CHAPTER

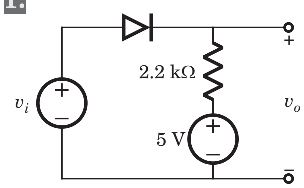
3.1

DIODE CIRCUITS

Statement for Q.1–4:

In the question a circuit and a waveform for the input voltage is given. The diode in circuit has cutin voltage $V_\gamma = 0$. Choose the option for the waveform of output voltage v_o .

1.



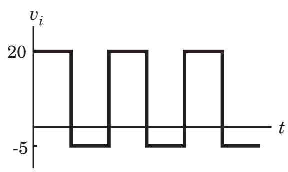
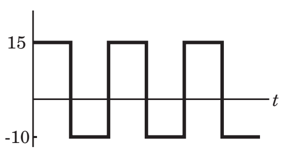
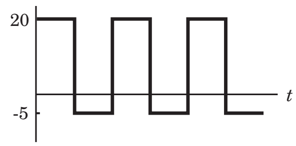


Fig.3.1.1



(A)



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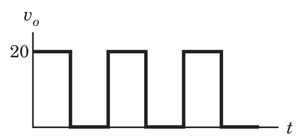
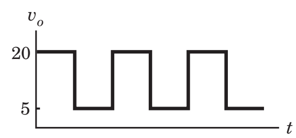
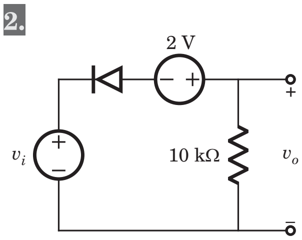


(A)



(D)

2.



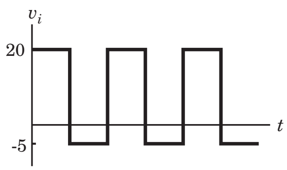
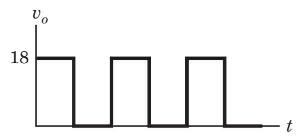
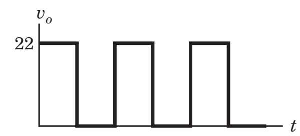


Fig.3.1.2



(A)



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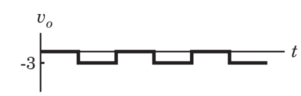
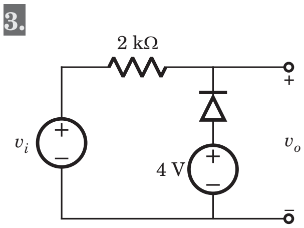


(C)

(D)

3.



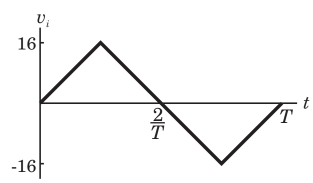
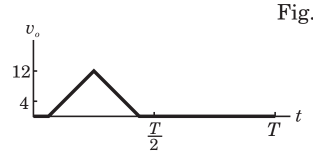
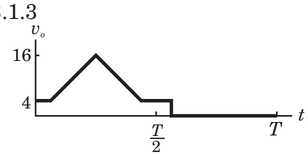


Fig. P3.1.3



(A)



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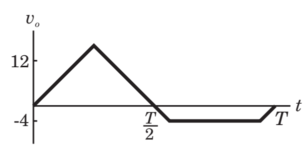

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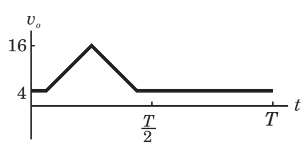

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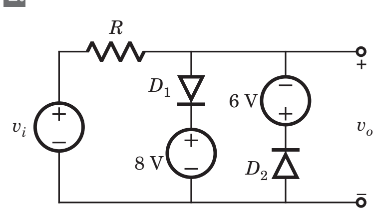


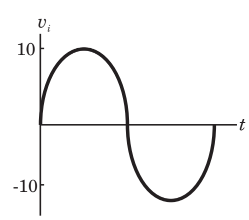
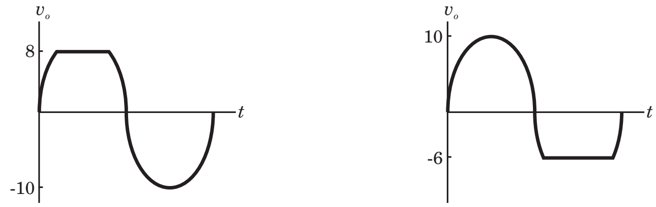
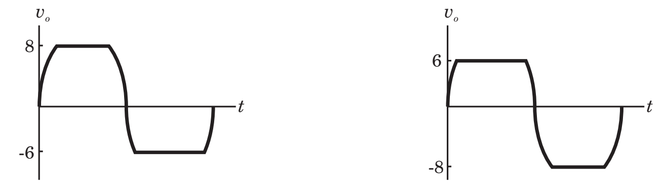


Fig.3.1.4



(A) (B)



(C) (D)

5. For the circuit in fig. P.3.1.5, let cutin voltage $V_\gamma = 0.7$ V. The plot of v_o verses v_i for $-10 \le v_i \le 10$ V is

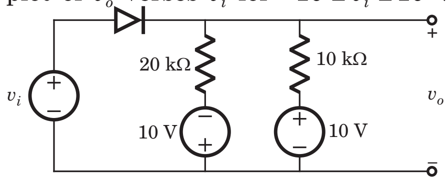
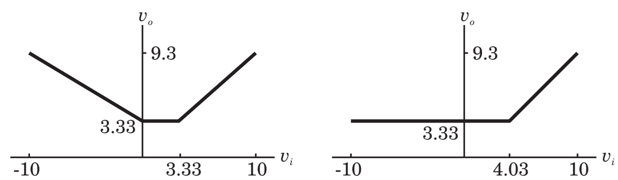
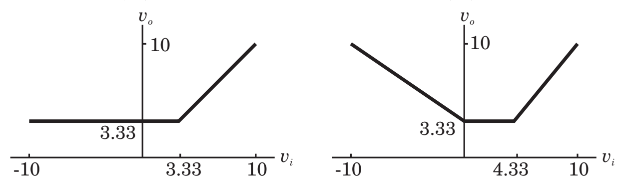


Fig. P3.1.5



(A) (B)



(C) (D)

6. For the circuit in fig. P3.1.6 the cutin voltage of diode is $V_\gamma = 0.7$ V. The plot of v_o versus v_i is

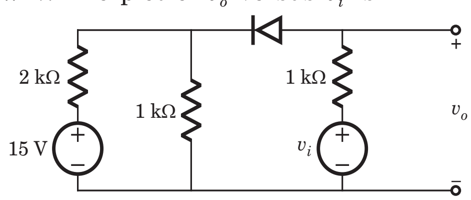
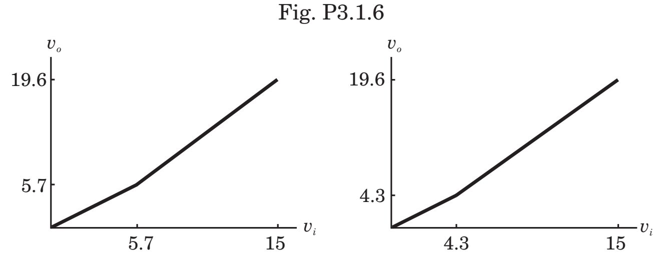
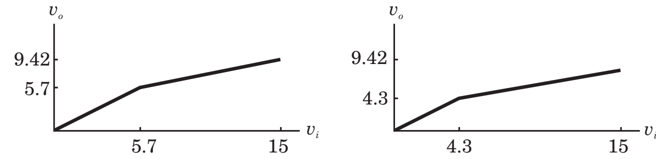


Fig. P3.1.6



(A) (B)



(C) (D)

7. For the circuit shown in fig. P3.1.7, each diode has $V_\gamma = 0.7$ V. The v_o for $-10 \le v_s$ +10 V is

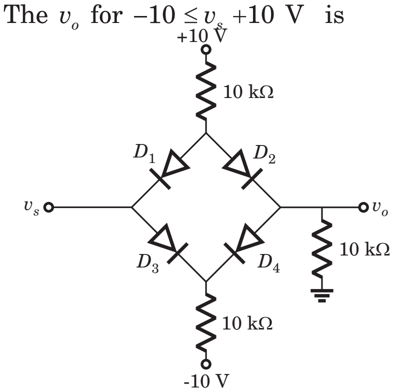
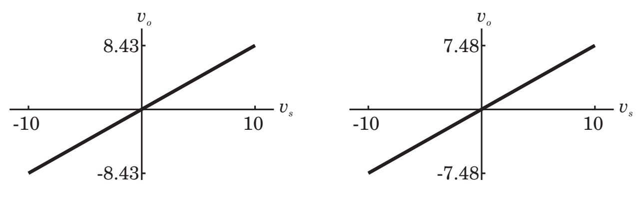
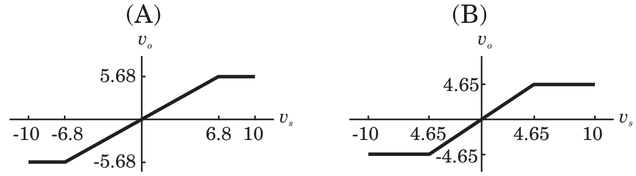


Fig. P3.1.7.



(A) (B)



(C) (D)

8. A symmetrical 5 kHz square wave whose output varies between +10 V and –10 V is impressed upon the clipping circuit shown in fig. P3.1.8. If diode has $r_f = 0$ and $r_r = 2$ MΩ and $V_\gamma = 0$, the output waveform is

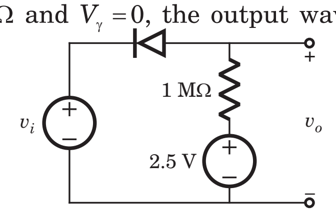
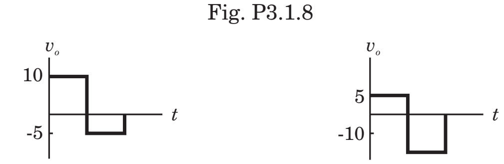


Fig. P3.1.8



(A) (B)

(C) (D)

9. In the circuit of fig. P3.1.9, the three signals of fig are impressed on the input terminals. If diode are ideal then the voltage v_o is

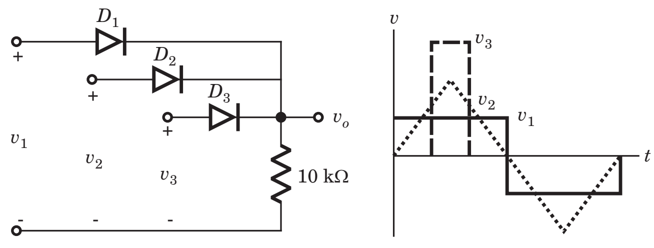
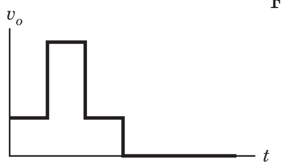
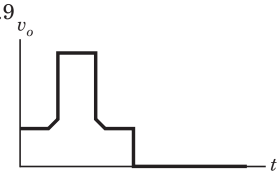


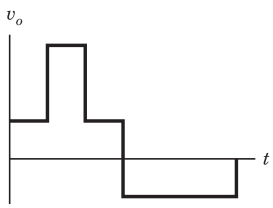
Fig. P.3.1.9



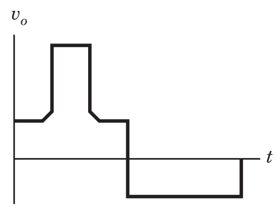
(A)



(B)



(C)



(D)

10. For the circuit shown in fig. P3.1.10 the input voltage v_i is as shown in fig. Assume the RC time constant large and cutin voltage of diode $V_\gamma = 0$. The output voltage v_o is

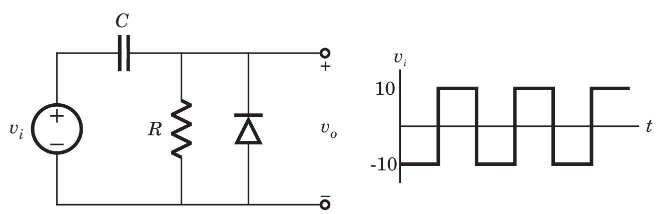
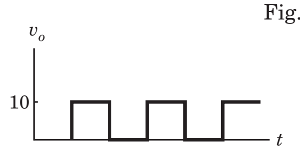
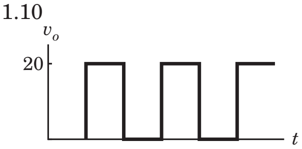


Fig. P.3.1.10



(A)



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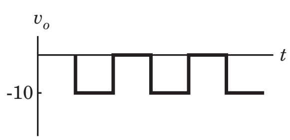
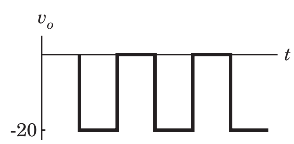


(C)



(D)

11. For the circuit shown in fig. P.3.1.11, the input voltage v_i is as shown in fig. Assume the RC time constant large and cutin voltage $V_\gamma = 0$. The output voltage v_o is

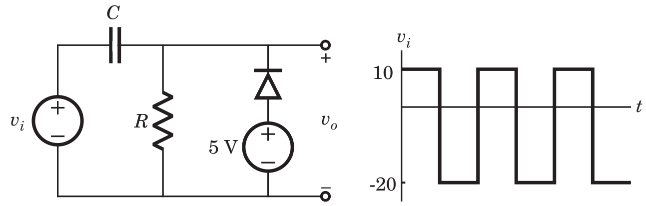
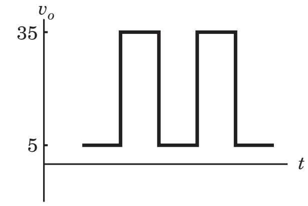
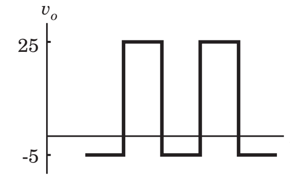


Fig. P.3.1.11



(A)



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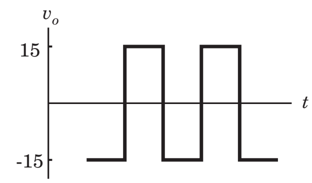

(C)

(D) None of the above

(D)

12. In the circuit of fig. P3.1.12, D_1 and D_2 are ideal diodes. The current i_1 and i_2 are

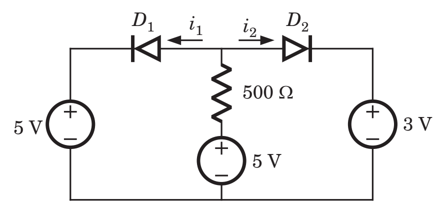

Fig. P3.1.12

(A) 0, 4 mA (B) 4 mA, 0

(C) 0, 8 mA (D) 8 mA, 0

13. In the circuit of Fig. P3.1.13 diodes has cutin voltage of 0.6 V. The diode in ON state are

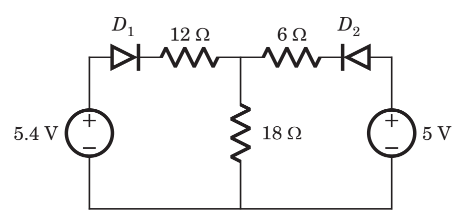

Fig. P3.1.13

(A) only D_1 (B) only D_2

(C) both D_1 and D_2 (D) None of the above

22. The diodes in the circuit in fig. P3.1.22 has parameters $V_\gamma = 0.6$ V and $r_f = 0$. The current i_{D2} is

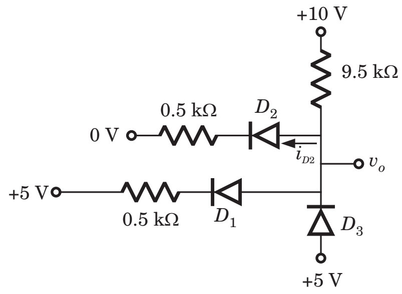

Fig. P3.1.22

(A) 8.4 mA
(B) 10 mA
(C) 7.6 mA
(D) 0 mA

Statement for Q.23–25:

The diodes in the circuit in fig. P3.1.23-25 have linear parameter of $V_\gamma = 0.6$ V and $r_f = 0$.

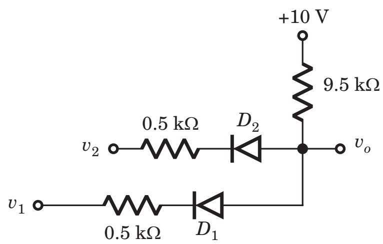

Fig. P3.1.23–25

23. If $v_1 = 10$ V and $v_2 = 0$ V, then v_o is
(A) 8.93 V
(B) 7.82 V
(C) 1.07 V
(D) 2.18 V

24. If $v_1 = 10$ V and $v_2 = 5$ V, then v_o is
(A) 9.13 V
(B) 0.842 V
(C) 5.82 V
(D) 1.07 V

25. If $v_1 = v_2 = 0$, then output voltage v_o is
(A) 0.964 V
(B) 1.07 V
(C) 10 V
(D) 0.842 V

Statement for Q.26–28:

The diodes in the circuit of fig. P3.1.26–28 have linear parameters of $V_\gamma = 0.6$ V and $r_f = 0$.

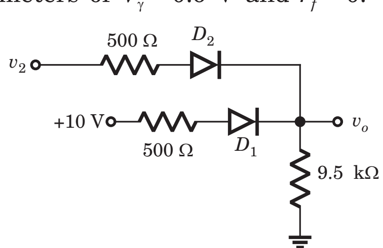

Fig. P3.1.26–28

26. If $v_2 = 0$, then output voltage v_o is
(A) 6.43 V
(B) 9.43 V
(C) 7.69 V
(D) 8.93 V

27. If $v_2 = 5$ V, then v_o is
(A) 8.93 V
(B) 12.63 V
(C) 18.24 V
(D) 10.56 V

28. If $v_2 = 10$ V, then v_o is
(A) 10 V
(B) 9.16 V
(C) 8.43 V
(D) 12.13 V

Statement for Q.29–30:

The diode in the circuit of fig. P3.1.29–30 has the non linear terminal characteristic as shown in fig. Let the voltage be $v_s = \cos \omega t$ V.

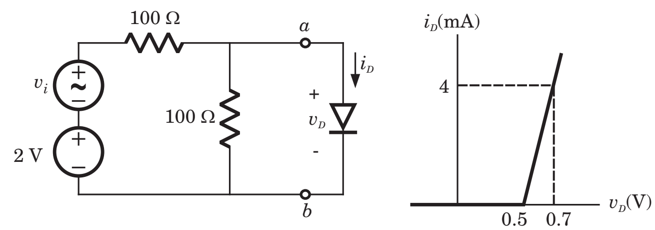

Fig. P3.1.29–30

29. The current i_D is
(A) $2.5(1 + \cos \omega t)$ mA
(B) $5(0.5 + \cos \omega t)$ mA
(C) $5(1 + \cos \omega t)$ mA
(D) $5(1 + 0.5 \cos \omega t)$ mA

30. The voltage v_D is
(A) $0.25(3 + \cos \omega t)$ V
(B) $0.25(1 + 3\cos \omega t)$ V
(C) $0.5(3 + 1\cos \omega t)$ V
(D) $0.5(2 + 3\cos \omega t)$ V

31. The circuit inside the box in fig. P3.1.31. contains only resistor and diodes. The terminal voltage v_o is connected to some point in the circuit inside the box. The largest and smallest possible value of v_o most nearly to is respectively

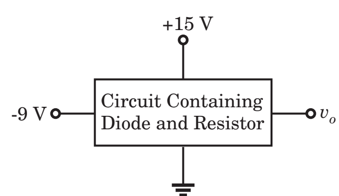

Fig. 3.1.31

(A) 15 V, 6 V
(B) 24 V, 0 V
(C) 24 V, 6 V
(D) 15 V, –9 V

32. In the voltage regulator circuit in fig. P3.1.32 the maximum load current i_L that can be drawn is

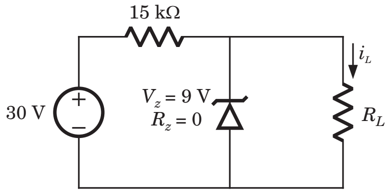

Fig. 3.1.32

(A) 1.4 mA (B) 2.3 mA

(C) 1.8 mA (D) 2.5 mA

33. In the voltage regulator shown in fig. P3.1.33 the power dissipation in the Zener diode is

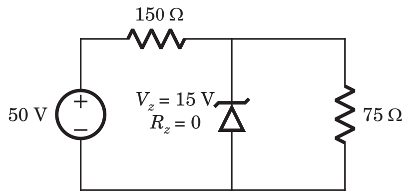

Fig. P3.1.33

(A) 1 W (B) 1.5 W

(C) 2 W (D) 0.5 W

34. The Q-point for the Zener diode in fig. P3.1.34 is

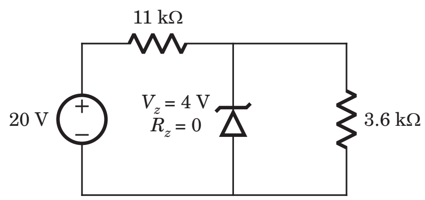

Fig. P3.1.34

(A) (0.34 mA, 4 V) (B) (0.34 mA, 4.93 V)

(C) (0.94 mA, 4 V) (D) (0.94 mA, 4.93 V)

35. In the voltage regulator circuit in fig. P3.1.35 the power rating of Zener diode is 400 mW. The value of R_L that will establish maximum power in Zener diode is

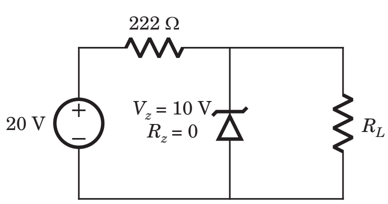

Fig. P3.1.35

(A) 5 kΩ (B) 2 kΩ

(C) 10 kΩ (D) 8 kΩ

Statement for Q.36–38:

In the voltage regulator circuit in fig. P3.1.36–38 the Zener diode current is to be limited to the range $5 \le i_z \le 100$ mA.

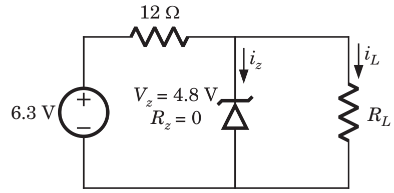

Fig. P3.1.36–38

36. The range of possible load current is

(A) $5 \le i_L \le 130$ mA (B) $25 \le i_L \le 120$ mA

(C) $10 \le i_L \le 110$ mA (D) None of the above

37. The range of possible load resistance is

(A) $60 \le R_L \le 372\ \Omega$ (B) $60 \le R_L \le 200\ \Omega$

(C) $40 \le R_L \le 192\ \Omega$ (D) $40 \le R_L \le 360\ \Omega$

38. The power rating required for the load resistor is

(A) 576 mW (B) 360 μW

(C) 480 mW (D) 75 μW

39. The secondary transformer voltage of the rectifier circuit shown in fig. P3.1.39 is $v_s = 60 \sin 2\pi 60t$ V. Each diode has a cut in voltage of $V_\gamma = 0.6$ V. The ripple voltage is to be no more than $V_{rip} = 2$ V. The value of filter capacitor will be

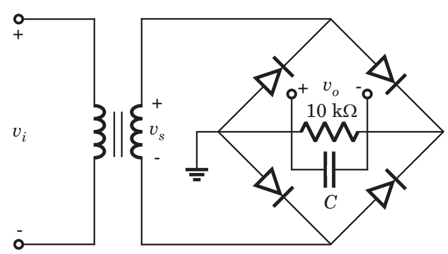

Fig. P3.1.39

(A) 48.8 μF (B) 24.4 μF

(C) 32.2 μF (D) 16.1 μF

40. The input to full-wave rectifier in fig. P3.1.40 is $v_i = 120 \sin 2\pi 60t$ V. The diode cutin voltage is 0.7 V. If the output voltage cannot drop below 100 V, the required value of the capacitor is

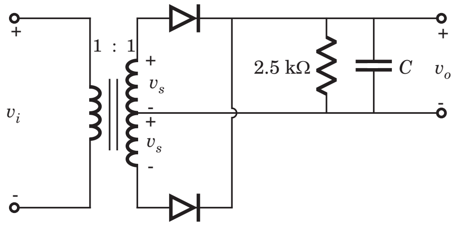

Fig. P3.1.40

(A) 61.2 μF
(B) 41.2 μF
(C) 20.6 μF
(D) 30.6 μF

41. For the circuit shown in fig. P3.1.41 diode cutin voltage is $V_{in} = 0$. The ripple voltage is to be no more than $v_{rip} = 4$ V. The minimum load resistance, that can be connected to the output is

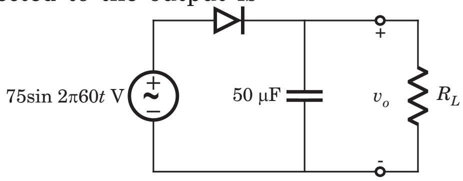

Fig. P3.1.41

(A) 6.25 kΩ
(B) 12.50 kΩ
(C) 30 kΩ
(D) None of the above

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SOLUTIONS

1. (D) Diode is off for $v_i < 5$ V. Hence $v_o = 5$ V.

For $v_i > 5$ V, $v_o = v_i$, Therefore (D) is correct option.

2. (C) Diode will be off if $v_i + 2 > 0$.Thus $v_o = 0$

For $v_i + 2 < 0$ V, $v_i < -2$, $v_o = v_i + 2 = -3$ V

Thus (C) is correct option.

3. (D) For $v_i < 4$ V the diode is ON and output $v_o = 4$ V.

For $v_i > 4$ V diode is off and output $v_o = v_i$.

Thus (D) is correct option.

4. (C) During positive cycle when $v_s < 8$ V, both diode are OFF $v_o = v_s$. For $v_s > 8$ V , $v_o = 8$ V, D_1 is ON. During negative cycle when $|v_s| < 6$ V, both diode are OFF, $v_o = v_s$. For $|v_s| > 6$ V, D_2 is on $v_o = -6$ V. Therefore (C) is correct.

5. (B) For D off , $v_o = \dfrac{\frac{10}{20} - \frac{10}{20}}{\frac{1}{20} + \frac{1}{10}} = 3.33$ V.

For $v_i \le 3.33 + 0.7 = 4.03$ V, $v_o = 3.33$ V

For $v_i > 4.03$ V , $v_o = v_i - 0.7$

For $v_i = 10$ V, $v_o = 9.3$ V

6. (C) Let v_1 be the voltage at n-terminal of diode,

$$v_1 = \frac{15 \times 1}{2 + 1} = 5 \text{ V}$$

For $v_i \le 5.7$ V, $v_o = v_i$

$$\frac{v_1 - 15}{2\text{k}} + \frac{v_1}{1\text{k}} + \frac{v_o - v_i}{1\text{k}} = 0 \quad \Rightarrow \quad 3v_1 + 2v_o - 2v_i = 15$$

$v_o = v_1 + 0.7$

$5v_o - 2v_1 = 15 + 2.1 = 17.9 \quad \Rightarrow \quad v_o = 0.4\, v_i + 3.42$

7. (D) For $v_s > 0$, when D_1 is OFF, Current through D_2 is

$$i = \frac{10 - 0.7}{10 + 10} = 0.465 \text{ mA}, \quad v_o = 10\text{k}i = 4.65 \text{ V}$$

$v_o = v_s$ for $0 < v_s < 4.65$ V.

For negative values of v_s , the output is negative of positive part. Thus (D) is correct option.

8. (B) The diode conducts (zero resistance) when $v_i < 2.5$ V and $v_o = v_i$. Diode is open (2 MΩ resistance) when $v_i > 2.5$ V and $v_o = 2.5 + \dfrac{v_i - 2.5}{3} = 5$ V.

$= 50 \times 5\,(1 + \cos \omega t) \times 10^{-3} + 0.5$

$= 0.75 + 0.25 \cos \omega t = 0.25(3 + \cos \omega t)$ V

31. (D) The output voltage cannot exceed the positive power supply voltage and cannot be lower than the negative power supply voltage.

32. (A) At regulated power supply $i_s = \frac{30-9}{15k} = 1.4$ mA i_L will remain less than 1.4 mA.

33. (D) $v_{TH} = \frac{75(50)}{75+150} = \frac{50}{3}$ V

$\frac{50}{3} > V_Z$, $R_{TH} = 150 \,||\, 75 = 50\,\Omega$

$i_Z = \frac{1}{50}\left(\frac{50}{3} - 15\right) = 33$ mA, $P = 15 i_Z = 0.5$ W

34. (A) $v_{TH} = \frac{3.6(20)}{11+3.6} = 4.93 \text{ V} > V_Z$,

$R_{TH} = 11 \,||\, 3.6 = 2.71$ kΩ, $i_Z = \frac{4.93-4}{2.71k} = 0.34$ mA

35. (B) $i_{Z(max)} = \frac{400m}{10} = 40$ mA

$i_L + i_Z = \frac{20-10}{222} = 45$ mA

$i_{L(min)} = 45 - 40 = 5$ mA, $R_L = \frac{10}{5m} = 2$ kΩ

36. (B) Current through 12 Ω resistor is

$i = \frac{6.3-4.8}{12} = 125$ mA

$i_L = i - i_Z = 125 - i_Z \quad \Rightarrow \quad 25 \le i_L \le 120$ mA

37. (C) $25 \le i_L \le 120$ mA, $i_L R_L = 4.8$ V

$25 \le \frac{4.8}{R_L} \le 120 \text{ mA} \quad \Rightarrow \quad 40 \le R_L \le 192\ \Omega$

38. (A) $P_L = i_L V_Z = (120\text{m})(4.8) = 576$ mV

39. (B) $v_s = 60 \sin 2\pi 60 t$ V

$v_{max} = 60 - 1.4 = 58.6$ V

$C = \frac{v_{max}}{2fRV_{rip}} = \frac{58.6}{2(60)10 \times 10^3 \times 2} = 24.4\ \mu$F

40. (C) Full wave rectifier

$v_s = v_i = 120 \sin 2\pi 60 t$ V

$v_{max} = 120 - 0.7 = 119.3$ V

$V_{rip} = 119.3 - 100 = 19.3$ V

$C = \frac{v_{max}}{2fkV_{rip}} = \frac{119.3}{2(60)2.5 \times 10^3 \times 14.4} = 20.6\ \mu$F

41. (A) $V_{rip} = \frac{v_{max}}{fR_L C}$

$R_L = \frac{v_{max}}{fCV_{rip}} = \frac{75}{60 \times 50 \times 10^{-5} \times 4} = 6.25$ kΩ

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