

Pro-One



GATE



Graduate Aptitude Test in Engineering

Electronics and Communication Engineering

Analog Circuits

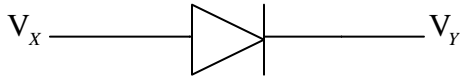


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ANALOG CIRCUITS-THEORY

Characteristics of devices:

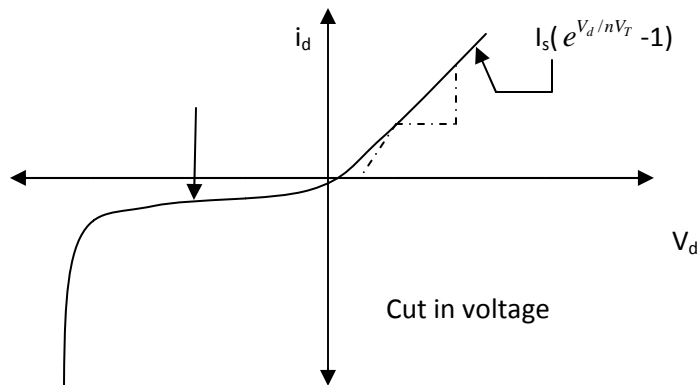
1) Diode:



When V_{xy} ($V_x - V_y$) is more than cut in voltage diode is forward biased. If $V_{xy} <$ (cut-in voltage) diode is reverse biased.

Diode current (i_d) = $I_s (e^{V_d/nV_T} - 1)$

Where, $I_s \Rightarrow$ reverse saturation current.

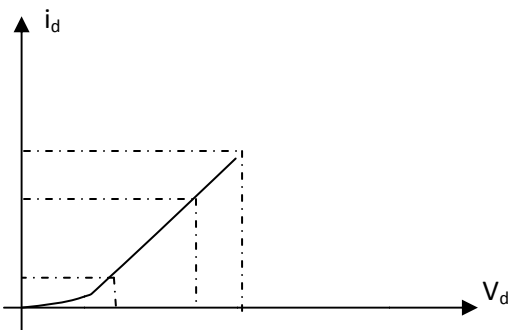


Where $x/y =$ output resistance

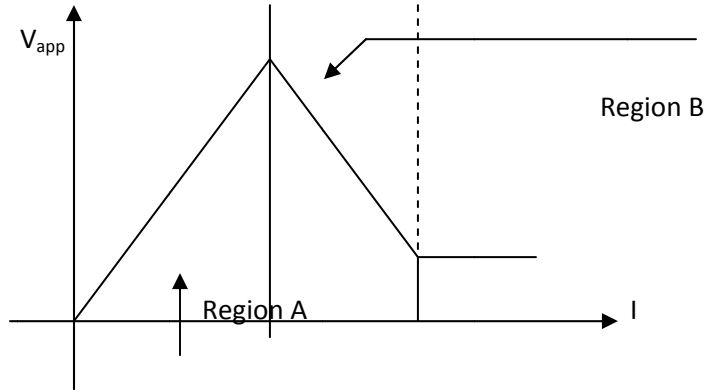
Output resistance = $R_0 = \frac{dV_d}{di_d}$

But $i_d \approx I_s (e^{\frac{V_d}{\eta V_T}} - 1) \approx I_s e^{\frac{V_d}{\eta V_T}}$

$R_0 = \frac{\eta V_T}{i_d}$



- If current through device is increases with applied increase in voltage resistance of device is +ve otherwise (current across device increases with decrease in applied voltage) resistance is -ve. e.g. consider a device characteristics as below.



In region A resistance is positive, but in region B , resistance is -ve.

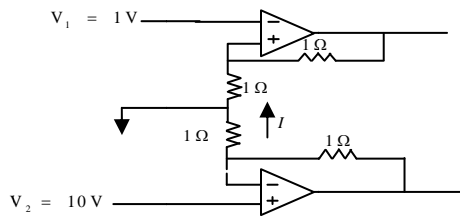
$$Resistance = \frac{\Delta V \text{ (change in voltage across diode)}}{\Delta I \text{ change in current across diode}}$$

When change in current in device is relatively constant for large change in applied voltage, resistance of device is high in that region of operation.

QUESTIONS

1. Circuit shown below, what is value of I?

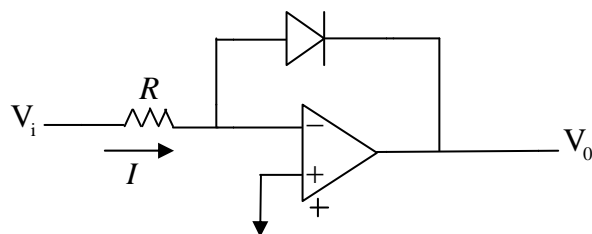
Gate Keyword → 15



- (a) 1A (b) 10A (c) 9A (d) 4.5A

2. Consider a circuit shown below what is output V_0 ?

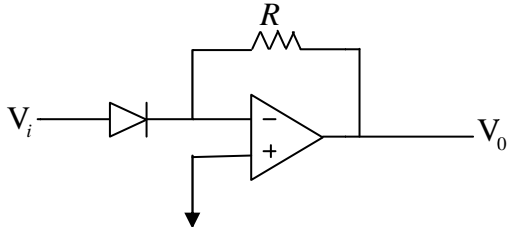
Gate Keyword → 5 & 15



- (a) $V_0 = -nV_T \left(\frac{I}{I_s} \right)$ (b) $V_0 = -\ln \left(\frac{I_s}{I} \right)$ (c) $V_0 = nV_T \ln \left(\frac{-I_s}{I} \right)$ (d) $V_0 = nV_T \ln (IR)$

3. What will be output V_0 of fig. shown?

Gate Keyword → 5 & 15



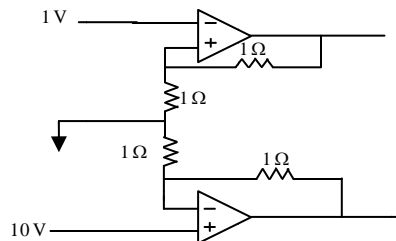
- (a) $|V_0| = I_s R e^{-V_i/nV_T}$ (b) $1/I_s R e^{V_i/nV_T} = |V_0|$ (c) $|V_0| = \frac{I_s}{R} \frac{V_i}{nV_T}$ (d) $|V_0| = V_s$

SOLUTIONS

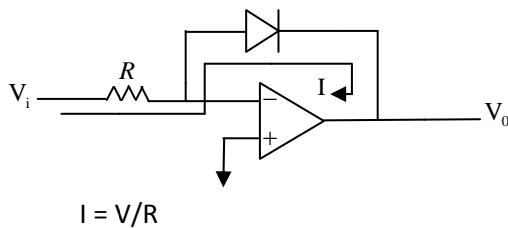
1. Solution: (d)

As both terminals of op-amp are at same potential equivalent circuit will look like as below

$$I = (10-1)/ 2\Omega = 9/2 = 4.5\Omega$$



2. Solution: (a)



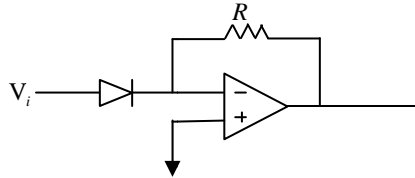
Current through diode, But $V_0 = -V_d$

$$I = I_s e^{V_d/nV_T}, \quad I = I_s e^{-V_0/nV_T}$$

$$I/I_s = e^{-V_0/nV_T}$$

Take log on both side $V_0 = -nV_T \ln(I/I_s)$

3. Solution: (a)



Current through diode $I = I_s e^{V_d/nV_T}$

But in above fig. $V_d = V_i$

$$|V_o| = IR, \quad I = I_s e^{V_i/nV_T}$$

$$|V_o| = I_s R e^{V_i/nV_T}$$
