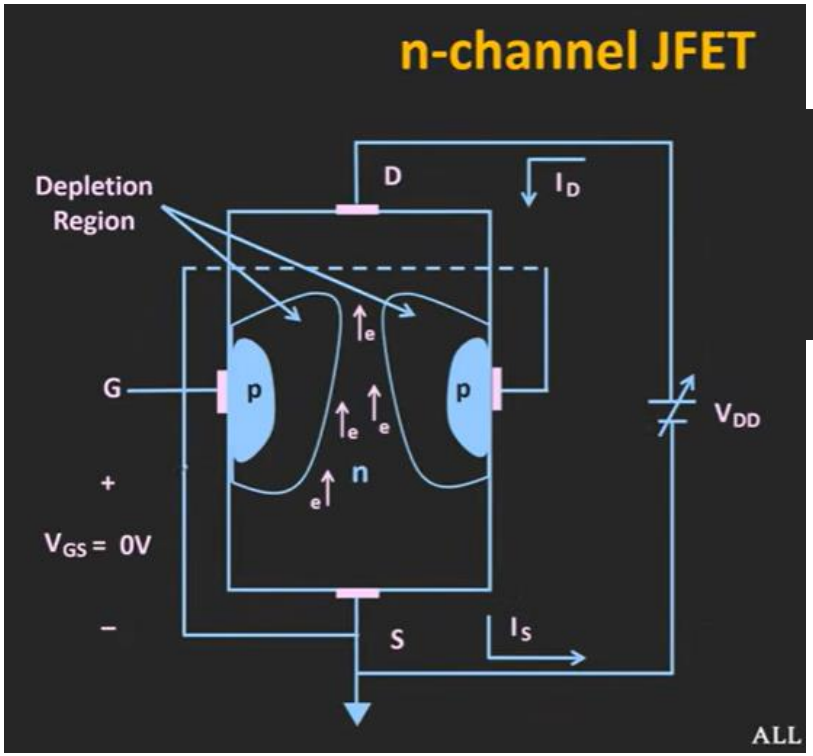
- FET's (Field – Effect Transistors) are much like BJT's (Bipolar Junction Transistors).

- ***Similarities:***
  - Amplifiers
  - Switching devices
  - Impedance matching circuits
- ***Differences:***
  - FET's are voltage controlled devices whereas BJT's are current controlled devices.
  - FET's are unipolar devices whereas BJT's are bipolar devices.
  - FET's also have a higher input impedance, but BJT's have higher gains.
  - FET's are less sensitive to temperature variations and because of their construction they are more easily integrated into IC's.


FET
JFET
MOSFET
n-channel
p-channel
Depletion Type
Enhancement Type
n-channel
p-channel
n-channel
p-channel


Drain
I_D
n - channel
or
p -channel
Gate
+
V_{GS}
–
Source

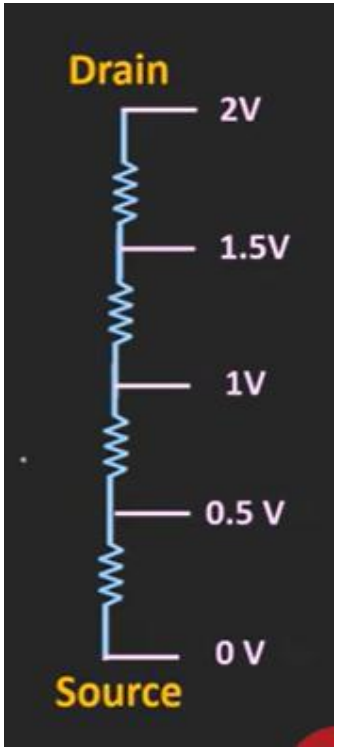

Junction Field Effect Transistor (JFET)
Ohmic Contact
Drain (D)
n- channel
Gate (G)
p
n
p
Depletion Region
Source (S)

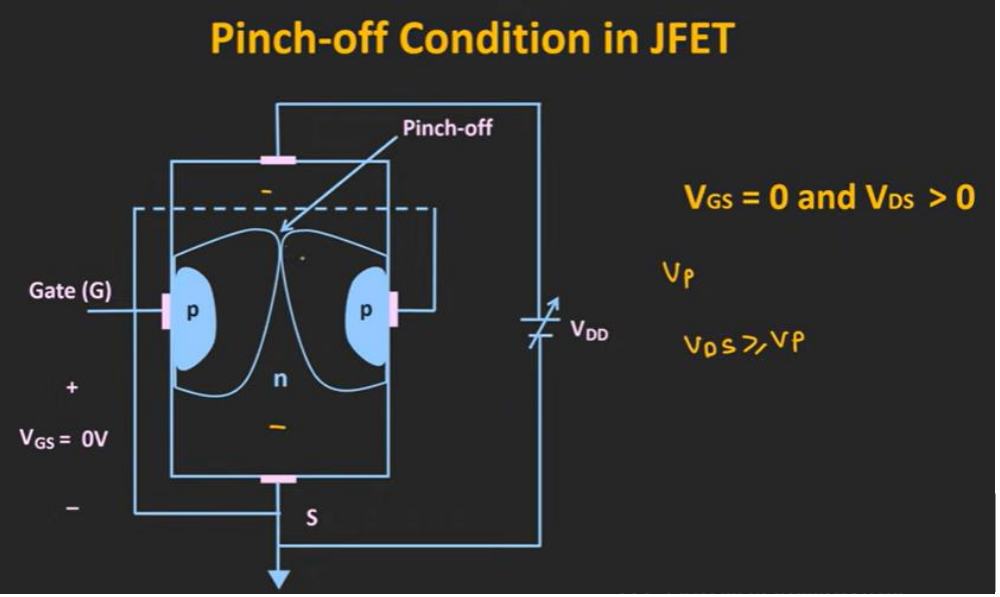


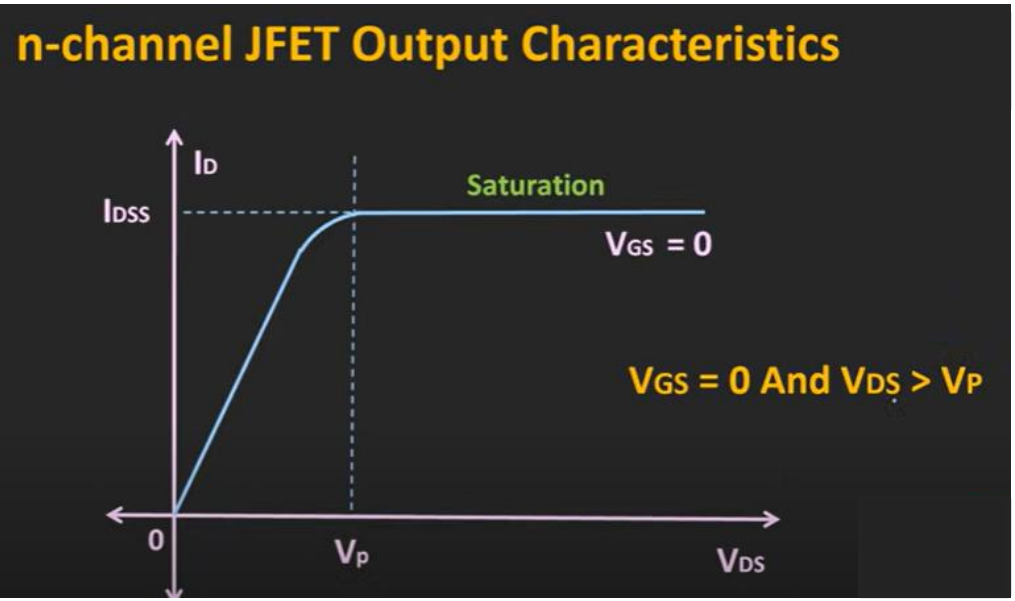
$I_D = I_S$

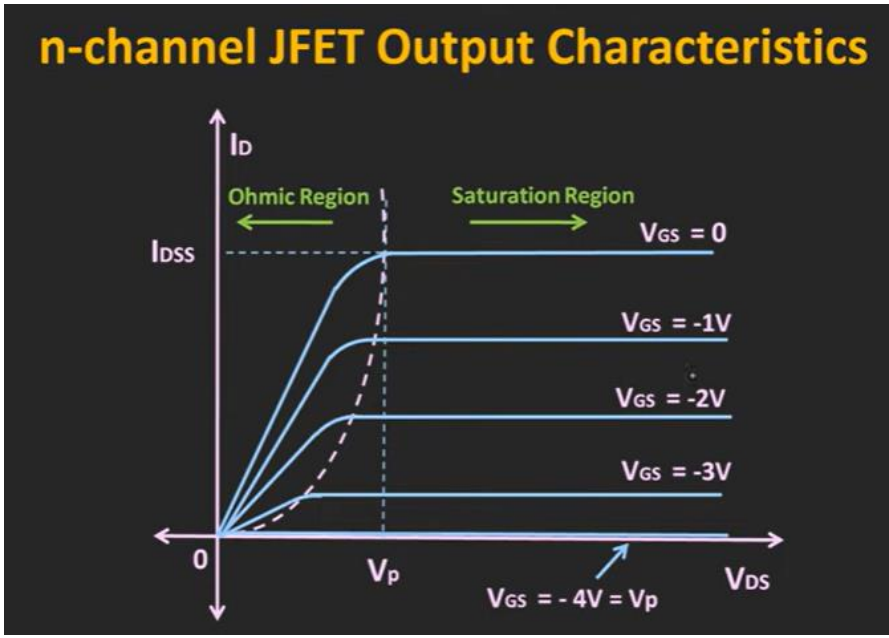
$V_{GS} = 0$ and $V_{DS} > 0$

$I_G = 0$



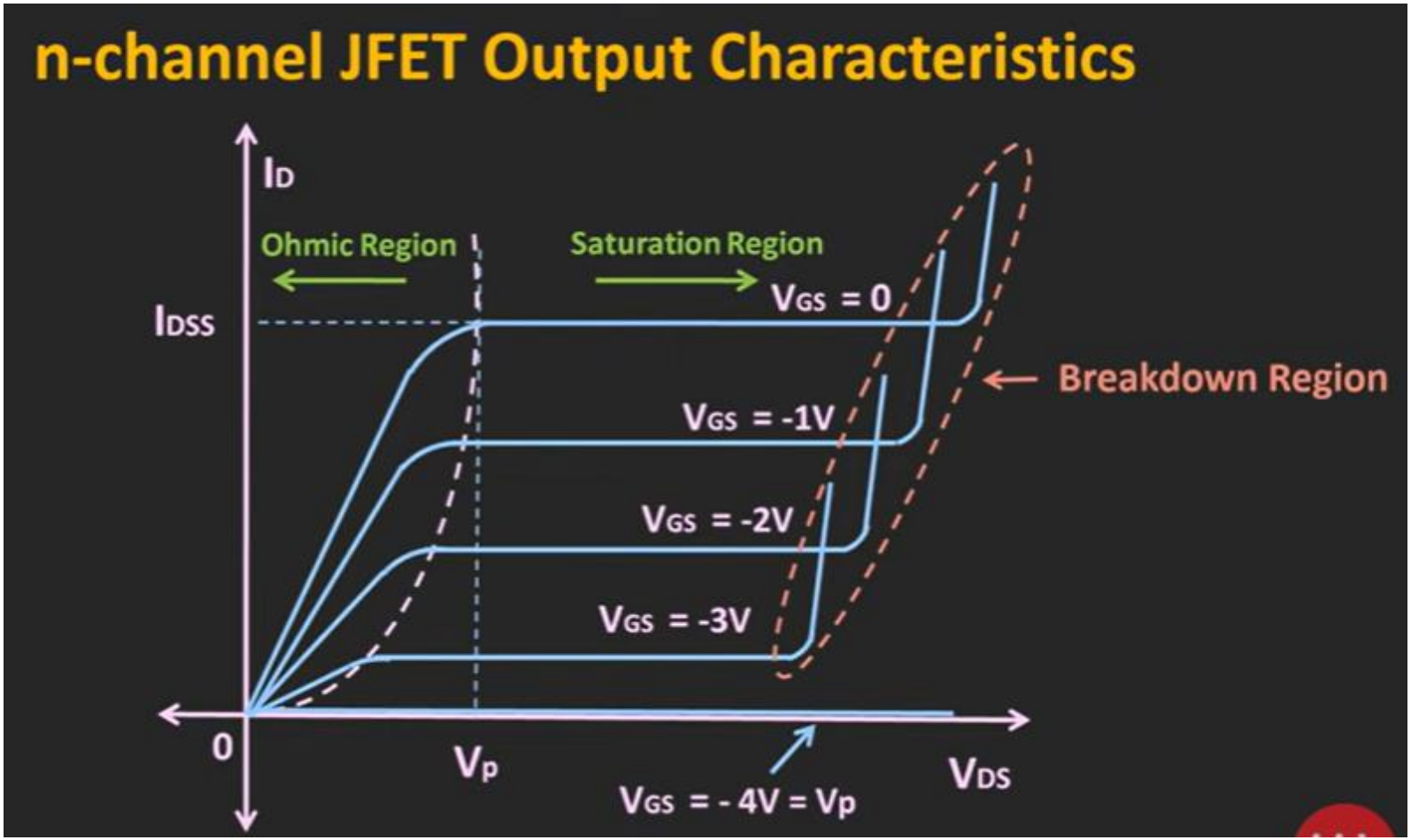

Pinch-off Condition in JFET
Pinch-off
Gate (G)
p
p
n
V_{DD}
+
V_{GS} = 0V
–
S
V_{GS} = 0 and V_{DS} > 0
V_P
$V_{DS} \geq V_P$

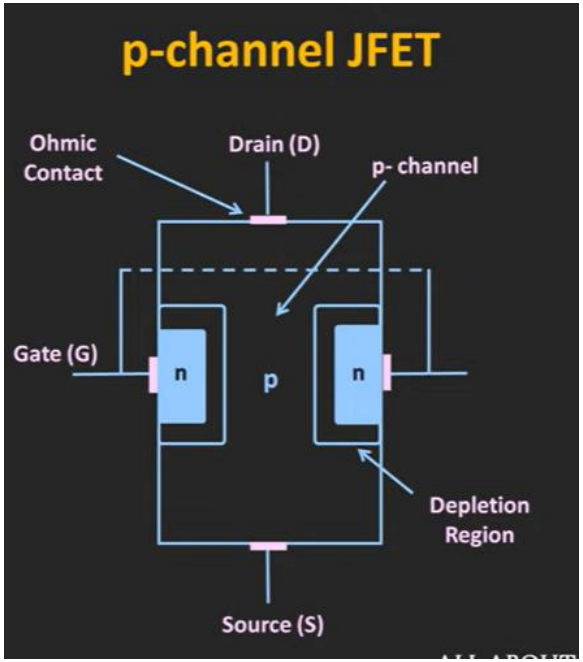

n-channel JFET Output Characteristics
I_D
I_{DSS}
Saturation
V_{GS} = 0
V_{GS} = 0 And V_{DS} > V_P
0
V_P
V_{DS}

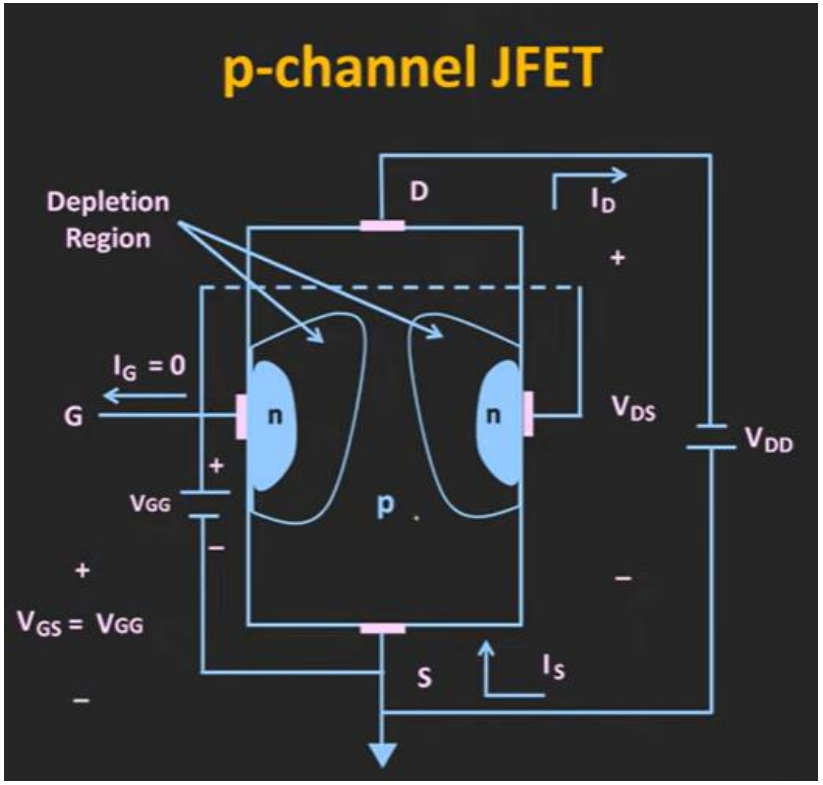

n-channel JFET Output Characteristics
I_D
Ohmic Region
Saturation Region
I_{DSS}
V_{GS} = 0
V_{GS} = -1V
V_{GS} = -2V
V_{GS} = -3V
0
V_P
V_{GS} = - 4V = Vp
V_{DS}

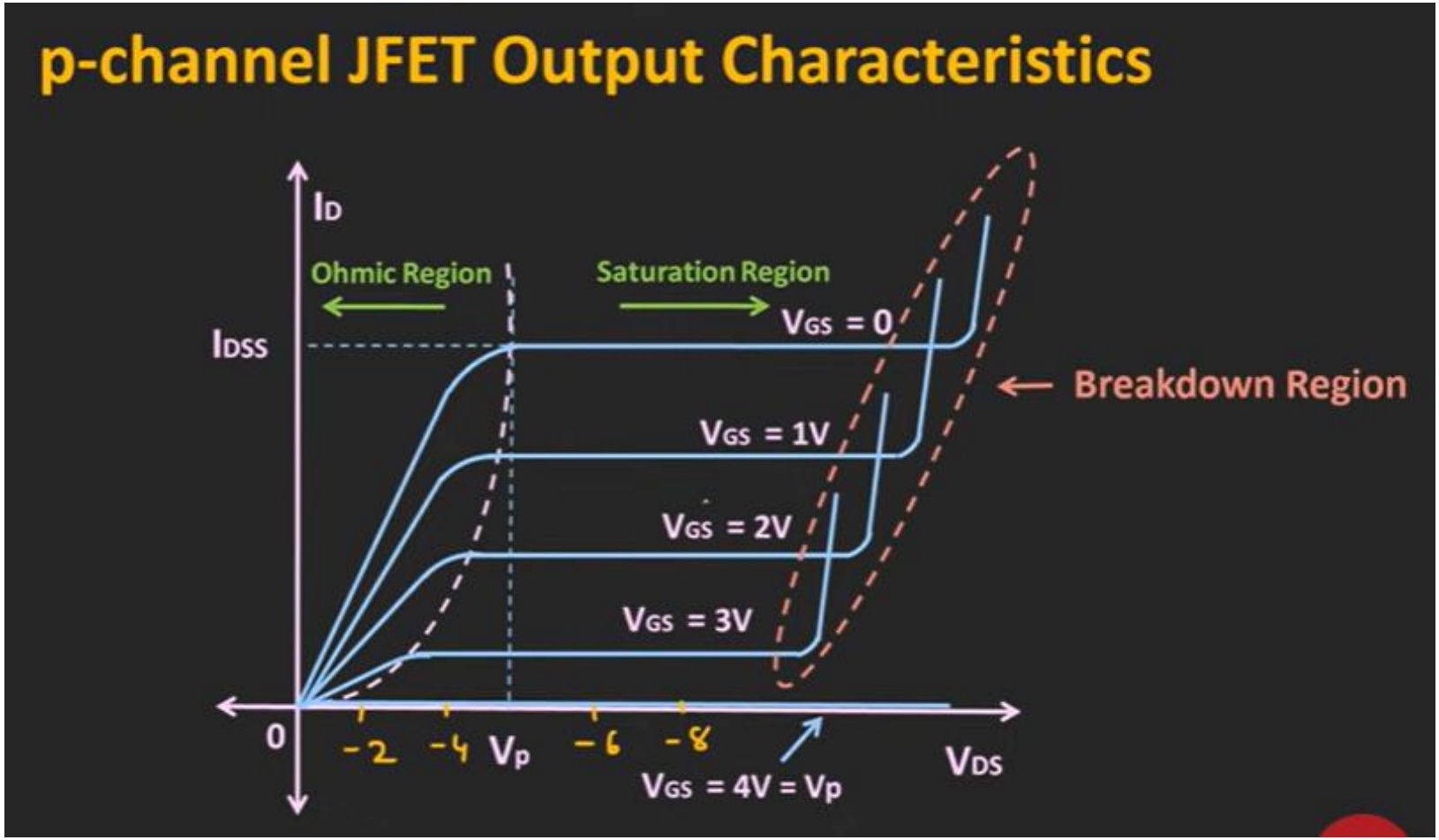
- Ohmic Region = JFET will work as a resistor.
- For Fixed value of Vgs it will provide constant resistance.
- Increase Vgs resistance will increase. So it can work as variable resistor.

- Vgs >= Vp, Id=0. cut off device is off.


n-channel JFET Output Characteristics
ID
Ohmic Region
Saturation Region
IDSS
VGS = 0
Breakdown Region
VGS = -1V
VGS = -2V
VGS = -3V
0
Vp
VDS
VGS = - 4V = Vp


p-channel JFET
Ohmic Contact
Drain (D)
p- channel
Gate (G)
n
p
n
Depletion Region
Source (S)


p-channel JFET
Depletion Region
D
I_D
+
$I_G = 0$
G
n
n
V_{DS}
V_{DD}
+
V_{GG}
p
–
+
–
$V_{GS} = V_{GG}$
S
I_S
–


p-channel JFET Output Characteristics
ID
Ohmic Region
Saturation Region
IDSS
VGS = 0
Breakdown Region
VGS = 1V
VGS = 2V
VGS = 3V
0
-2
-4
Vp
-6
-8
VGS = 4V = Vp
VDS

JFET OPERATING CHARACTERISTICS: VOLTAGE CONTROLLED RESISTOR

- The region to the left of the pinch-off point is called the ohmic region.
- The slope of each curve and therefore the resistance of the device between drain and source for $V_{DS} < V_P$ is a function of the applied voltage V_{GS}.
- As V_{GS} becomes more negative, the resistance (r_d) increases.
- The JFET can be used as a variable resistor, where V_{GS} controls the drain-source resistance (r_d).

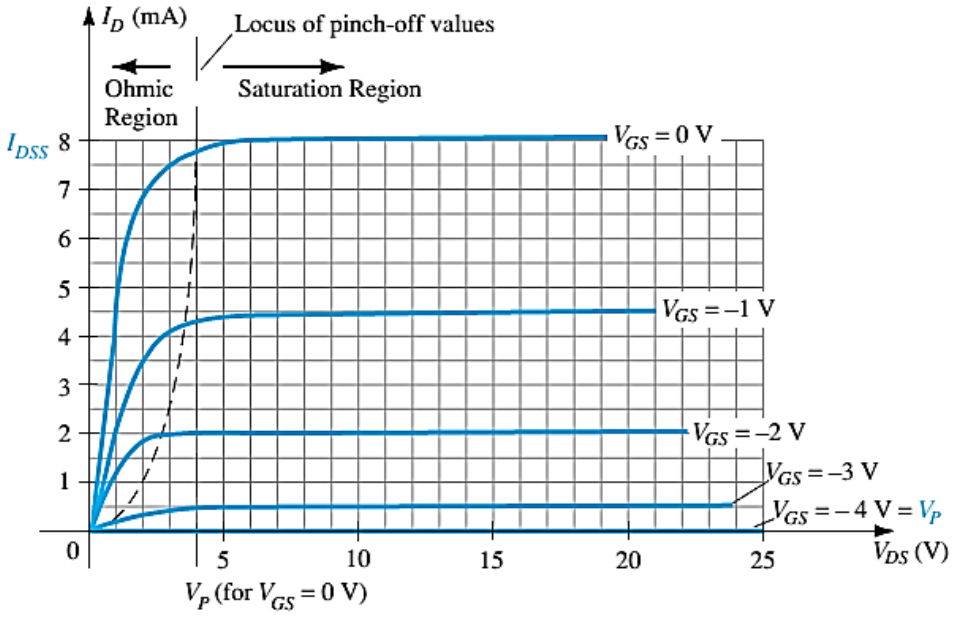
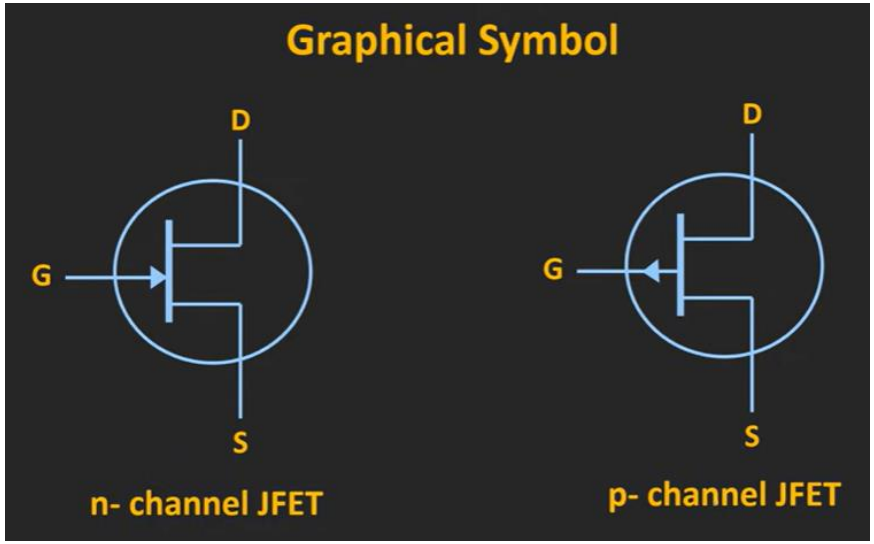
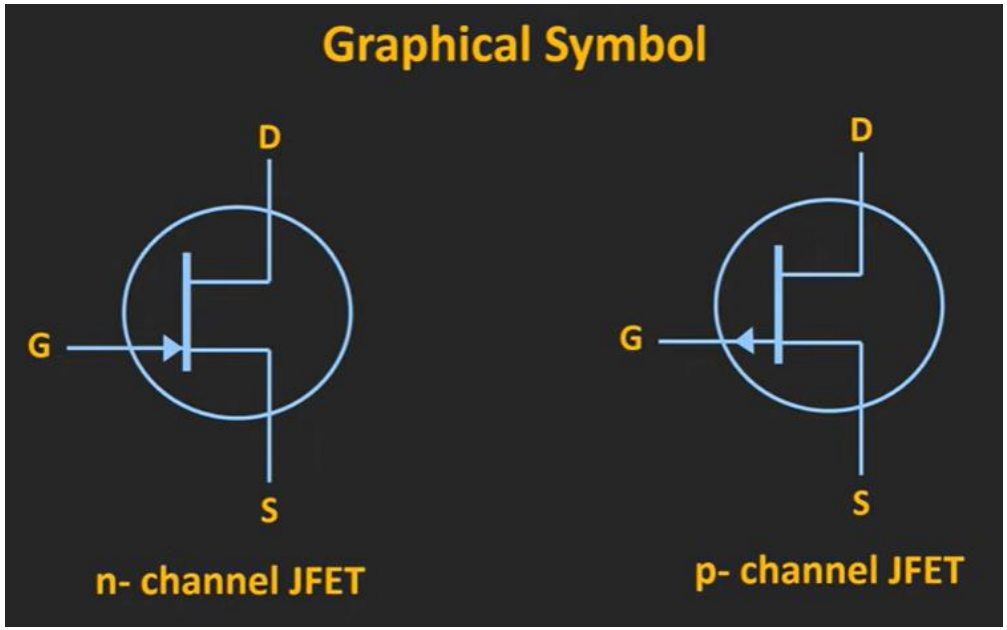


FIG. 6.11
n-Channel JFET characteristics with $I_{DSS} = 8$ mA and $V_P = -4$ V.

$$r_d = \frac{r_o}{(1 - V_{GS}/V_P)^2}$$


Graphical Symbol
D
G
S
n- channel JFET
D
G
S
p- channel JFET


Graphical Symbol
D
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