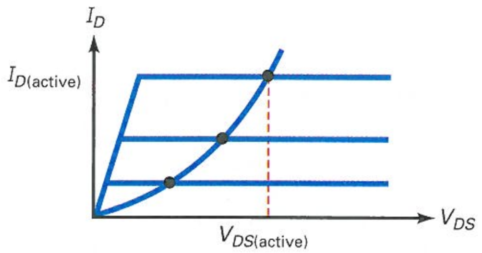
(14-6) Two-terminal resistance:



$$R_D = \frac{V_{DS(\text{active})}}{I_{D(\text{active})}}$$

(14-8) E-MOSFET constant k:

$$k = \frac{I_{D(\text{on})}}{[V_{GS(\text{on})} - V_{GS(\text{th})}]^2}$$

(14-10) E-MOSFET g_m:

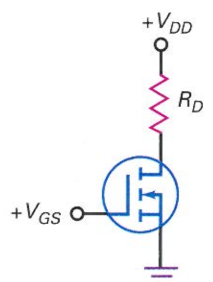
$$g_m = 2\,k\,[V_{GS} - V_{GS(\text{th})}]$$

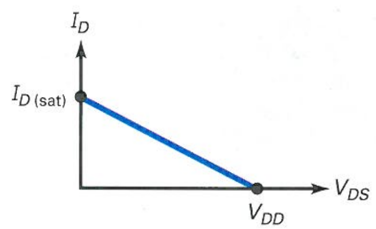
Derivations

(14-2) D-MOSFET zero-bias:

$$V_{DS} = V_{DD} - I_{DSS}\,R_D$$

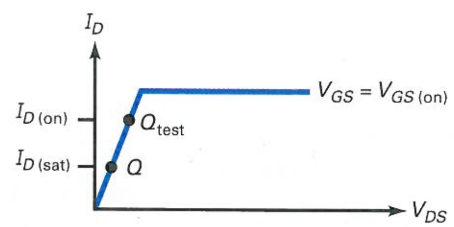
(14-4) Saturation current:





$$I_{D(\text{sat})} = \frac{V_{DD}}{R_D}$$

(14-5) Ohmic region:



$$I_{D(\text{sat})} < I_{D(\text{on})}$$

(14-7) E-MOSFET drain current:

$$I_D = k\,[V_{GS} - V_{GS(\text{th})}]^2$$

(14-9) R_D for drain-feedback bias:

$$R_D = \frac{V_{DD} - V_{DS(\text{on})}}{I_{D(\text{on})}}$$

Student Assignments

1. A D-MOSFET can operate in the
a. Depletion-mode only
b. Enhancement-mode only
c. Depletion-mode or enhancement-mode
d. Low-impedance mode

2. When an *n*-channel D-MOSFET has $I_D > I_{DSS}$, it
a. Will be destroyed
b. Is operating in the depletion mode
c. Is forward biased
d. Is operating in the enhancement mode

3. The voltage gain of a D-MOSFET amplifier is dependent on
a. R_D
b. R_L
c. g_m
d. All of the above

4. Which of the following devices revolutionized the computer industry?
a. JFET
b. D-MOSFET
c. E-MOSFET
d. Power FET

5. The voltage that turns on an EMOS device is the
a. Gate-source cutoff voltage
b. Pinchoff voltage
c. Threshold voltage
d. Knee voltage

6. Which of these may appear on the data sheet of an enhancement-mode MOSFET?
a. $V_{GS(\text{th})}$
b. $I_{D(\text{on})}$
c. $V_{GS(\text{on})}$
d. All the above

7. The $V_{GS(\text{on})}$ of an *n*-channel E-MOSFET is
a. Less than the threshold voltage
b. Equal to the gate-source cutoff voltage
c. Greater than $V_{DS(\text{on})}$
d. Greater than $V_{GS(\text{th})}$

8. An ordinary resistor is an example of
a. A three-terminal device
b. An active load
c. A passive load
d. A switching device

9. An E-MOSFET with its gate connected to its drain is an example of
a. A three-terminal device
b. An active load
c. A passive load
d. A switching device

10. An E-MOSFET that operates at cutoff or in the ohmic region is an example of
a. A current source
b. An active load
c. A passive load
d. A switching device

11. VMOS devices generally
a. Switch off faster than BJTs
b. Carry low values of current
c. Have a negative temperature coefficient
d. Are used as CMOS inverters

12. A D-MOSFET is considered to be a
a. Normally off device
b. Normally on device
c. Current controlled device
d. High-power switch

13. CMOS stands for
a. Common MOS
b. Active-load switching
c. *p*-channel and *n*-channel devices
d. Complementary MOS

14. $V_{GS(\text{on})}$ is always
a. Less than $V_{GS(\text{th})}$
b. Equal to $V_{DS(\text{on})}$
c. Greater than $V_{GS(\text{th})}$
d. Negative

15. With active-load switching, the upper E-MOSFET is a
a. Two-terminal device
b. Three-terminal device
c. Switch
d. Small resistance

16. CMOS devices use
a. Bipolar transistors
b. Complementary E-MOSFETs
c. Class A operation
d. DMOS devices

17. The main advantage of CMOS is its
a. High power rating
b. Small-signal operation
c. Switching capability
d. Low power consumption

18. Power FETs are
a. Integrated circuits
b. Small-signal devices
c. Used mostly with analog signals
d. Used to switch large currents

19. When the internal temperature increases in a power FET, the
a. Threshold voltage increases
b. Gate current decreases
c. Drain current decreases
d. Saturation current increases

20. Most small-signal E-MOSFETs are found in
a. Heavy-current applications
b. Discrete circuits
c. Disk drives
d. Integrated circuits

21. Most power FETS are
a. Used in high-current applications
b. Digital computers
c. RF stages
d. Integrated circuits

22. An *n*-channel E-MOSFET conducts when it has
a. $V_{GS} > V_P$
b. An *n*-type inversion layer
c. $V_{DS} > 0$
d. Depletion layers

23. With CMOS, the upper MOSFET is
a. A passive load
b. An active load
c. Nonconducting
d. Complementary

24. The high output of a CMOS inverter is
a. $V_{DD}/2$
b. V_{GS}
c. V_{DS}
d. V_{DD}

25. The $R_{DS(\text{on})}$ of a power FET
a. Is always large
b. Has a negative temperature coefficient
c. Has a positive temperature coefficient
d. Is an active load

Problems

SEC. 14-2 D-MOSFET CURVES

14-1 An *n*-channel D-MOSFET has the specifications $V_{GS(\text{off})} = -2$ V and $I_{DSS} = 4$ mA. Given V_{GS} values of -0.5 V, -1.0 V, -1.5 V, $+0.5$ V, $+1.0$ V, and $+1.5$ V, determine I_D in the depletion mode only.

14-2 Given the same values as in the previous problem, calculate I_D for the enhancement mode only.

14-3 A *p*-channel D-MOSFET has $V_{GS(\text{off})} = +3$ V and $I_{DSS} = 12$ mA. Given V_{GS} values of -1.0 V, -2.0 V, 0 V, $+1.5$ V, and $+2.5$ V, determine I_D in the depletion mode only.

SEC. 14-3 DEPLETION-MODE MOSFET AMPLIFIERS

14-4 The D-MOSFET in Fig. 14-36 has $V_{GS(\text{off})} = -3$ V and $I_{DSS} = 12$ mA. Determine the circuit's drain current and V_{DS} values.

14-5 In Fig. 14-36, what are the values of r_d, A_v, and V_{out} using a g_{mo} of 4000 μS?

14-6 Using Fig. 14-36 find r_d, A_v, and V_{out} if $R_D = 680\ \Omega$ and $R_L = 10$ kΩ.

14-7 What is the approximate input impedance of Fig. 14-36?

SEC. 14-5 THE OHMIC REGION

14-8 Calculate $R_{DS(\text{on})}$ for each of these E-MOSFET values:
a. $V_{DS(\text{on})} = 0.1$ V and $I_{D(\text{on})} = 10$ mA
b. $V_{DS(\text{on})} = 0.25$ V and $I_{D(\text{on})} = 45$ mA
c. $V_{DS(\text{on})} = 0.75$ V and $I_{D(\text{on})} = 100$ mA
d. $V_{DS(\text{on})} = 0.15$ V and $I_{D(\text{on})} = 200$ mA