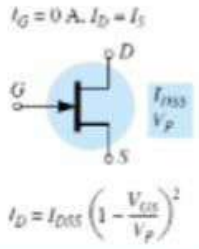
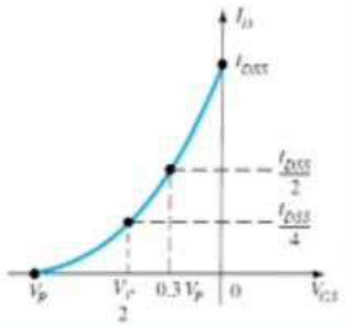
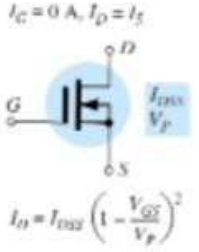
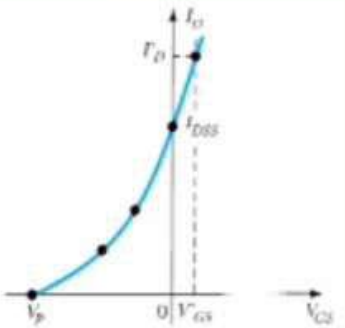
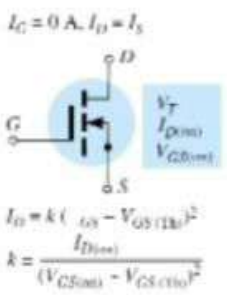
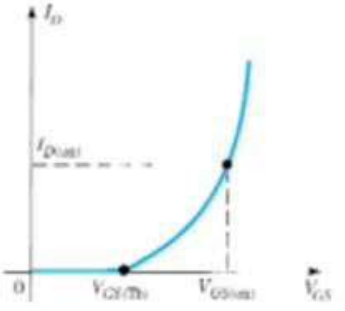
5.12 SUMMARY TABLE

Since the transfer curves and some important characteristics vary from one type of FET to another, Table 5.2 was developed to clearly display the differences from one device to the next. A clear understanding of all the curves and parameters of the table will provide a sufficient background for the dc and ac analyses to follow in Chapters 6 and 8. Take a moment to ensure that each curve is recognizable and its derivation understood, and then establish a basis for comparison of the levels of the important parameters of R_i and C_i for each device.

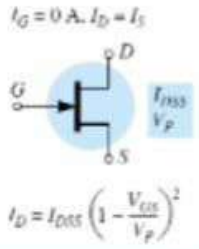
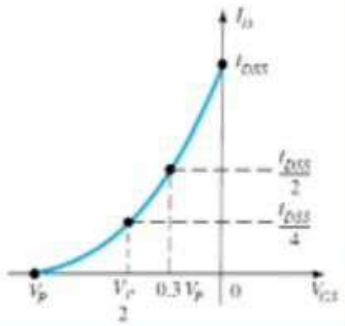
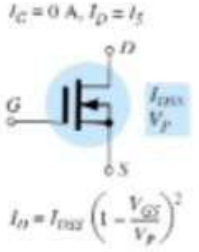
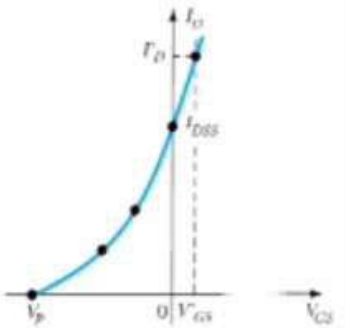
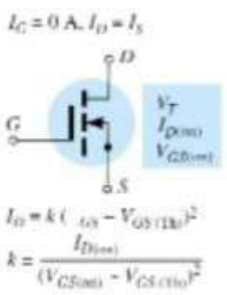
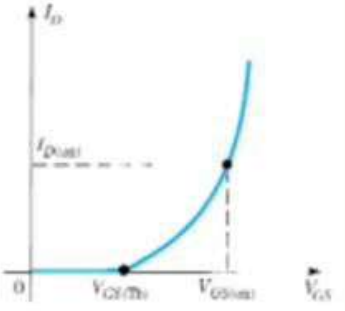
TABLE 5.2 Field Effect Transistors

Type	*-Symbol- Basic Relationships*	*Transfer Curve*	*Input Resistance and Capacitance*
JFET (*n*-channel)			$R_i > 100$ MΩ C_i: (1 – 10) pF
MOSFET depletion-type (*n*-channel)			$R_i > 10^{10}$ Ω C_i: (1 – 10) pF
MOSFET enhancement-type (*n*-channel)			$R_i > 10^{10}$ Ω C_i: (1 – 10) pF

5.12 SUMMARY TABLE

Since the transfer curves and some important characteristics vary from one type of FET to another, Table 5.2 was developed to clearly display the differences from one device to the next. A clear understanding of all the curves and parameters of the table will provide a sufficient background for the dc and ac analyses to follow in Chapters 6 and 8. Take a moment to ensure that each curve is recognizable and its derivation understood, and then establish a basis for comparison of the levels of the important parameters of R_i and C_i for each device.

TABLE 5.2 Field Effect Transistors

Type	*-Symbol- Basic Relationships*	*Transfer Curve*	*Input Resistance and Capacitance*
JFET (*n*-channel)			$R_i > 100$ MΩ C_i: (1 – 10) pF
MOSFET depletion-type (*n*-channel)			$R_i > 10^{10}$ Ω C_i: (1 – 10) pF
MOSFET enhancement-type (*n*-channel)			$R_i > 10^{10}$ Ω C_i: (1 – 10) pF

1. (a) Draw the basic construction of a *p*-channel JFET.
   (b) Apply the proper biasing between drain and source and sketch the depletion region for $V_{GS} = 0$ V.
2. Using the characteristics of Fig. 5.10, determine I_D for the following levels of V_{GS} (with $V_{DS} > V_P$).
   (a) $V_{GS} = 0$ V.
   (b) $V_{GS} = -1$ V.
   (c) $V_{GS} = -1.5$ V.
   (d) $V_{GS} = -1.8$ V.
   (e) $V_{GS} = -4$ V.
   (f) $V_{GS} = -6$ V.
3. (a) Determine V_{DS} for $V_{GS} = 0$ V and $I_D = 6$ mA using the characteristics of Fig. 5.10.
   (b) Using the results of part (a), calculate the resistance of the JFET for the region $I_D = 0$ to 6 mA for $V_{GS} = 0$ V.
   (c) Determine V_{DS} for $V_{GS} = -1$ V and $I_D = 3$ mA.
   (d) Using the results of part (c), calculate the resistance of the JFET for the region $I_D = 0$ to 3 mA for $V_{GS} = -1$ V.
   (e) Determine V_{DS} for $V_{GS} = -2$ V and $I_D = 1.5$ mA.
   (f) Using the results of part (e), calculate the resistance of the JFET for the region $I_D = 0$ to 1.5 mA for $V_{GS} = -2$ V.
   (g) Defining the result of part (b) as r_o, determine the resistance for $V_{GS} = -1$ V using Eq. (5.1) and compare with the results of part (d).
   (h) Repeat part (g) for $V_{GS} = -2$ V using the same equation, and compare the results with part (f).
   (i) Based on the results of parts (g) and (h), does Eq. (5.1) appear to be a valid approximation?
4. Using the characteristics of Fig. 5.10:
   (a) Determine the difference in drain current (for $V_{DS} > V_P$) between $V_{GS} = 0$ V and $V_{GS} = -1$ V.
   (b) Repeat part (a) between $V_{GS} = -1$ and -2 V.
   (c) Repeat part (a) between $V_{GS} = -2$ and -3 V.
   (d) Repeat part (a) between $V_{GS} = -3$ and -4 V.
   (e) Is there a marked change in the difference in current levels as V_{GS} becomes increasingly negative?
   (f) Is the relationship between the change in V_{GS} and the resulting change in I_D linear or nonlinear? Explain.
5. What are the major differences between the collector characteristics of a BJT transistor and the drain characteristics of a JFET transistor? Compare the units of each axis and the controlling variable. How does I_C react to increasing levels of I_B versus changes in I_D to increasingly negative values of V_{GS}? How does the spacing between steps of I_B compare to the spacing between steps of V_{GS}? Compare $V_{C_{sat}}$ to V_P in defining the nonlinear region at low levels of output voltage.
6. (a) Describe in your own words why I_G is effectively zero amperes for a JFET transistor.
   (b) Why is the input impedance to a JFET so high?
   (c) Why is the terminology *field effect* appropriate for this important three-terminal device?
7. Given $I_{DSS} = 12$ mA and $|V_P| = 6$ V, sketch a probable distribution of characteristic curves for the JFET (similar to Fig. 5.10).
8. In general, comment on the polarity of the various voltages and direction of the currents for an *n*-channel JFET versus a *p*-channel JFET.

§ 5.3 Transfer Characteristics

9. Given the characteristics of Fig. 5.49:
   (a) Sketch the transfer characteristics directly from the drain characteristics.
   (b) Using Fig. 5.49 to establish the values of I_{DSS} and V_P, sketch the transfer characteristics using Shockley's equation.
   (c) Compare the characteristics of parts (a) and (b). Are there any major differences?