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ESE 2021

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Topicwise **Objective** Solved Questions

Volume-I

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Director's Message

Engineering is one of the most chosen graduating field. Taking engineering is usually a matter of interest but this eventually develops into "purpose of being an engineer" when you choose engineering services as a carrier option.

B. Singh (Ex. IES)

Train goes in tunnel we don't panic but sit still and trust the engineer, even we don't doubt on signalling system, we don't think twice crossing over a bridge reducing our travel time; every engineer has a purpose in his department which when coupled with his unique talent provides service to mankind.

I believe *"the educator must realize in the potential power of his pupil and he must employ all his art, in seeking to bring his pupil to experience this power"*. To support dreams of every engineer and to make efficient use of capabilities of aspirant, MADE EASY team has put sincere efforts in compiling all the previous years' ESE-Pre questions with accurate and detailed explanation. The objective of this book is to facilitate every aspirant in ESE preparation and so, questions are segregated chapterwise and topicwise to enable the student to do topicwise preparation and strengthen the concept as and when they are read.

I would like to acknowledge efforts of entire MADE EASY team who worked hard to solve previous years' papers with accuracy and I hope this book will stand up to the expectations of aspirants and my desire to serve student fraternity by providing best study material and quality guidance will get accomplished.

B. Singh (Ex. IES)
CMD, MADE EASY Group

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E&T Engineering

Volume-I

Objective Solved Questions

of UPSC Engineering Services Examination

■■■■

UNIT

III

Analog Circuits

Syllabus

Small signal equivalent circuits of diodes, BJTS and FETs; Diode circuits for different uses; Biasing & stability of BJT & JFET amplifier circuits; Analysis/design of amplifier- single/multi-stage; Feedback& uses; Active filters, timers, multipliers, wave shaping, oscillators and other circuits; Basics of linear ICs, operational amplifiers and their applications-linear/non-linear.

Contents

1 Diodes Circuits

1.1 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) $8/\pi$ (b) 2
(c) $4/\pi$ (d) $8/\pi^2$ **[ESE-1999]**

1.2 Consider the following statements in relation to a large value of capacitor filter used in a full-wave rectifier:
It gives the
1. low conduction period for the diode rectifier.
2. increased peak current rating of the diode.
3. large peak inverse voltage rating of the diode.
Which of these statements are correct?
(a) 1, 2 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1 and 3
[ESE-2000]

1.3 Consider the following statements:
The function of bleeder resistance in filter circuit is to
1. maintain minimum current necessary for optimum inductor filter operation.
2. work as voltage divider in order to provide variable output from the supply.
3. provide discharge to capacitors so that output becomes zero when the circuit has been de-energised.
Which of these statements are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3
[ESE-2001]

1.4 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
[ESE-2001]

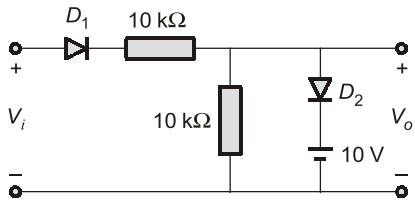
1.5 The use of a rectifier filter in a capacitor circuit gives satisfactory performance only when the load
(a) current is high (b) current is low
(c) voltage is high (d) voltage is low
[ESE-2001]

1.6 The PIV rating of the diodes used in power supply circuits are chosen by which one of the following criteria? (V_m is the peak input supply voltage to the rectifier circuit used in the power supply)
(a) The diodes that are to be used in a full wave rectifier should be rated $2V_m$ and in bridge rectifier equal to V_m
(b) The diodes that are to be used in a full wave rectifier should be rated V_m and in bridge rectifier equal to $2V_m$
(c) All diodes should be rated for V_m only
(d) All diodes should be rated for $2V_m$
[ESE-2002]

1.7 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)
[ESE-2003]

1.8 The average value of the full-wave rectified sine wave with period π, and a peak value of V_m is
(a) 0.707 V_m (b) 0.500 V_m
(c) 0.637 V_m (d) 0.318 V_m
[ESE-2003]

1.9 Consider the following circuit:



For the circuit shown above, which one of the following is a correct statement?

(a) D_2 does not conduct for any value of V_i

(b) V_o = 10 V for all values of V_i > 10 V

(c) V_o = 0 V for all values of V_i < 0 V

(d) V_o = 10 V for all values of V_i > 0 V

[ESE-2004]

1.10 Which one of the following statements is correct? Under small signal operation of a diode,

(a) its bulk resistance increases

(b) its junction resistance predominates

(c) it acts like a closed switch

(d) it behaves as a clipper

[ESE-2004]

1.11 Consider the following statements:

A clamper circuit

1. adds or subtracts a dc voltage to or from a waveform.
2. does not change the shape of the waveform.
3. amplifies the waveform.

Which of the statements given above are correct?

(a) 1 and 2 (b) 2 and 3

(c) 1 and 3 (d) 1, 2 and 3

[ESE-2005]

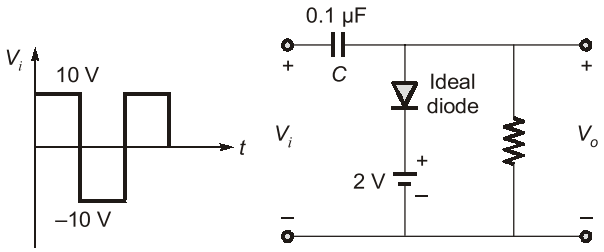
1.12 In a half-wave rectifier, if an a.c. supply is 60 Hz, then what is the a.c. ripple at output?

(a) 30 Hz (b) 60 Hz

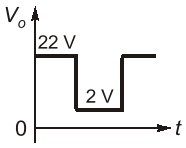
(c) 120 Hz (d) 15 Hz

[ESE-2005]

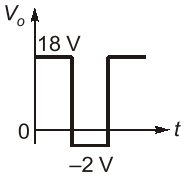
1.13 Select the correct output (V_o) wave-shape for a given input (V_i) in the clamping network given below:



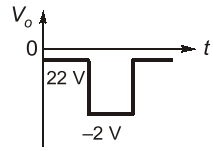
(a)



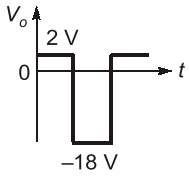
(b)



(c)



(d)



[ESE-2005]

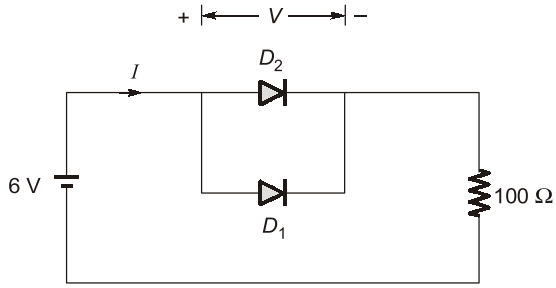
1.14 A half-wave rectifier having a resistance load of 1 kΩ rectifies an a.c. voltage of 325 V peak value and the diode has a forward resistance of 100 Ω. What is the RMS value of the current?

(a) 295.4 mA (b) 94.0 mA

(c) 147.7 mA (d) 208.0 mA

[ESE-2005]

1.15 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

[ESE-2006]

1.16 A power supply has a full-load voltage of 24 V. What is its no-load voltage for 5% regulation (rounded to the nearest integer)?

(a) 12 V (b) 23 V

(c) 25 V (d) 6 V [ESE-2007]

1.17 Which of the following components are chosen to construct a d.c. power supply to supply 6 V DC voltage from 230 V a.c. to operate a tape recorder?

1. Step down transformer
2. Diodes
3. Resistors and capacitors
4. Three-pin voltage stabilizer

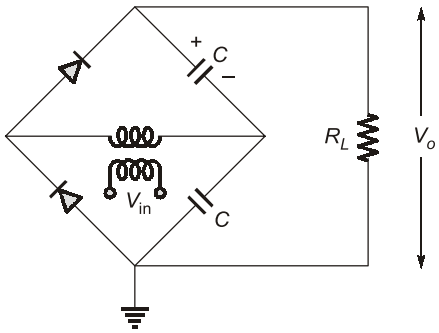
Select the correct answer using the code given below :

(a) 1, 2 and 3 only (b) 1 and 4 only

(c) 3 and 4 only (d) 1, 2, 3 and 4

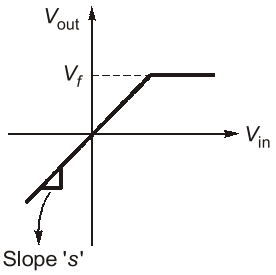
[ESE-2008]

1.18 The figure shown below is a circuit of which one of the following?



(a) Bridge rectifier
(b) Voltage doubler
(c) Rectifier with filter
(d) Comparator **[ESE-2008]**

1.19 The figure given below shows the transfer characteristics of which one of the following



(a) Peak clipper (b) Bottom clipper
(c) Clamper (d) Two level clipper
[ESE-2008]

1.20 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 **[ESE-2008]**

1.21 **Assertion (A):** A high value of resistor is connected across the diode in a clamper circuit for better performance.
Reason (R): If this resistor is not present, the circuit will respond to sudden decrease in the magnitude of the input pulse train, but the response to sudden increase in the amplitude will cause improper response.
(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 **[ESE-2008]**

1.22 Silicon diodes are less suited for low voltage rectifier operation because
(a) it cannot withstand high temperatures
(b) its reverse saturation current is low
(c) its cut-in voltage is high
(d) its breakdown voltage is high **[ESE-2008]**

1.23 The 'voltage stability with time' of reference diodes incorporating Zener diodes is comparable to that of which of the following?
(a) Dry cells
(b) Nickel -cadmium cells
(c) Lead-acid accumulator batteries
(d) Conventional standard cells **[ESE-2008]**

1.24 Consider the following statements about a good power supply :
1. The a.c. ripple should be high.
2. S_V, (Voltage stability factor) should be low.
3. S_T, (Temperature stability factor) should be low.

Which of the above statements are correct?
(a) 1, 2 and 3 (b) 2 only
(c) 3 only (d) 2 and 3 only
[ESE-2009]

1.25 **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 **[ESE-2009]**

1.26 Consider the following statements:
When compared with a bridge rectifier, a centre-tapped full wave rectifier:
1. Has larger transformer utilization factor.
2. Can be used for floating output terminals i.e. no input terminal is grounded.

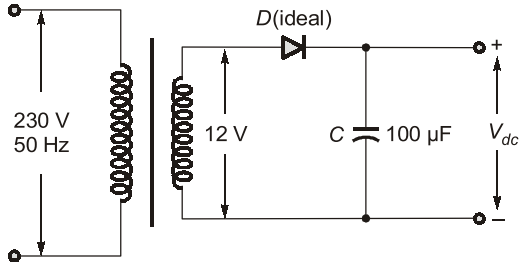
3. Needs two diodes instead of four.
4. Needs diodes of a lower PIV rating.

Which of these statements is/are correct?

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

[ESE-2010]

1.27 The output V_{dc} from the below circuit is



(a) $12\sqrt{2}$ (b) $\frac{12}{\pi}$

(c) $\frac{24}{\pi}$ (d) $\frac{12}{\sqrt{2}}$

[ESE-2010]

1.28 A rectifier (without filter) with fundamental ripple frequency equal to twice the mains frequency, has ripple factor of 0.482 and power conversion efficiency equal to 81.2%. The rectifier is

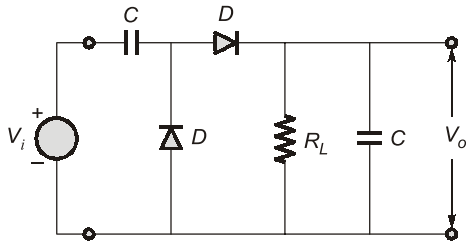
1. Bridge rectifier
2. Full-wave (non bridge) rectifier
3. Half-wave rectifier

Which of these are correct?

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

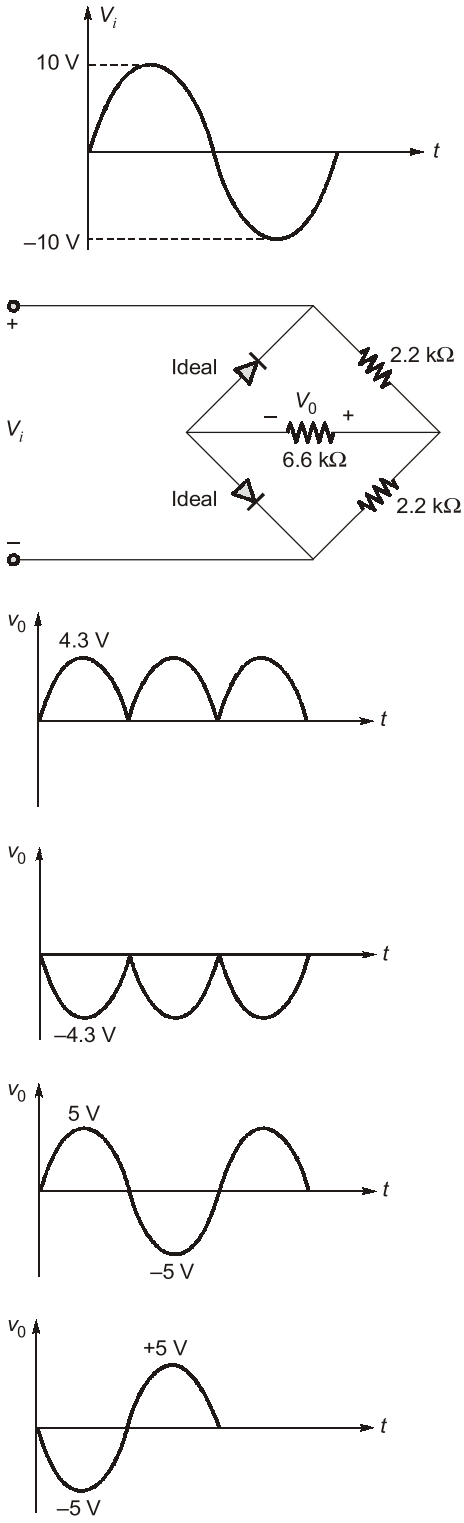
[ESE-2010]

1.29 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) $-V_m$

1.30 The correct waveform for output (V_0) for below network is



[ESE-2010]

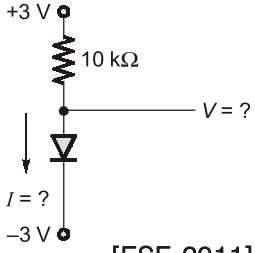
1.31 A half-wave rectifier has an input voltage of 240 V rms. If the step-down transformer has turns ratio of 8 : 1, what is the peak load voltage? Ignore diode drop.

(a) 27.5 V (b) 86.5 V
(c) 30.0 V (d) 42.5 V

[ESE-2011]

1.32 A 700 mW maximum power dissipation diode at 25°C has 5 mW/°C de-rating factor. If the forward voltage drop remains constant at 0.7 V, the maximum forward current at 65°C is
(a) 700 mA (b) 714 mA
(c) 1 A (d) 1 mA [ESE-2011]

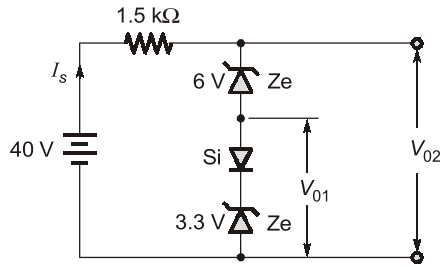
1.33 For the circuit shown below, using ideal diode, the values of voltage and current are



(a) –3 V and 0.6 mA
(b) 3 V and 0.0 mA
(c) 3 V and 0.6 mA
(d) –3 V and 0.0 mA

[ESE-2011]

1.34 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 [ESE-2012]

1.35 For a full wave rectifier, with sinusoidal input and inductor as filter, ripple factor for maximum load current and minimum load current conditions are respectively
(a) 0.1 and 1 (b) 0.1 and 0.47
(c) 0 and 0.47 (d) 0 and 0.22

[ESE-2012]

1.36 The ripple factor in case of a full-wave rectifier is
(a) 1.21 (b) 0.50
(c) 0.48 (d) 1.0

[ESE-2013]

1.37 The maximum efficiency of half-wave rectifier is
(a) 33.33% (b) 40.60%
(c) 50.00% (d) 68.00%

[ESE-2013]

1.38 **Statement (I):** Centre tap transformer is essential for a centre-tapped rectifier.
Statement (II): In half wave rectification minimum two diodes are required.
(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

[ESE-2013]

1.39 The maximum depletion layer width in Silicon is
(a) 0.143 μm (b) 0.57 μm
(c) 1 μm (d) 1.143 μm

[ESE-2014]

1.40 A full wave rectifier with a center tapped transformer supplies dc current of 100 mA to a load resistance of 20 Ω. The secondary resistance of transformer is 1 Ω. Each diode has a forward resistance of 0.5 Ω. What are rms value of signal voltage across each half of the secondary as well as dc power supplied to the load?
(a) 2.39 V and 0.2 Watt
(b) 23.9 V and 2 Watt
(c) 0.239 V and 20 Watt
(d) 2.39 V and 2 Watt [ESE-2014]

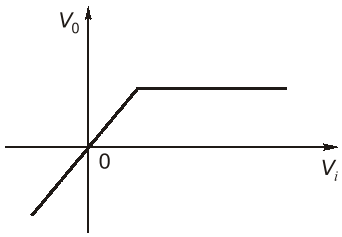
1.41 A bridge rectifier uses a 9 V ac input voltage. The diodes are ideal what is the dc output voltage?
(a) 12.726 V (b) –12.726 V
(c) 9 V (d) 8.1 V

[ESE-2014]

1.42 A half-wave rectifier is used to supply 50 V DC to a resistive load of 800 Ω. The diode has resistance of 25 Ω. What is the required ac voltage.
(a) 50 π (b) 51.5 π
(c) 25.7 π (d) 25 π

[ESE-2014]

1.53 The voltage transfer characteristic as shown in the figure will relate to a



1. voltage regulator
2. half-wave rectifier
3. full-wave rectifier

Which of the above is/are correct?

(a) 1 only (b) 2 only
(c) 1 and 2 (d) 1 and 3

[ESE-2018]

1.54 The input to a bridge rectifier is 230 V (rms), 50 Hz. The DC output voltage and the ripple factor with R_L of 100 Ω and capacitor filter of 1000 μF are

(a) 207 V and 0.028 (b) 325 V and 0.028
(c) 207 V and 0.020 (d) 325 V and 0.020

[ESE-2019]

1.55 The peak-to-peak ripple voltage for a half-wave rectifier and filter circuit operating at 60 Hz, which has a 680 μF reservoir capacitor, an average output of 28 V and 200 Ω load resistance, will be nearly

(a) 2.5 V (b) 3.4 V
(c) 4.3 V (d) 5.2 V

[ESE-2019]

1.56 The components of full-wave voltage doubler circuit are

(a) 2 diodes and 1 capacitor
(b) 4 diodes and 1 capacitor
(c) 2 diodes and 2 capacitor
(d) 4 diodes and 2 capacitor

[ESE-2019]

1.57 A single-phase full wave rectifier uses semiconductor diodes. The transformer voltage is 35 V rms to center tap. The load consists of a 40 μF capacitor in parallel with a 250 Ω resistor. The diode and transformer resistances and leakage reactance are neglected. If the power line frequency is 50 Hz, the dc current in the circuit will be

(a) 132 mA (b) 144 mA
(c) 156 mA (d) 168 mA

[ESE-2020]

■■■

Answers Diodes Circuits

1.1 (d)	1.2 (c)	1.3 (d)	1.4 (a)	1.5 (b)	1.6 (a)	1.7 (c)	1.8 (c)	1.9 (c)
1.10 (b)	1.11 (a)	1.12 (b)	1.13 (d)	1.14 (c)	1.15 (a)	1.16 (c)	1.17 (d)	1.18 (b)
1.19 (a)	1.20 (c)	1.21 (c)	1.22 (c)	1.23 (c)	1.24 (d)	1.25 (c)	1.26 (c)	1.27 (a)
1.28 (c)	1.29 (c)	1.30 (a)	1.31 (d)	1.32 (b)	1.33 (a)	1.34 (d)	1.35 (c)	1.36 (c)
1.37 (b)	1.38 (c)	1.39 (d)	1.40 (a)	1.41 (d)	1.42 (b)	1.43 (d)	1.44 (a)	1.45 (c)
1.46 (b)	1.47 (c)	1.48 (c)	1.49 (b)	1.50 (c)	1.51 (a)	1.52 (b)	1.53 (a)	1.54 (b)
1.55 (b)	1.56 (c)	1.57 (a)						

Explanations Diodes Circuits

1.1 (d)

For full wave rectifier,

$$I_{dc} = \frac{2I_m}{\pi}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$\frac{P_{dc}}{P} = \frac{(I_{dc})^2 R}{(I_{rms})^2 R} = \frac{\left(\frac{2I_m}{\pi}\right)^2}{\left(\frac{I_m}{\sqrt{2}}\right)^2} = \frac{8}{\pi^2}$$

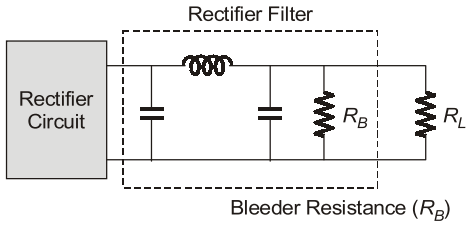
1.2 (c)

$$\tau = R_L C = T_{OFF}$$
$$T = T_{ON} + T_{OFF}$$

- when C increases, T_{OFF} increases and T_{ON} decreases. Hence Conduction period decreases.
- Larger value of capacitor requires larger current to charge it.

1.3 (d)

Purpose of bleeder resistance: It is used to maintain a certain minimum current through the choke (inductor) even if no load.



$$R_B \geq 10R_L$$

- The value of bleeder resistance (R_B) should be such that to draw only 10% of total load current.
- It provides better voltage regulation.
- It provides safety to operator by providing discharge path to the capacitor.
- Single power supply can be used to provide more voltage.
- Bleeder resistance can be used as voltage divider for tapping out any desired output.

1.4 (a)

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

For HWR, $r = \sqrt{\left(\frac{I_m/2}{I_m/\pi}\right)^2 - 1} = 1.21$

(highest ripple factor)

For FWR, $r = \sqrt{\left(\frac{I_m/\sqrt{2}}{2I_m/\pi}\right)^2 - 1} = 0.48$

Series inductance or shunt capacitance both are used to reduce the ripple factor of FWR.

1.5 (b)

Capacitor filter is used for high load resistance (for low current) to minimise ripple.

$$\therefore \quad r \propto \frac{1}{R_L C}$$

1.6 (a)

For HWR, PIV = V_m
For Center-tapped FWR, PIV = $2V_m$
For Bridge rectifier, PIV = V_m

1.7 (c)

$$V_r = \frac{I_{DC}}{2fC}$$

1.8 (c)

$$V_{avg} = \frac{1}{T}\int_0^T v(t)dt = \frac{1}{\pi}\int_0^\pi V_m \sin\theta\, d\theta$$
$$= \frac{V_m}{\pi}(-\cos\theta)_0^\pi = \frac{2V_m}{\pi}$$
$$= 0.637\, V_m$$

1.9 (c)

In the given circuit, for $V_i < 0$ V, both the diodes D_1 and D_2 will be in reverse bias region.
Hence, $V_o = 0$ V for all values of $V_i < 0$ V.

1.11 (a)

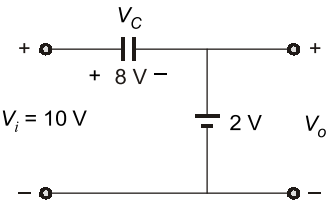
(i) A clamper clamps a signal to a different dc level.
(ii) The total swing of the output signal is equal to the total swing of input signal.
(iii) The shape of the signal does not change. Only dc level shifts.

1.12 (b)

In case of HWR, frequency of a.c. ripple is same as input signal frequency.

1.13 (d)

When V_i = 10 V, diode is forward biased:

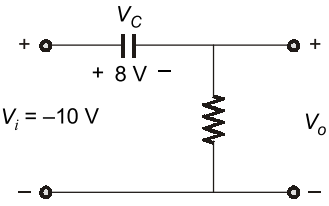


$V_o = 2$ V

$-10 + V_C + 2 = 0$

$V_C = +8$ V

When V_i = –10 V, diode is reverse biased:



$-V_i + V_C + V_o = 0$

$10\text{ V} + 8\text{ V} + V_o = 0$

$V_o = -18$ V

1.14 (c)

Peak value of current,

$$I_m = \frac{V_m}{R_f + R_L} = \frac{325}{100 + 1000} = 295.45\text{ mA}$$

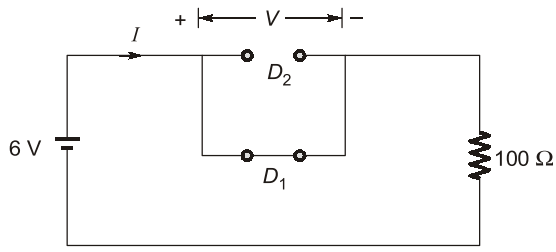
$$I_{rms} = \frac{I_m}{2} \text{ for HWR}$$

$$I_{rms} = \frac{295.45}{2} = 147.7\text{ mA}$$

1.15 (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,

$V = 0$ V

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

1.16 (c)

$$\%\text{ Regulation} = \frac{V_{\text{no load}} - V_{\text{full load}}}{V_{\text{full load}}} \times 100$$

$$5 = \frac{V_{\text{no load}} - 24}{24} \times 100$$

$$120 = 100\,V_{\text{no load}} - 2400$$

$$100\,V_{\text{no load}} = 2520$$

$$V_{\text{no load}} = 25.2\text{ V} \approx 25\text{ V}$$

1.17 (d)

Components required to construct a 6 V DC from 230 V AC are given below:

(i) Step down transformer for high AC to low AC.

(ii) Diode as rectifiers to convert AC to DC.

(iii) Resistors and capacitors to filter the output.

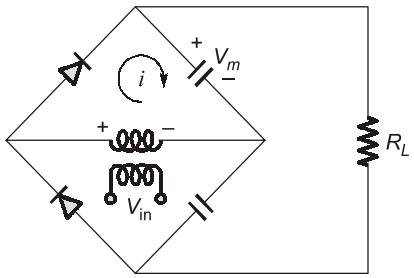
(iv) 3-pin voltage stabilizer to stabilize the signal.

1.18 (b)

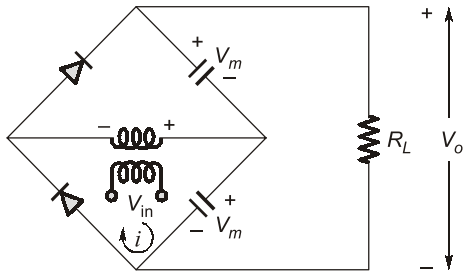
The given circuit is a voltage doubler which is operated by alternately charging each of the two capacitors to the transformer peak voltage V_m, current being continually drained from the capacitors through the load.

Let $V_{in} = V_m \sin \omega t$

For first half cycle,



For next half cycle,

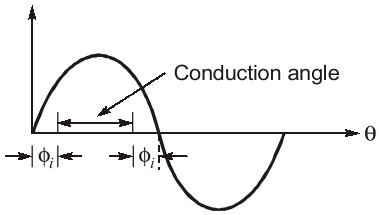


$V_o = V_m + V_m = 2\,V_m$

1.19 (a)

The given transfer characteristic curve exhibits a suppression of the peak of a signal.

1.20 (c)



Conduction angle = $\pi - 2\phi_i$

1.21 (c)

If the resistor is not present, then the capacitor does not have the discharge path and thus will not respond to sudden decrease in the magnitude of input pulse train.

1.24 (d)

In a good power supply, the AC ripple should be as low as possible.

1.25 (c)

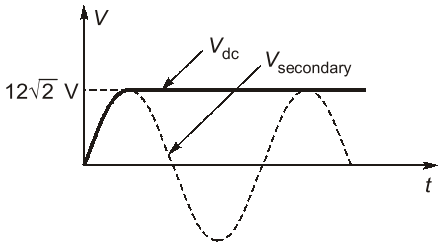
- A rectifier with inductor filter is more efficient for high laod current (i.e., for low values of load resistance R_L).
- Inductor offers zero ressitance for DC signal.

1.27 (a)

$$V_m = 12\sqrt{2}\ \text{V}$$

Since there is no discharge path available, once the capacitor gets charged it remain at the same voltage i.e. output remain constant.

$$\therefore \quad V_o = V_m = 12\sqrt{2}\ \text{V}$$



1.28 (c)

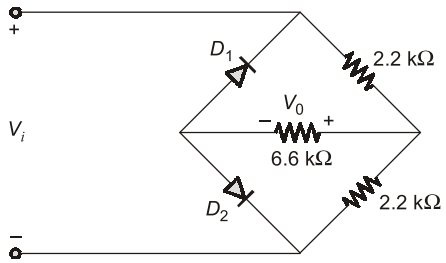
Parameter / Rectifier type	Ripple factor	Ripple factor	Ripple frequency
Half wave rectifier	1.21	40.6%	f_{supply}
Full wave rectifier	0.482	81.2%	$2f_{supply}$
Bridge rectifier	0.482	81.2%	$2f_{supply}$

1.29 (c)

The given circuit is a voltage doubler. Hence,

$$V_o = 2\,V_m$$

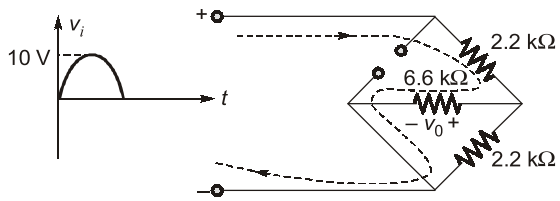
1.30 (a)



For positive half cycle of input voltage

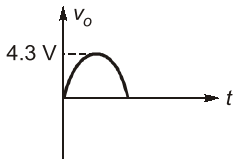
$D_1 \rightarrow$ OFF

$D_2 \rightarrow$ ON

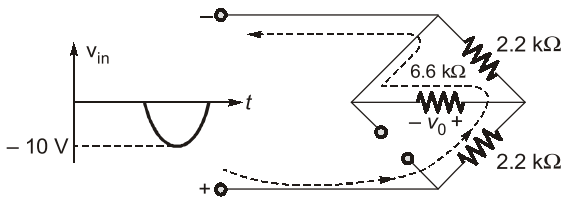


$$V_{o_{max}} = \frac{[6.6\,\text{k}\Omega \,\|\, 2.2\,\text{k}\Omega]}{2.2\,\text{k}\Omega + [6.6\,\text{k}\Omega \,\|\, 2.2\,\text{k}\Omega]} V_{i\,max}$$

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



For negative half cycle of input voltage



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

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