1. Define the region of operation for the 2N5457 JFET using the range of I_{DSS} and V_P provided. That is, sketch the transfer curve defined by the maximum I_{DSS} and V_P and the transfer curve for the minimum I_{DSS} and V_P. Then, shade in the resulting area between the two curves.

ANSWER:

From Fig. 6.22:

$-0.5\text{ V} < V_P < -6\text{ V}$

$1\text{ mA} < I_{DSS} < 5\text{ mA}$

For $I_{DSS} = 5$ mA and $V_P = -6$ V:

$V_{GS} = 0\text{ V}, I_D = 5\text{ mA}$

$V_{GS} = 0.3V_P = -1.8\text{ V}, I_D = 2.5\text{ mA}$

$V_{GS} = V_P/2 = -3\text{ V}, I_D = 1.25\text{ mA}$

$V_{GS} = V_P = -6\text{ V}, I_D = 0\text{ mA}$

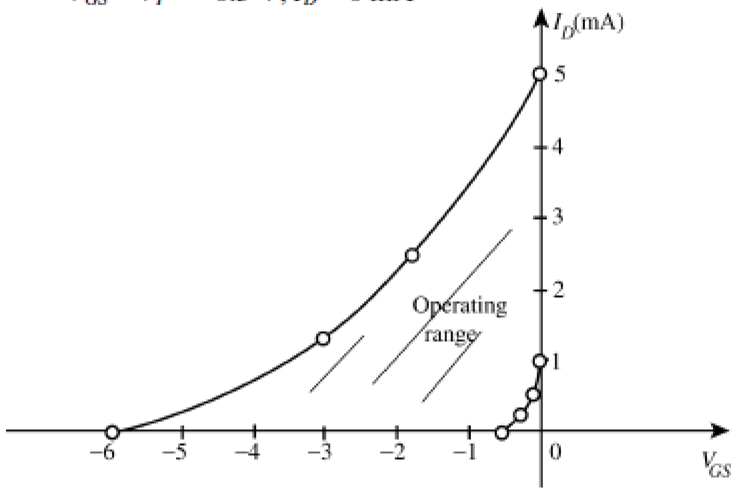
For $I_{DSS} = 1$ mA and $V_P = -0.5$ V:

$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$

$V_{GS} = 0.3V_P = -0.15\text{ V}, I_D = 0.5\text{ mA}$

$V_{GS} = V_P/2 = -0.25\text{ V}, I_D = 0.25\text{ mA}$

$V_{GS} = V_P = -0.5\text{ V}, I_D = 0\text{ mA}$



2. For the 2N5457 JFET, what is the power rating at a typical operating temperature of 45°C using the 5.0 mW/°C derating factor.

ANSWER

At 25°C, $P_D = 625$ mW

$45°\text{C} - 25°\text{C} = 20°\text{C}$

$$20°\cancel{\text{C}}\ \frac{5\text{ mW}}{°\cancel{\text{C}}} = 100\text{ mW}$$

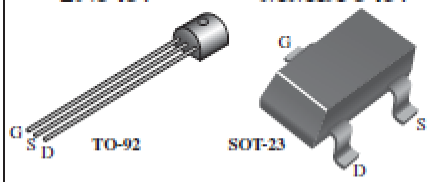
$$P_D' = 625\text{ mW} - 100\text{ mW}$$
$$= \mathbf{525\text{ mW}}$$

:

FAIRCHILD

SEMICONDUCTOR ™

2N5457 **MMBF5457**



NOTE: Source & Drain are interchangeable

N-Channel General Purpose Amplifier

This device is a low-level audio amplifier and switching transistor, and can be used for analog switching applications.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Units
V_{DS}	Drain-Source Voltage	25	V
V_{DG}	Drain-Gate Voltage	25	V
V_{GS}	Gate-Source Voltage	–25	V
I_{GF}	Forward Gate Current	10	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	–55 to +150	°C

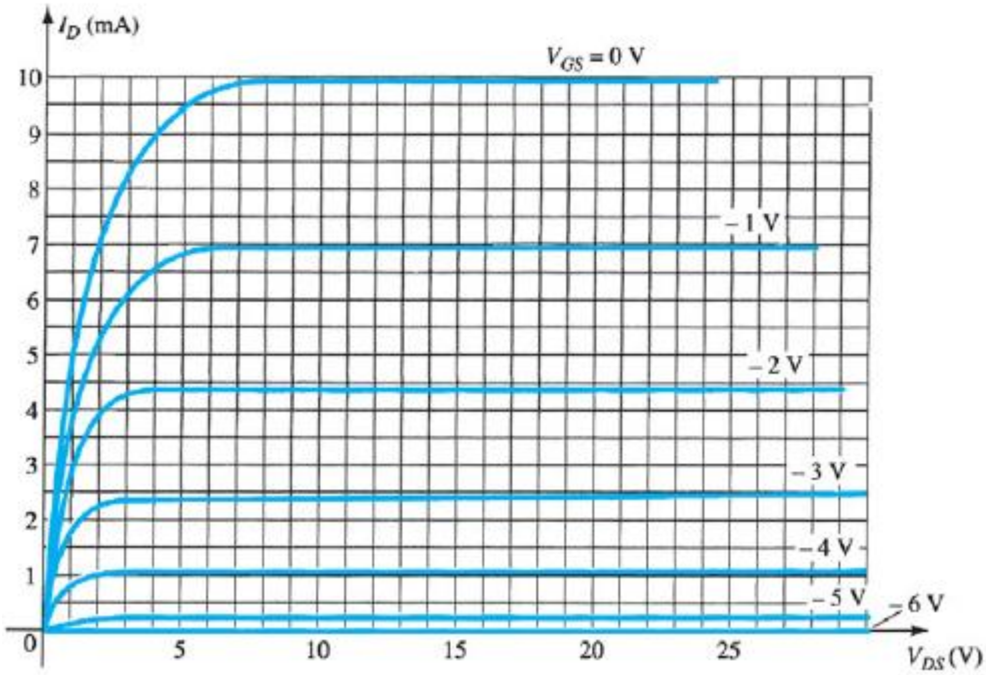
THERMAL CHARACTERISTICS

Symbol	Characteristic	Max		Units
		2N5457	*MMBF5457	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	125		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	357	556	°C/W

ELECTRICAL CHARACTERISTICS $T_A = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
OFF CHARACTERISTICS						
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = 10\ \mu A$, $V_{DS} = 0$	–25			V
I_{GSS}	Gate Reverse Current	$V_{GS} = -15$ V, $V_{DS} = 0$ $V_{GS} = -15$ V, $V_{DS} = 0$, $T_A = 100°C$			–1.0 –200	nA nA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15$ V, $I_D = 10$ nA 5457	–0.5		–6.0	V
V_{GS}	Gate-Source Voltage	$V_{DS} = 15$ V, $I_D = 100\ \mu A$ 5457		–2.5		V
ON CHARACTERISTICS						
I_{DSS}	Zero-Gate Voltage Drain Current	$V_{DS} = 15$ V, $V_{GS} = 0$ 5457	1.0	3.0	5.0	mA
SMALL SIGNAL CHARACTERISTICS						
g_{fs}	Forward Transfer Conductance	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1.0 kHz 5457	1000		5000	μmhos
g_{os}	Output Conductance	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1.0 MHz		10	50	μmhos
C_{iss}	Input Capacitance	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1.0 MHz		4.5	7.0	pF
C_{rss}	Reverse Transfer Capacitance	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1.0 MHz		1.5	3.0	pF
NF	Noise Figure	$V_{DS} = 15$ V, $V_{GS} = 0$, f = 1.0 kHz, $R_G = 1.0$ megohm, BW = 1.0 Hz			3.0	dB

3. Define the region of operation for the JFET below, if $V_{DSmax} = 30$ V and $P_{Dmax} = 100$ mW.



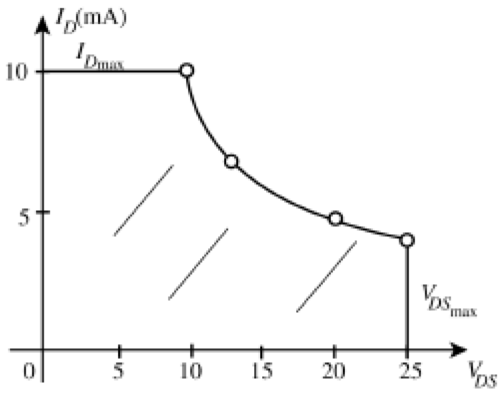
ANSWER:

$$V_{DS} = V_{DS_{\max}} = \mathbf{25\ V},\ I_D = \frac{P_{D_{\max}}}{V_{DS_{\max}}} = \frac{100\text{ mW}}{25\text{ V}} = \mathbf{4\ mA}$$

$$I_D = I_{DSS} = \mathbf{10\ mA},\ V_{DS} = \frac{P_{D_{\max}}}{I_{DSS}} = \frac{100\text{ mW}}{10\text{ mA}} = \mathbf{10\ V}$$

$$V_D = 20\text{ V},\ I_D = 6.67\text{ mA}$$

$$V_D = 15\text{ V},\ I_D = 5\text{ mA}$$



4.

a. Given $V_{GS(Th)}$ = 4 V and $I_{D(on)}$ = 4 mA at $V_{GS(on)}$ = 6 V, determine k and write the general expression for I_D in the format of

$$I_D = k(V_{GS} - V_T)^2$$

b. Sketch the transfer characteristics for the device of part (a).
c. Determine I_D for the device of part (a) at V_{GS} = 2, 5, and 10 V.

ANSWER:

(a) $k = \dfrac{I_{D(\text{on})}}{\left(V_{GS(\text{on})} - V_T\right)^2} = \dfrac{4 \text{ mA}}{(6 \text{ V} - 4 \text{ V})^2} = \mathbf{1 \text{ mA/V}^2}$

$I_D = k(V_{GS} - V_T)^2 = \mathbf{1 \times 10^{-3}(V_{GS} - 4 \text{ V})^2}$

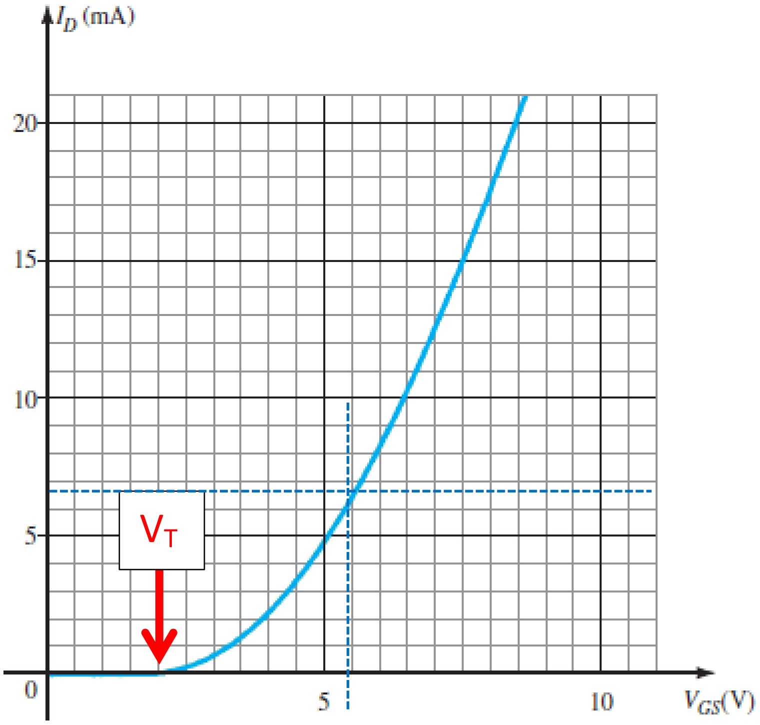
(b) For $V_{GS} < V_T = 4$ V, $I_D = 0$ mA

V_{GS}	I_D
4 V	0 mA
5 V	1 mA
6 V	4 mA
7 V	9 mA
8 V	16 mA

(c) $(V_{GS} < V_T)$

V_{GS}	I_D
2 V	0 mA
5 V	1 mA
10 V	36 mA

5. Given the transfer characteristics of Fig. 6.55 , determine V_T and k and write the general equation for I_D .



6:38

ANSWER

From Fig. 6.58, $V_T = 2.0$ V

At $I_D = 6.5$ mA, $V_{GS} = 5.5$ V:

Choose the I_D in the linear region

$I_D = k(V_{GS} - V_T)^2$

$6.5 \text{ mA} = k(5.5 \text{ V} - 2 \text{ V})^2$

$\mathbf{k = 5.31 \times 10^{-4}}$

$I_D = \mathbf{5.31 \times 10^{-4}(V_{GS} - 2)^2}$

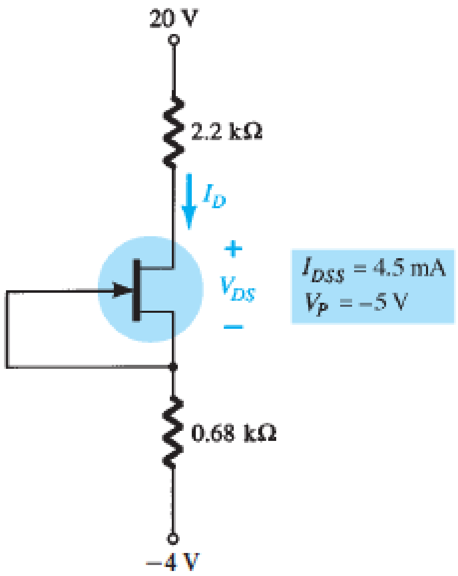
6. For the network determine:

a. I_D.

b. V_{DS}.

c. V_D.

d. V_S.



ANSWER

(a) $V_{GS} = 0\text{ V}$

$\therefore I_D = I_{DSS} = \mathbf{4.5\text{ mA}}$

(b) $V_{DS} = V_{DD} - I_D(R_D + R_S)$

$= 20\text{ V} + 4\text{ V} - (4.5\text{ mA})(2.2\text{ k}\Omega + 0.68\text{ k}\Omega)$

$= 24\text{ V} - 12.96$

$= \mathbf{11.04\text{ V}}$

(c) $V_D = V_{DD} - I_D R_D$

$= 20\text{ V} - (4.5\text{ mA})(2.2\text{ k}\Omega)$

$= \mathbf{10.1\text{ V}}$

(d) $-4\text{ V} + I_S R_S - V_S = 0$

$V_S = I_S R_S - 4\text{ V} = I_D R_S - 4\text{ V} = (4.5\text{ mA})(0.68\text{ k}\Omega) - 4\text{ V}$

$= 3.06\text{ V} - 4\text{ V}$

$= \mathbf{-0.94\text{ V}}$

7. Determine the value of R_S for the network to establish $V_D = 10$ V.

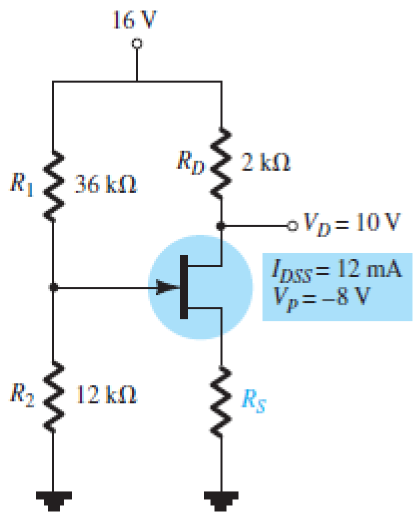


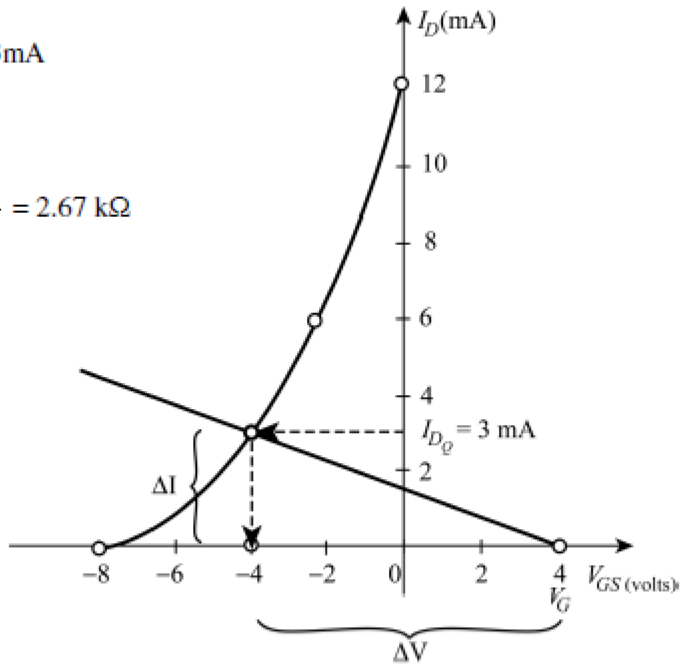
FIG. 7.87

ANSWER

$$I_{D_Q} = \frac{16\text{ V} - 10\text{ V}}{2\text{ k}\Omega} = \frac{6\text{ V}}{2\text{ k}\Omega} = 3\text{mA}$$

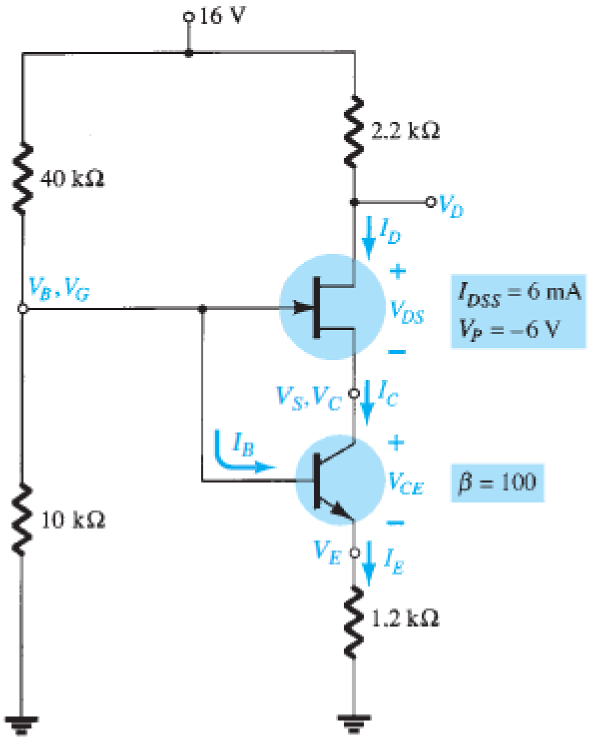
$$V_G = \frac{12\text{ k}\Omega(16\text{ V})}{12\text{ k}\Omega + 36\text{ k}\Omega} = 4\text{ V}$$

$$R_S = \frac{\Delta V}{\Delta I} = \frac{4\text{ V} + 4\text{ V}}{3\text{ mA}} = \frac{8\text{ V}}{3\text{ mA}} = 2.67\text{ k}\Omega$$



8. For the combination network of, determine:

a. V_B and V_G.
b. V_E.
c. I_E, I_C, and I_D.
d. I_B.
e. V_C, V_S, and V_D.
f. V_{CE}.
g. V_{DS}.



ANSWER:

Testing:

$\beta R_E \geq 10R_2$

$(100)(1.2\text{ k}\Omega) \geq 10(10\text{ k}\Omega)$

$120\text{ k}\Omega > 100\text{ k}\Omega$ (satisfied)

(a) $V_B = V_G = \dfrac{R_2 V_{DD}}{R_1 + R_2} = \dfrac{10\text{ k}\Omega(16\text{ V})}{40\text{ k}\Omega + 10\text{ k}\Omega}$

$= \mathbf{3.2\text{ V}}$

(b) $V_E = V_B - V_{BE} = 3.2\text{ V} - 0.7\text{ V} = \mathbf{2.5\text{ V}}$

(c) $I_E = \dfrac{V_E}{R_E} = \dfrac{2.5\text{ V}}{1.2\text{ k}\Omega} = \mathbf{2.08\text{ mA}}$

$I_C \cong I_E = \mathbf{2.08\text{ mA}}$

$I_D = I_C = \mathbf{2.08\text{ mA}}$

(d) $I_B = \dfrac{I_C}{\beta} = \dfrac{2.08\text{ mA}}{100}$ $= \mathbf{20.8\ \mu A}$

(e) $V_C = V_G - V_{GS}$

$$V_{GS} = V_P\left(1 - \sqrt{\frac{I_D}{I_{DSS}}}\right)$$

$$= (-6\text{ V})\left(1 - \sqrt{\frac{2.08\text{ mA}}{6\text{ mA}}}\right)$$

$$= -2.47\text{ V}$$

$V_C = 3.2 - (-2.47\text{ V})$
$= \mathbf{5.67\ V}$
$V_S = V_C = \mathbf{5.67\ V}$
$V_D = V_{DD} - I_D R_D$
$= 16\text{ V} - (2.08\text{ mA})(2.2\text{ k}\Omega)$
$= \mathbf{11.42\ V}$

(f) $V_{CE} = V_C - V_E = 5.67\text{ V} - 2.5\text{ V}$
$= \mathbf{3.17\ V}$

(g) $V_{DS} = V_D - V_S = 11.42\text{ V} - 5.67\text{ V}$
$= \mathbf{5.75\ V}$