NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

Electronic Devices & Circuits (EE-215)

Assignment # 2

Diodes

Submitted to:	Dr. Shakeel Alvi
Submitted by:	Muhammad Umer
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• Assignment 2

EE - 215

Muhammad Umer — 345834

D4.15

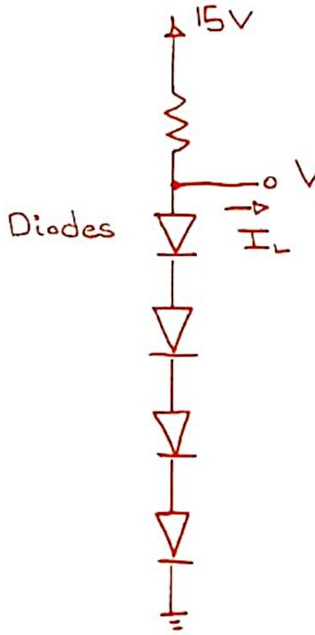
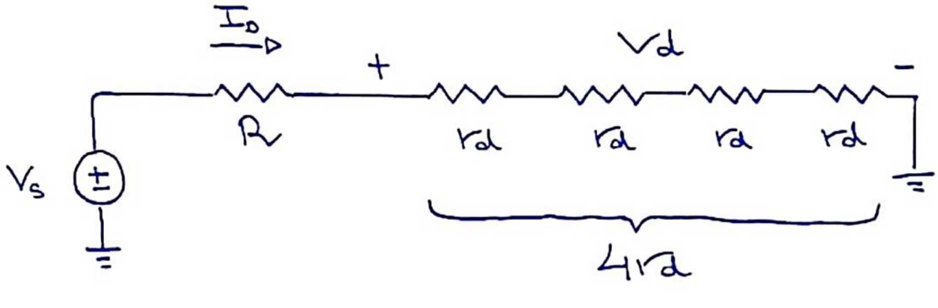


Figure E4.15

a)

Small Signal Model



Given that $\Delta V_d = 20\,mV$ for $\Delta i_d = 1\,mA$;

And without any load, i.e. $I_L = 0$, $V_{out} = V_d$

$\therefore$ Using $r_d = \dfrac{\partial V_d}{\partial i_d}$

$$\Rightarrow 4\, r_d = \frac{20\, mV}{1\, mA} = 20\, \Omega$$

$$\Rightarrow \boxed{r_d} = \frac{20}{4}\, \Omega = 5\, \Omega$$

- The diode current I_D can then be calculated as:

- $r_d = \frac{V_T}{I_D} \Rightarrow I_D = \frac{V_T}{r_d}$

$$\Rightarrow \boxed{I_D} = \frac{25\, mV}{5\, \Omega} = 5\, mA$$

- The current through R is the same as I_D.

$$\Rightarrow \frac{15 - V_{out}}{R} = I_D \Rightarrow \frac{15 - 3}{R} = 5\, mA$$

$$\Rightarrow \boxed{R} = 2400\, \Omega = 2.4\, k\Omega$$ | Part (a)

b)

Saturation Current

- We know that;

$I_D = I_S\, e^{V_D / V_T}$ $\therefore$ (where V_D is the voltage across a single diode)

$$\underset{(single)}{V_D} = \frac{V_d}{4} = \frac{3}{4}$$

$$\Rightarrow \quad I_S = I_D \, e^{-V_D/V_T}$$

$$I_S = (5\,mA)\, e^{-(3/4)/25\,mV}$$

$$\boxed{I_S} = \underline{4.678 \times 10^{-16}\ A} \quad \Big|\ \text{Part (b)}$$

c)

Change in Voltage

For exponential models:

$$V_2 - V_1 = 2.3\ V_T \log_{10}(I_2/I_1)$$

or $\Delta V_D = 2.3\ V_T \log_{10}(I_2/I_1)$ — (*)

- If the load draws $I_L = 1\ mA$ from the regulator, we observe a decrease of $1\ mA$ from I_D without load.

- $I_2 = I_D - 1\,mA = 5\,mA - 1\,mA = 4\,mA$

Substituting $I_2 = 4\,mA$ and $I_1 = I_D = 5\,mA$ in (*)

$$\Rightarrow \quad \Delta V_D = 2.3\,(25\,mV) \log_{10}\left(\frac{4\,mA}{5\,mA}\right)$$

$$\Delta V_D = -5.572 \times 10^{-3}\ V$$

- Which is the change in voltage across a single diode

• As we have 4 diodes in series, the total change in output voltage is ;

$$\Delta V_o = 4 \Delta V_D = -22.28 \times 10^{-3} \text{ V}$$

$$\boxed{\Delta V_o} = -22.28 \text{ mV}$$ | Part (c)

20/03/2022 END