MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2024

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ELECTRICAL ENGINEERING

Objective Practice Sets

Analog Electronics

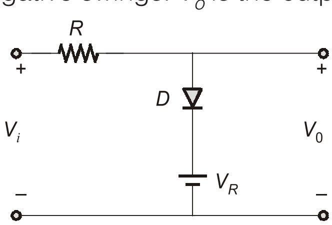
1 CHAPTER Basics of Semiconductor Diodes

MCQ and NAT Questions

Q.1 A diode whose terminal characteristics are related as $i_D = I_s e^{V/V_T}$, where I_s is the reverse saturation current and V_T is thermal voltage (V_T = 25 mV), is biased at I_D = 4 mA. Its dynamic resistance is

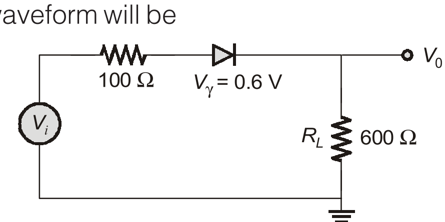
(a) 12.5 Ω (b) 50 Ω
(c) 6.25 Ω (d) 25 Ω

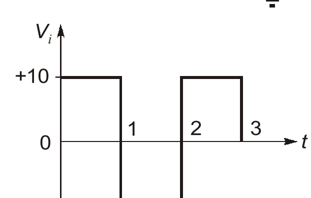
Q.2 In the circuit shown below the input V_i has positive and negative swings. V_o is the output.



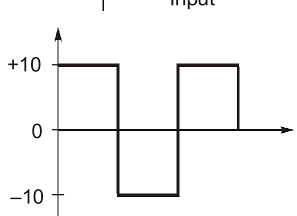
(a) V_o = 0 for negative V_i
(b) $V_o = V_R$ for positive V_i
(c) $V_o = V_R$ for $V_i > V_R$
(d) $V_o = V_R$ for all V_i

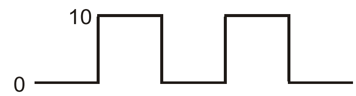
Q.3 In the circuit shown below, if the input voltage V_i is as shown below then the corresponding output waveform will be





Input

(a)


(b)


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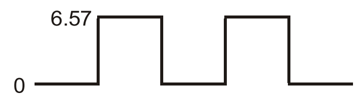
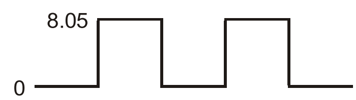
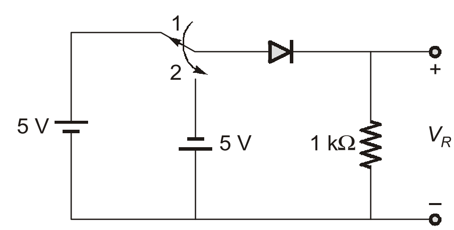


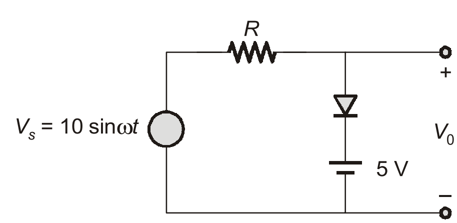
(d)


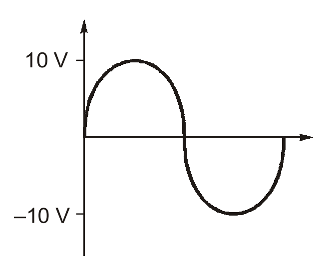
Q.4 In the circuit shown below, the switch was connected to position 1 at $t < 0$ and at $t = 0$, it is changed to position 2. Assume that the diode has zero voltage drop and a storage time t_s. For $0 < t \le t_s$, V_R is given by (all in Volts)

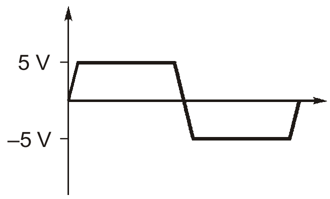


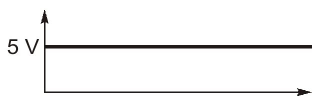
(a) $V_R = -5$ (b) $V_R = 0$
(c) $0 \le V_R < 5$ (d) $-5 < V_R < 0$

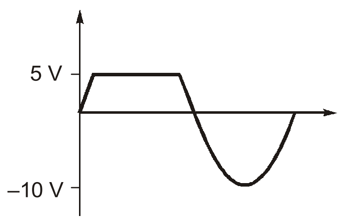
Q.5 For the circuit shown below assuming ideal diode, the output waveform V_0 is



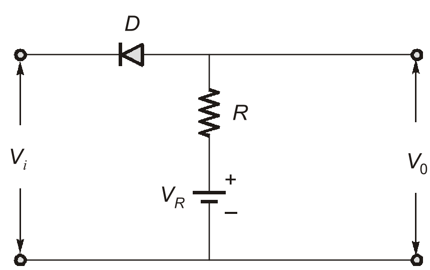
(a)


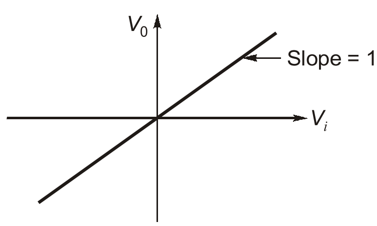
(b)


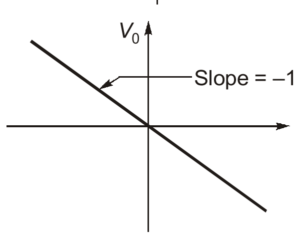
(c)


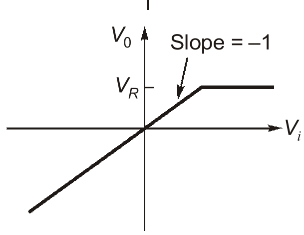
(d)


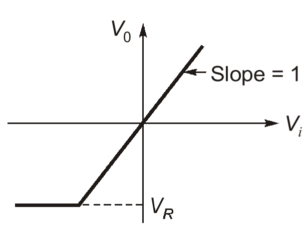
Q.6 The transfer characteristic of the network shown below is represented as



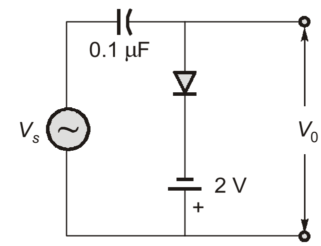
(a)


(b)


(c)


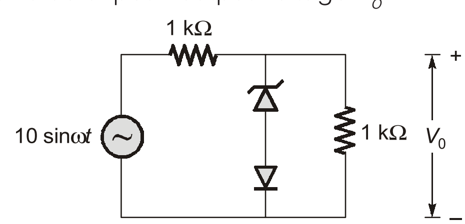
(d)


Q.7 For an input of $V_s = 5 \sin\omega t$, (assuming ideal diode), circuit shown below will behave as a



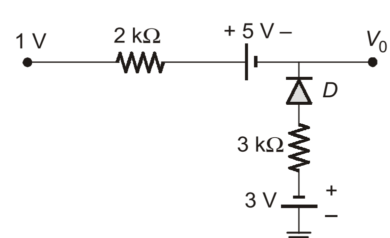
(a) clipper, sine wave clipped at –2 V
(b) clamper, sine wave clamped at –2 V
(c) clamper, sine wave clamped at zero volt
(d) clipper, sine wave clipped at 2 V

Q.8 The cut-in voltage of both zener diode D_z and D shown in figure is 0.65 V, while breakdown voltage of the zener is 3 V. Diode is considered to be ideal. The value of peak output voltage V_o.



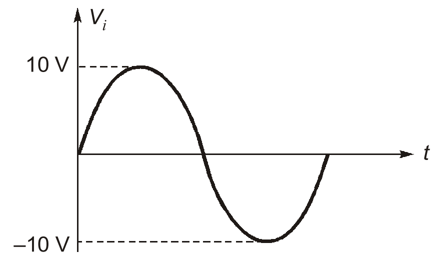
(a) 3 V in the positive half cycle and 0.65 V in the negative half cycle.
(b) 3.65 V in the positive half cycle and –5 V in the negative half cycle.
(c) 3 V in positive half cycle and –5 V in the negative half cycle
(d) –3.65 V in positive half cycle and 5 V in the negative half cycle

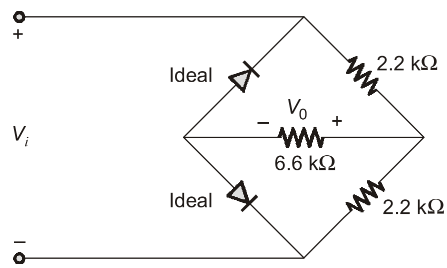
Q.9 What is the output voltage V_0 for the circuit shown below assuming an ideal diode?

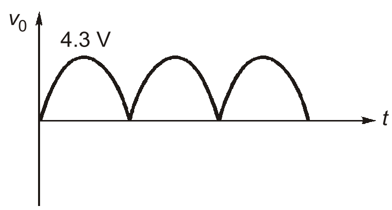


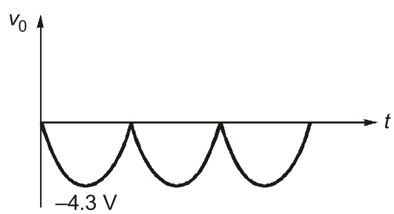
(a) $-\frac{18}{5}$ V (b) $\frac{18}{5}$ V
(c) $-\frac{13}{5}$ V (d) $\frac{13}{5}$ V

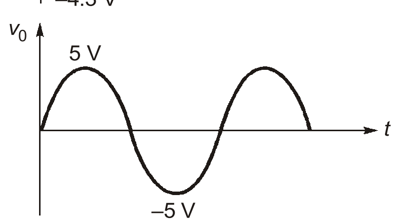
Q.10 The correct waveform for output (V_0) for below network is

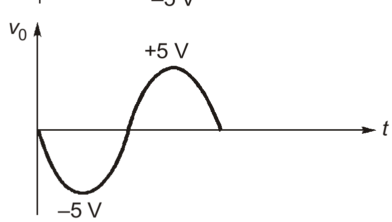




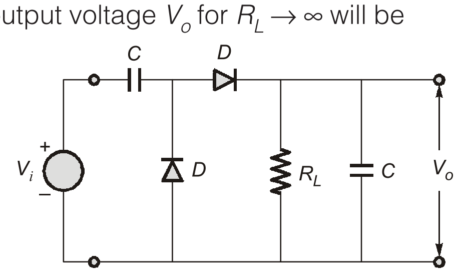
(a)


(b)


(c)


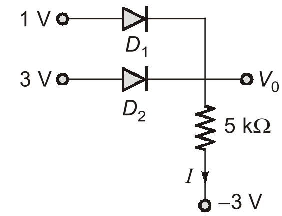
(d)


Q.11 Consider the below circuit, for $V_i = V_m \sin \omega t$, the output voltage V_o for $R_L \to \infty$ will be



(a) Zero (b) V_m
(c) $2\,V_m$ (d) $-V_m$

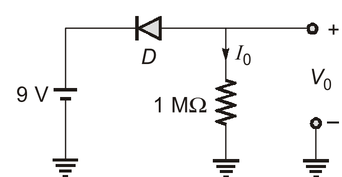
Q.12 Consider the circuit shown in the figure below:



If diode D_1 and D_2 are made up of same material with the cut-in voltage $V_\gamma = 0.7$ V, then the value of current I is equal to

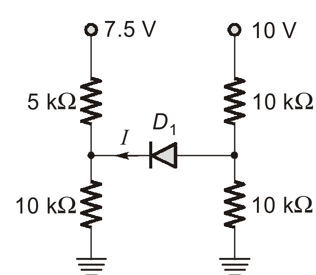
(a) 0.46 mA (b) 0.99 mA
(c) 0.59 mA (d) 1.06 mA

Q.13 Consider the diode circuit shown in the figure below:



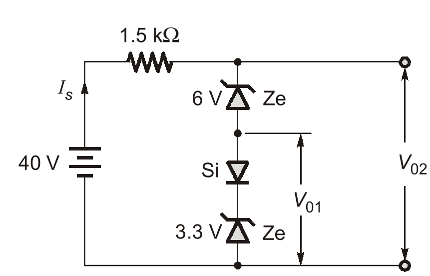
The diode in the circuit is a large high-current silicon device whose reverse leakage current is reasonably independent of voltage appearing on the diode. If $V_0 = 1$ V at 20° C, then the value of output voltage at 40°C is equal to ______ V.

Q.14 Consider the circuit shown in the figure below



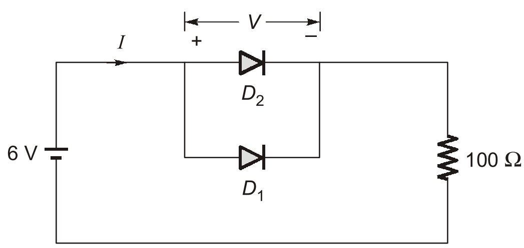
If the cut-in voltage of the diode D_1 is equal to 0.7 V, then the value of current flowing through the diode is equal to ________ mA.

Q.15 A 40 V dc supply is connected across the network comprising of Zener and Silicon diodes as shown. The regulated voltages V_{01}, V_{02} and source current I_s are



(a) 2.4 V, 5.1 V and 21.7 mA
(b) 3 V, 6 V and 22.7 mA
(c) 3.3 V, 9.3 V and 20.5 mA
(d) 4 V, 10 V and 20 mA

Q.16 In the given circuit, D_1 is an ideal germanium diode and D_2 is a silicon diode having its cut-in voltage as 0.7 V, forward resistance as 20 Ω and reverse saturation current (I_S) as 10 nA. What are the values of I and V for this circuit, respectively?



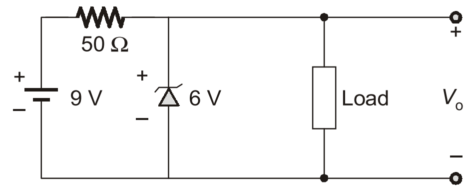
(a) 60 mA and 0 V (b) 50 mA and 0 V
(c) 53 mA and 0.7 V (d) 44 mA and 1.58 V

Q.17 Consider the following statements :
A clamper circuit
1. adds/subtracts a dc voltage to/from a waveform.
2. does not change the shape of the waveform.
3. amplifies the waveform.

Of these statements
(a) 1 and 2 are correct
(b) 1 and 3 are correct
(c) 2 and 3 are correct
(d) 1, 2 and 3 are correct

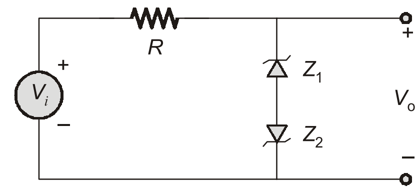
Q.18 In order to rectify sinusoidal signals of millivolt range (< 0.6 V)
(a) bridge rectifier using diodes can be employed
(b) full-wave diode rectifier can be used
(c) a diode is to be inserted in the feedback loop of an OP-AMP
(d) a diode is to be inserted in the input of an OP-AMP

Q.19 A zener diode in the circuit shown below has a knee current of 5 mA, and a maximum allowed power dissipation of 300 mW. What are the minimum and maximum load currents that can be drawn safely from the circuit, keeping the output voltage V_o constant at 6 V?



(a) 0 mA, 180 mA (b) 5 mA, 110 mA
(c) 10 mA, 55 mA (d) 60 mA, 180 mA

Q.20 In the circuit shown below the zener voltage $V_{Z1} = V_{Z2} = 5$ volts, $V_\gamma = 0.6$, V_o is the output



(a) For $|V_i| \le 5.6$ volts, $V_o = V_i$
(b) For $|V_i| \le 10$ volts, $V_o = V_i$
(c) For $|V_i| \ge 5.6$ volts, $V_o = V_i$
(d) $V_i \le 5.6$ volts for all V_i

Q.21 Following are the three statements regarding zener diode regulator. Which of them is incorrect?
1. It is a simple circuit, light weight, more reliable and provides regulation over a wide range of current
2. As there is power dissipation in series resistor and the diode, it results in poor efficiency
3. The stabilized output is independent of zener breakdown voltage and can be varied

(a) only 1 (b) only 2
(c) only 3 (d) all are incorrect

Q.22 If the input ac is 10 V rms, the maximum voltage that will appear across the diode of a half-wave rectifier with a capacitor input filter will be
(a) 10 V (b) 14 V
(c) 20 V (d) 28 V

Q.23 A single-phase diode-bridge rectifier is connected to a load-resistor of 50 Ω. The source voltage is $V = 200 \sin\omega t$ where $\omega = 2\pi \times 50$ radians/second. The power dissipated in the load resistor is

(a) $\frac{400}{\pi}$ W (b) $\frac{3200}{\pi^2}$ W
(c) 400 W (d) $\frac{800}{\pi}$ W

Q.24 The ripple factor of a power supply is given by (symbols have the usual meaning)

(a) $\frac{P_{dc}}{P_{ac}}$ (b) $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$

(c) $\sqrt{\left(\frac{I_{dc}}{I_{rms}}\right)^2 - 1}$ (d) $\frac{I_{dc}}{I_{rms}}$

Q.25 A voltage of 200 cos100t is applied to a HWR with a load resistance of 5 kΩ. The rectifier is represented by an ideal diode in series with a resistance of 1 kΩ. The maximum value of current, d.c component of current and rms value of current will be respectively

(a) 33.33 mA, 14.61 mA, 16.67 mA
(b) 33.33 mA, 10.61 mA, 16.67 mA
(c) 28.33 mA, 14.61 mA, 13.33 mA
(d) 40 mA, 20 mA, 25 mA

Q.26 An ideal low-pass filter has a cut-off frequency of 100 Hz. If the input to the filter in volts is $v(t) = 30\sqrt{2}\sin 1256t$, the magnitude of the output of the filter will be

(a) 0 V (b) 20 V
(c) 100 V (d) 200 V

Q.27 The ratio of available power from the DC component of a full-wave rectified sinusoid to the available power of the rectified sinusoid is

(a) 8/π (b) 2
(c) 4/π (d) $8/\pi^2$

Q.28 For a full-wave rectifier with shunt capacitor filter, the peak to peak ripple voltage is

(a) $\frac{2I_{DC}}{fC}$ (b) $\frac{I_{DC}}{fC}$

(c) $\frac{I_{DC}}{2fC}$ (d) $\frac{I_{DC}}{4fC}$

(where f = fundamental power line frequency, I_{DC} = DC current)

Q.29 Consider the following rectifier circuits:

1. Half-wave rectifier without filter.
2. Full-wave rectifier without filter.
3. Full-wave rectifier with series inductance filter.
4. Full-wave rectifier with capacitance filter.

The sequence of these rectifier circuits in decreasing order of their ripple factor is

(a) 1, 2, 3, 4 (b) 3, 4, 1, 2
(c) 1, 4, 3, 2 (d) 3, 2, 1, 4

Q.30 **Assertion (A) :** A rectifier with inductor filter is more efficient for high load current.

Reason (R) : In rectifier with inductor filter we can use a larger choke to reduce ripple, larger choke will have higher dc resistance which will result in lower dc output voltage for higher load current.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.31 When a junction diode is used as a half-wave rectifier with purely resistive load and sinusoidal input voltage, what is the value of diode conduction angle (where ϕ_i is the ignition angle corresponding to the cut-in voltage)?

(a) π
(b) $\pi - \phi_i$
(c) $\pi - 2\phi_i$
(d) Slightly greater than π

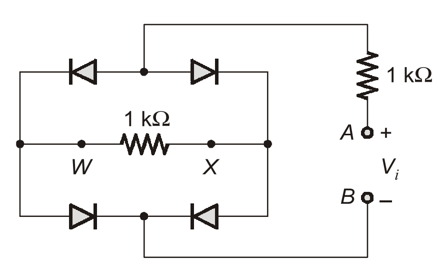
Q.32 For full wave rectification, a four diode bridge rectifier is claimed to have the following advantages over a two diode circuit:

(1) less expensive transformer
(2) smaller size transformer, and
(3) suitability for higher voltage application.

Of these,

(a) only 1 and 2 are true
(b) only 1 and 3 are true
(c) only 2 and 3 are true
(d) 1, 2 and 3 are true

Q.33 A signal of 25sinωt is applied across AB assuming ideal diodes, the output measured across WX is



(a) sinωt (b) 50 V
(c) $|\sin\omega t|$ (d) 0 V

Answers Basics of Semiconductor Diodes

1. (c)	2. (c)	3. (d)	4. (a)	5. (d)	6. (c)	7. (b)	8. (b)
9. (a)	10. (a)	11. (c)	12. (d)	13. (4)	14. (0)	15. (d)	16. (a)
17. (a)	18. (c)	19. (c)	20. (a)	21. (c)	22. (d)	23. (c)	24. (b)
25. (b)	26. (a)	27. (d)	28. (c)	29. (a)	30. (c)	31. (c)	32. (d)
33. (d)	34. (b)	35. (c)	36. (b)	37. (d)	38. (c)	39. (a)	40. (b)
41. (a)	42. (c)	43. (d)	44. (c)	45. (b)	46. (d)	47. (b)	48. (d)
49. (b)	50. (a)	51. (d)	52. (b)	53. (d)	54. (b)	55. (c)	56. (d)
57. (b)	58. (a)	59. (a)	60. (b)	61. (d)	62. (b)	63. (b)	64. (c)
65. (c)	66. (c)	67. (500)	68. (1.048)	69. (b)	70. (d)	71. (b)	72. (b)
73. (c)	74. (d)	75. (b)	76. (a)	77. (c)	78. (b)	79. (b)	80. (d)
81. (d)	82. (a)	83. (d)	84. (b)	85. (b)	86. (c)	87. (d)	88. (c)
89. (c)	90. (b)	91. (a)	92. (b)	93. (d)	94. (c)	95. (d)	96. (b)
97. (c)	98. (d)	99. (d)	100. (c)	101. (b)	102. (c)	103. (a)	104. (b)
105. (c)	106. (a)	107. (b)	108. (a)	109. (a)	110. (c)	111. (0.12)	112. (40)
113. (0.5147)	114. (10)	115. (b)	116. (c,d)	117. (a,b,c,d)	118. (a,b,c,d)	119. (c,d)	120. (a,d)

Explanations Basics of Semiconductor Diodes

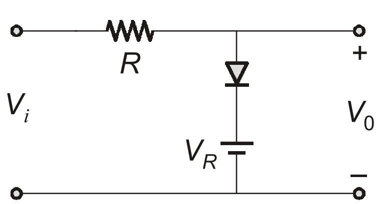
1. (c)

$$\frac{1}{r_d} = \frac{\partial I_D}{\partial V} = \frac{I_D}{V_T}$$

r_d : dynamic resistance.

$$\therefore \qquad r_d = \frac{V_T}{I_D} = \frac{25}{4} = 6.25\ \Omega$$

2. (c)



Considering ideal diode :

for $V_i < V_R$, diode is OFF hence there is no current through R and $V_0 = V_i$.

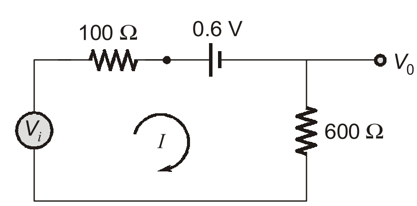
For $V_i > V_R$, diode is ON hence

$$V_0 = V_R$$

(as diode will act as short circuit)

3. (d)

For $0 \le t \le 1$, diode is ON



$$I = \frac{V_i - 0.6}{100 + 600} = \frac{10 - 0.6}{700}$$

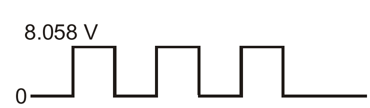
$$= 0.01343 \text{ A}$$

$$\therefore \qquad V_0 = 600 \times 0.01343 = 8.058 \text{ V}$$

For $1 < t < 2$, diode is OFF, there will be no current in the circuit and hence

$$V_0 = 0 \text{ V}$$

Hence output waveform can be given as shown below:



4. (a)

For $0 < t < t_s$ diode will remain ON and hence

$$V_R + 5 = 0$$

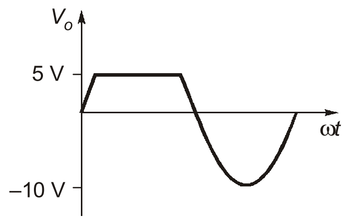
$$\therefore \qquad V_R = -5 \text{ V}$$

5. (d)

For $0 \le V_i < V_R$ = diode is OFF $\Rightarrow V_0 = V_i$

For $V_R \le V_i \Rightarrow$ diode is ON $\Rightarrow V_0 = 5$ V

Hence output waveform can be as shown below

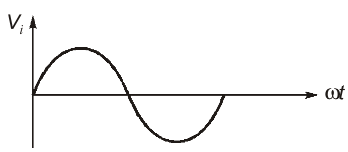


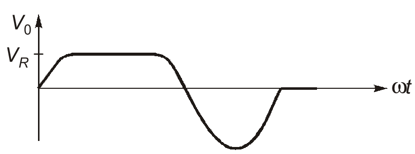
6. (c)

For $V_i < V_R$ = Diode is OFF $\Rightarrow V_0 = V_i$

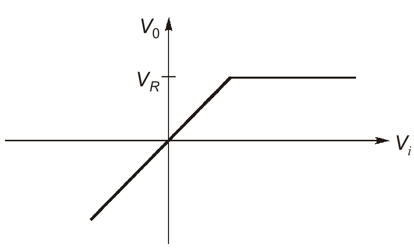
For $V_i > V_R$ = Diode is ON $\Rightarrow V_0 \simeq V_R$

Hence for a sinusoidal input, output can be shown as below

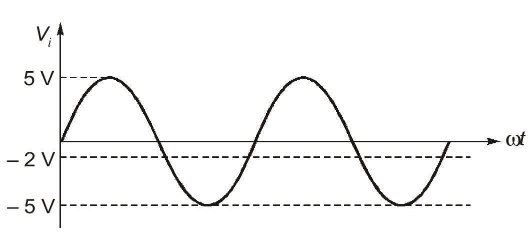




Hence characteristic can be as shown below



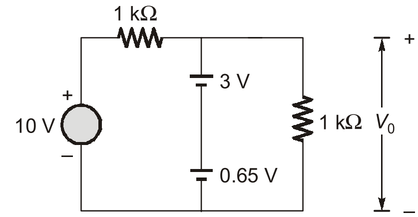
7. (b)



Hence given circuit acts as a clamper, sine wave clamped at – 2 V.

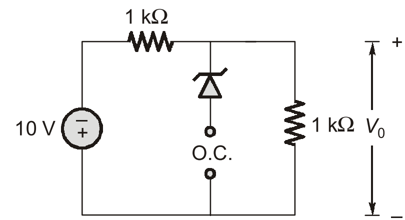
8. (b)

For positive half cycle:



So, $V_o = 3.65$ V

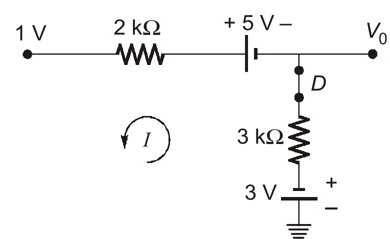
In negative half cycle:



So, $V_o = -5$ V

9. (a)

∵ Diode is forward bias (short circuit)



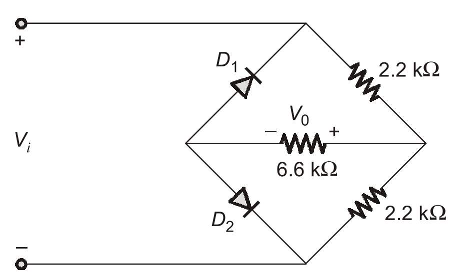
By applying KVL,

$3\text{ V} + 3\text{ k}\Omega I - 5\text{ V} + 2\text{ k}\Omega\, I + 1\text{ V} = 0$

$$I = \frac{1\text{V}}{5\text{k}\Omega} = \frac{1}{5}\text{ mA}$$

$$\therefore \quad V_o = -3 - 3 \times \frac{1}{5} = -\frac{18}{5}\text{ V}$$

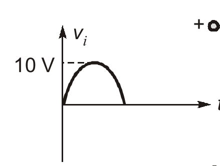
10. (a)

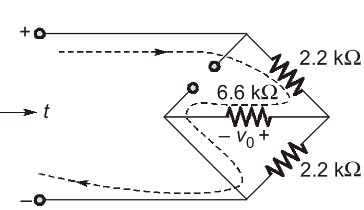


For positive half cycle of input voltage,

$D_1 \rightarrow$ OFF

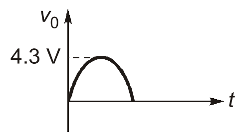
$D_2 \rightarrow$ ON



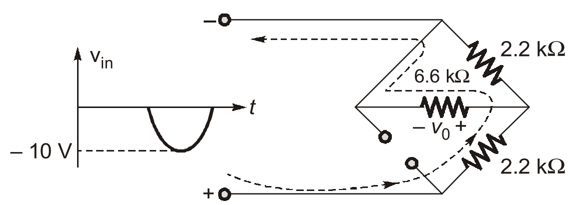


$$V_{0max} = \frac{[6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]}{2.2\text{ k}\Omega + [6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]} V_{i\,max}$$

$$= \frac{0.75}{1+0.75} \times 10\text{ V} = 4.3\text{ V}$$

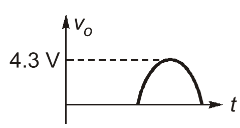


For negative half cycle of input voltage

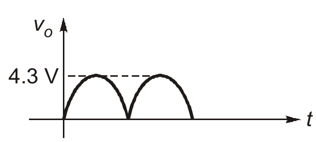


$$V_{0max} = \frac{[6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]}{2.2\text{ k}\Omega + [6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]} V_{i\,max}$$

$$= \frac{0.75}{1+0.75} \times 10\text{ V} = 4.3\text{ V}$$



Still the polarity of output voltage is in the same direction. So, net output of the circuit will be a full rectified wave.



11. (c)

The given circuit is a voltage doubler. Hence,

$$V_o = 2\,V_m$$

12. (d)

When D_2 is ON then the value of V_0 will be

$$V_0 = 3 - 0.7\text{ V} = 2.3\text{ V}$$

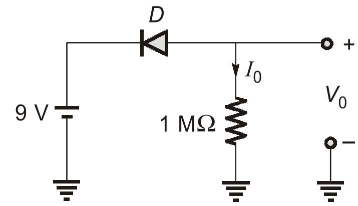
Hence, D_1 will be OFF.

Thus,The current,

$$I = \frac{2.3-(-3)}{5} \times 10^{-3}$$

$$= \frac{5.3}{5} \times 10^{-3} = 1.06\text{ mA}$$

13. (4)



Calculating the value of reverse saturation current (I_{01}) flowing through the diode at 20°C

We get,

$$I_{01} = \frac{V_0}{1\text{M}\Omega} = 1\,\mu\text{A} \quad (\text{for } V_0 = 1\text{ V})$$

The reverse saturation current doubles for every 10° rise in temperature. Hence, the rise in temperature.

$$\Delta T = (40° - 20°)\text{C} = 20°\text{ C}$$

Thus, $\quad I_{02} = I_{01} 2^{(\Delta T/10)}$

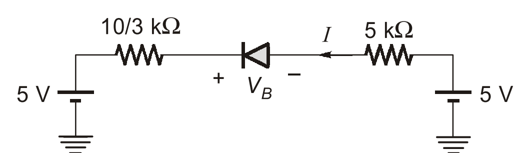
(where I_{02} is reverse saturation current at 40°C)

$$= (1\ \mu\text{A}) \times 2^{(20/10)} = 4\ \mu\text{A}$$

Hence, $\quad V_0 = I_{02} \times 1 \times 10^6 = 4\text{ V}$

14. (0)

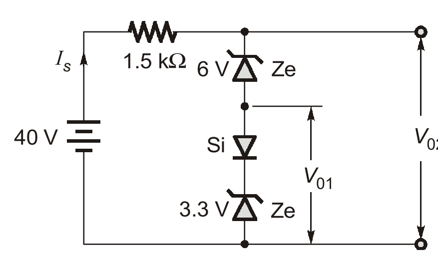
Drawing the Thevenin equivalent circuit, we get



Applying KVL we get $V_D = 0$ V, thus no current will flow through the diode D_1 .

Hence, $\quad I = 0$ A

15. (d)



Cut in voltage of Si diode

$$= 0.7\text{ V}$$

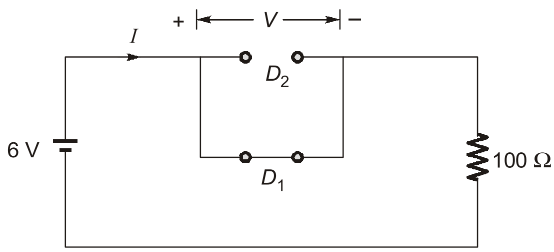
So $\quad V_{01} = 0.7\text{ V} + 3.3\text{ V} = 4.0\text{ V}$

$$V_{02} = 6\text{ V} + 4\text{ V} = 10\text{ V}$$

$$\therefore \quad I_s = \frac{40\text{ V} - 10\text{ V}}{1.5\text{ k}\Omega} = 20\text{ mA}$$

16. (a)

In the given circuit, only the ideal germanium diode (D_1) will be in ON state and D_2 will be in OFF state. So, the equivalent circuit can be drawn as given below:



From the above equivalent circuit,

$$V = 0 \text{ V}$$

and $$I = \frac{6}{100} \text{ A} = 60 \text{ mA}$$

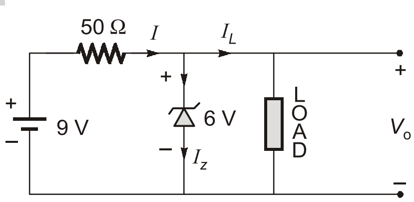
17. (a)

1. A clamper clamps a signal to a different dc level.
2. The total swing of the output signal is equal to the total swing of input signal.
3. The shape of signal does not change; only dc level shifts.
4. The use of capacitor is essential in clamper circuit.

18. (c)

In order to rectify sinusoidal signals of millivolt range we use a precision rectifier. In precision rectifier a diode is to be inserted in the feedback loop of an OP-AMP.

19. (c)



$$I = \frac{9-6}{50} = \frac{3}{50} = 60 \text{mA}$$

Now when load current is maximum then

$$I_z = I_{knee}$$

$$\therefore \quad I_{knee} + I_{L_{max}} = I$$

$$\Rightarrow \quad 5 \text{ mA} + I_{L_{max}} = 60 \text{ mA}$$

$$\Rightarrow \quad I_{L_{max}} = 55 \text{ mA}$$

Now maximum power dissipation in zener diode is

$$P_{Z_{max}} = V_Z I_{Z_{max}}$$

$$\therefore \quad I_{Z_{max}} = \frac{300 \text{mW}}{6} = 50 \text{mA}$$

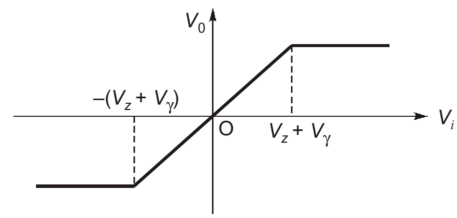
When I_z is maximum, then I_L will be minimum

$$\therefore \quad I_{Z_{max}} + I_{L_{min}} = 60 \text{ mA}$$

$$\therefore \; I_{L_{min}} = 60 \text{ mA} - I_{Z_{max}} = 60 - 50 = 10 \text{ mA}$$

20. (a)

The transfer characteristic of the given circuit is shown below:



Hence $$V_0 = V_i \text{ for } |V_i| \le V_z + V_\gamma$$

$$= 5 + 0.6 = 5.6 \text{ V}$$

21. (c)

The stabilized output is dependent on zener breakdown voltage and can not be varied.

22. (d)

The presence of the capacitor causes the peak inverse voltage to increase from a value equal to the transformer maximum when no capacitor filter is used to a value equal to twice the transformer maximum value when the filter is used.

Hence, Maximum voltage across the diode

$$= 2 \times 10 \times \sqrt{2} = 28.28 \simeq 28 \text{ V}$$

23. (c)

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{200}{\sqrt{2}} \text{V}$$

Hence power dissipated in the load resistor is

$$P = \frac{V_{rms}^2}{R_L} = \frac{(200/\sqrt{2})^2}{50} = \frac{200 \times 200}{2 \times 50} = 400 \text{ W}$$

24. (b)

$$\text{Ripple factor} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

25. (b)