1 a. $V_t = \frac{kT_K}{q} = \frac{(1.38 \text{ x} 10^{-23} \text{J/K})(20\text{C}+273\text{C})}{1.6 \text{ x } 10^{-19} \text{ C}} = \mathbf{25.27\ mV}$

1 b. $I_D = I_s\left(e^{V_D/nV_t} - 1\right) = 40nA\left(e^{0.5V/(2)(25.5mV)} - 1\right) = \mathbf{0.789\ mA}$

2. $I_D = I_s\left(e^{V_D/nV_t} - 1\right) \rightarrow 8mA = 1nA\left(e^{V_D/(1)(26mV)} - 1\right) \rightarrow V_D \approx \mathbf{0.41\ V}$

3.

	−75°C	25°C	100°C	200°C
V_F @ 10 mA	1.1 V	0.85 V	1.0 V	0.6 V
I_s	0.01 pA	1 pA	1 μA	1.05 μA

.

V_F decreased with increase in temperature
1.7 V: 0.65 V ≅ **2.6:1**
I_s increased with increase in temperature
2 µA: 0.1 µA = **20:1**

4. a.

$V_D \cong 0.7$ V, $I_D = 4$ mA

$$R_{DC} = \frac{V_D}{I_D} = \frac{0.7\text{ V}}{4\text{ mA}} = \mathbf{175\ \Omega}$$

4. b.

At $I_D = 15$ mA, $V_D = 0.82$ V

$$R_{DC} = \frac{V_D}{I_D} = \frac{0.82\text{ V}}{15\text{ mA}} = \mathbf{54.67\ \Omega}$$

As the forward diode current increases, the static resistance decreases.

4.c.

$V_D = -10$ V, $I_D = I_s = \mathbf{-0.1\ \mu A}$

$$R_{DC} = \frac{V_D}{I_D} = \frac{10\text{ V}}{0.1\ \mu\text{A}} = \mathbf{100\ M\Omega}$$

$V_D = -30$ V, $I_D = I_s = \mathbf{-0.1\ \mu A}$

$$R_{DC} = \frac{V_D}{I_D} = \frac{30\text{ V}}{0.1\mu\text{A}} = \mathbf{300\ M\Omega}$$

As the reverse voltage increases, the reverse resistance increases directly (since the diode
leakage current remains constant).

5.

(a) $r_d = \dfrac{\Delta V_d}{\Delta I_d} = \dfrac{0.79\text{ V} - 0.76\text{ V}}{15\text{ mA} - 5\text{ mA}} = \dfrac{0.03\text{ V}}{10\text{ mA}}$ $= \mathbf{3\ \Omega}$

(b) $r_d = \dfrac{26\text{ mV}}{I_D} = \dfrac{26\text{ mV}}{10\text{ mA}}$ $= \mathbf{2.6\ \Omega}$

(c) quite close

6.

(a) $V_R = -25\text{ V}$: $C_T \cong \mathbf{0.75\ pF}$
$V_R = -10\text{ V}$: $C_T \cong \mathbf{1.25\ pF}$

$$\left|\frac{\Delta C_T}{\Delta V_R}\right| = \left|\frac{1.25\text{ pF} - 0.75\text{ pF}}{10\text{ V}\ \ - 25\text{ V}}\right| = \frac{0.5\text{ pF}}{15\text{ V}} = \mathbf{0.033\ pF/V}$$

(b) $V_R = -10\text{ V}$: $C_T \cong \mathbf{1.25\ pF}$
$V_R = -1\text{ V}$: $C_T \cong \mathbf{3\ pF}$

$$\left|\frac{\Delta C_T}{\Delta V_R}\right| = \left|\frac{1.25\text{ pF} - 3\text{ pF}}{10\text{ V}\ \ - 1\text{ V}}\right| = \frac{1.75\text{ pF}}{9\text{ V}} = \mathbf{0.194\ pF/V}$$

(c) 0.194 pF/V: 0.033 pF/V = 5.88:1 $\cong$ **6:1**
Increased sensitivity near $V_D = 0$ V

7.

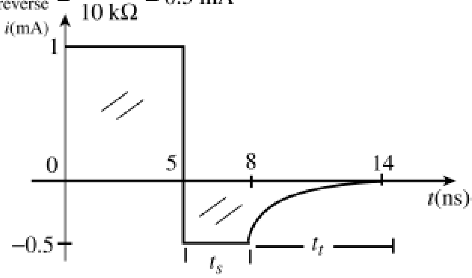
$$C_T = \frac{C(0)}{\left(1 + |V_R / V_K|\right)^n} = \frac{8\text{ pF}}{\left(1 + |5\text{ V}/0.7\text{ V}|\right)^{1/2}}$$
$$= \frac{8\text{pF}}{(1+7.14)^{1/2}} = \frac{8\text{ pF}}{\sqrt{8.14}} = \frac{8\text{ pF}}{2.85}$$
$$= \mathbf{2.81\,pF}$$

8.

$I_f = \dfrac{10\text{ V}}{10\text{ k}\Omega} = 1\text{ mA}$

$t_s + t_t = t_{rr} = 9$ ns
$t_s + 2t_s = 9$ ns
$t_s = \mathbf{3\ ns}$
$t_t = 2t_s = \mathbf{6\ ns}$

$I_{\text{reverse}} = \dfrac{5\text{ V}}{10\text{ k}\Omega} = 0.5\text{ mA}$



9.

$T = 25°\text{C}$: $P_{max} = 500$ mW
$T = 100°\text{C}$: $P_{max} = 260$ mW
$P_{max} = V_F I_F$

$$I_F = \frac{P_{max}}{V_F} = \frac{500 \text{ mW}}{0.7 \text{ V}} = \mathbf{714.29 \text{ mA}}$$

$$I_F = \frac{P_{max}}{V_F} = \frac{260 \text{ mW}}{0.7 \text{ V}} = \mathbf{371.43 \text{ mA}}$$

714.29 mA: 371.43 mA = 1.92:1 ≅ **2:1**

10.