3.43) The \( V_D \) of each diode 'OR' gate is lower than the \( V_{DD} \) by 0.6V. Starting with an \( V_{DD} \) of 5V, the \( V_D \) of the 1st gate is 4.4V, the \( V_D \) of the second gate is 3.8V & the \( V_D \) of 3rd gate is 3.2V. Therefore, we can cascade only 2 'OR' gates if we require the \( V_D \) in the high state to be at least 3.5V.

3.45)
\[
I_0 = \frac{-(V_{SS} + V_D)}{R} = \frac{14 - 6}{100} = -0.08 \text{mA}
\]
(Notice that \( I_0 \) & \( V_D \) are -ve in this circuit).

\[
P_D = V_D I_D = (-6)(-0.08) = 0.48 \text{W}
\]

3.51)
\[
i_D = I_s \left[ \exp \left( \frac{V_D}{nV_T} \right) - 1 \right]
\]
Under forward bias, the exponential is \( \gg 1 \)

\[
i_D = I_s \left[ \exp \left( \frac{V_D}{nV_T} \right) \right]
\]
or \[ I_s = I_0 \exp \left( \frac{-V_0}{nV_T} \right) \]

(a) For \( n = 1 \); \( I_s = 10^{-3} \exp \left( \frac{-0.6}{0.026} \right) = 95.0 \times 10^{-15} \text{A} \)

(b) For \( n = 2 \); \( I_s = 10^{-3} \exp \left( \frac{-0.6}{2 \times 0.026} \right) = 7.75 \times 10^{-9} \text{A} \)

3.54) \[ I_0 = I_s \left[ \exp \left( \frac{V_0}{nV_T} \right) - 1 \right] = I_s \exp \left( \frac{V_0}{nV_T} \right) \]

For the 1st diode, we have

\[ I_{s1} = I_0, \exp \left( \frac{-V_0}{nV_T} \right) = 10^{-3} \exp \left( \frac{-0.6}{0.026} \right) = 95.0 \times 10^{-15} \text{A} \]

For second diode, we have \( I_{s2} = 10I_{s1} = 950 \times 10^{-15} \text{A} \)

Solving for the diode voltage & substituting values, we have

\[ V_{D2} = nV_T \ln \left( \frac{I_{02}}{I_{s1}} \right) = 0.026 \ln \left[ \frac{10^{-3}}{950 \times 10^{-15}} \right] \]

\[ = 0.540 \text{V} \]

3.56) (a) \( r_d = \frac{nV_T}{I_{ca}} = \frac{26 \text{mV}}{2 \text{mA}} = 13.2 \)

(b) With 2 diodes in parallel, the dynamic resistance of each of them is \( (26 \text{mV})/1 \text{mA} = 26 \Omega \).
as only half the current (1mA) flows in each of them. However the parallel combination of two 26Ω resistors is 13Ω.

Thus placing diodes in parallel does not reduce the dynamic resistance. Dynamic resistance is independent of diode area if the current remains constant.

3.58) (a) \( R_d = \frac{nV_i}{I_{co}} = 26Ω \)

(b) \( \Delta V_d = \Delta I \cdot R_d = (0.1mA) \times (26Ω) = 2.6mV \)

(c) \( I_0 = I_s \left( \exp \left( \frac{V_d}{nV_i} \right) - 1 \right) \)

\[ V_d = nV_i \ln \left( \frac{I_d}{I_s} - 1 \right) \]

For \( I_o = 1mA \), we find \( V_d = 0.65854V \) & for \( I_o = 1.1mA \), \( V_d = 0.66102V \)

\( \Delta V_d = 2.48mV \) which is 4.8% lower than the result using the dynamic resistance.
With the switch open, we have
\[ i_{D1} = \ln A = I_s \left[ \exp \left( \frac{V_{01}}{nV_T} \right) - 1 \right] = i_D = I_s \left[ \exp \left( \frac{V_{01}}{nV_T} \right) - 1 \right] \]
Solving, we find \( I_s = 9.5 \times 10^{14} \text{A} \).

With the switch closed, the current splits equally between the 2 diodes, & we have
\[ i_{D1} = 0.5 mA = i_D = I_s \left[ \exp \left( \frac{V_{01}}{nV_T} \right) - 1 \right] \]
Solving for \( V_{01} \), we have
\[ V_{01} = nV_T \ln \left( \frac{i_{D1}}{I_s} + 1 \right) = 582 \text{mV} \]
Repeating with \( n = 2 \), we find \( I_s = 9.75 \times 10^9 \text{A} \)
& \( V_{01} = 564 \text{mV} \).