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ELECTRONICS ENGINEERING

OBJECTIVE PRACTICE SETS VOLUME - I

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NETWORK THEORY

OBJECTIVE PRACTICE SETS

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1 CHAPTER

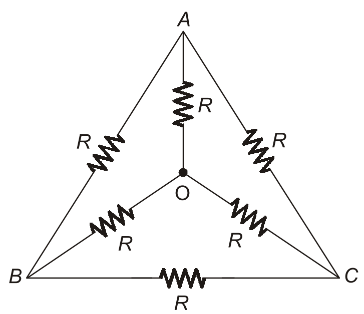
Circuit Element and Energy Sources

MCQ and NAT Questions

Q.1 The equivalent star impedance of a balanced delta connected load of value $6 + j\,9\ \Omega$ is given by

(a) $9 + j6\ \Omega$ (b) $2 + j3\ \Omega$
(c) $18 + j27\ \Omega$ (d) $6 - j9\ \Omega$

Q.2 The effective resistance between the terminals A and B in the circuit shown in the figure is

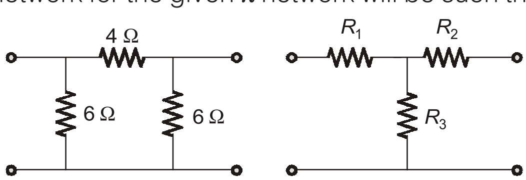


(a) R (b) $R - 1$
(c) $\frac{R}{2}$ (d) $\frac{6}{11}R$

Q.3 A network contains only independent current sources and resistors. If the values of all resistors are doubled, the values of the node voltages

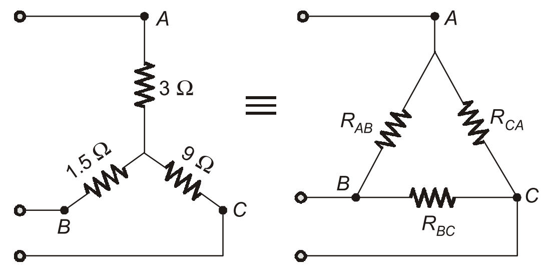
(a) will become half
(b) will remain unchanged
(c) will become double
(d) cannot be determined unless the circuit configuration and the values of the resistors are known

Q.4 The value of R_1, R_2 and R_3 of the equivalent 'T' network for the given π network will be such that



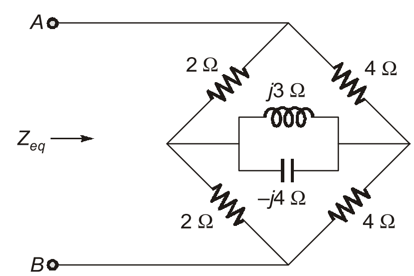
	R_1	R_2	R_3
(a)	2.25 Ω	1.5 Ω	1.5 Ω
(b)	1.5 Ω	1.5 Ω	2.25 Ω
(c)	2.25 Ω	1.5 Ω	2.25 Ω
(d)	1.5 Ω	2.25 Ω	1.5 Ω

Q.5 For the equivalent figure circuit shown in the given figure, the values of R_{AB} and R_{BC} are respectively



(a) 5 Ω and 15 Ω (b) 15 Ω and 30 Ω
(c) 30 Ω and 5 Ω (d) 20 Ω and 35 Ω

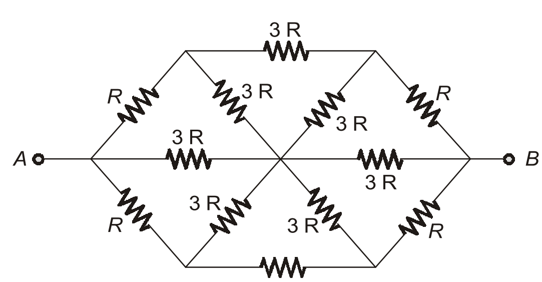
Q.6 In the circuit of figure. The equivalent impedance seen across terminals A, B is ______ Ω.



Q.7 If each branch of a delta circuit has impedance $Z/\sqrt{3}$ then, each branch of the equivalent Y circuit has impedance.

(a) $\frac{Z}{\sqrt{3}}$ (b) $\frac{Z}{3\sqrt{3}}$
(c) $3\sqrt{3}\,Z$ (d) $Z/3$

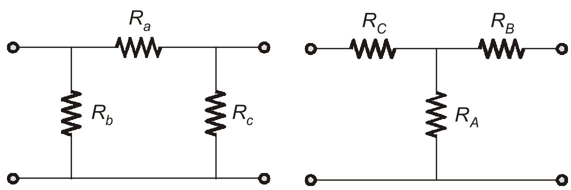
Q.8 The equivalent resistance between terminals A and B for the circuit shown is:



(a) R (b) $\frac{R}{3}$

(c) $\frac{3R}{2}$ (d) $2R$

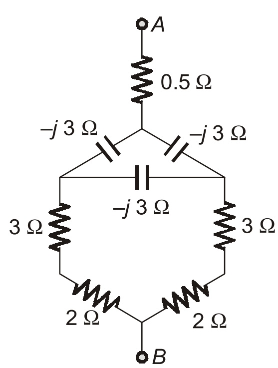
Q.9 Consider a delta connection of resistors and its equivalent star connection as shown below. If all elements of delta connection are scaled by a factor of K, $K > 0$, the elements of the corresponding star equivalent will be scaled by a factor of



(a) K^2 (b) K

(c) $1/K$ (d) $\sqrt{K}$

Q.10 For the circuit shown, the impedance between terminals A and B is:



(a) $9 - j3\ \Omega$ (b) $3 - j1.5\ \Omega$

(c) $j1.5\ \Omega$ (d) $0\ \Omega$

Q.11 A lamp rated at 10 watts, 50 volts is proposed to be used in 110 volts, system. The wattage and resistance of the resistor to be connected in series with the lamp should be

(a) 15 watt, 350 ohms

(b) 10 watts, 250 ohms

(c) 12 watts, 300 ohms

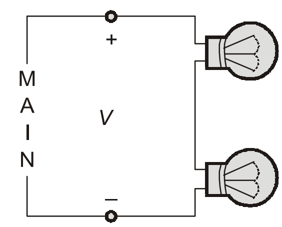
(d) 15 watts, 250 ohms

Q.12 The equivalent resistance of four resistors joined in parallel is 20 ohms. The currents flowing through them are 0.6, 0.3, 0.2 and 0.1 amp. The lowest value resistor is of

(a) 240 ohms (b) 120 ohms

(c) 80 ohms (d) 40 ohms

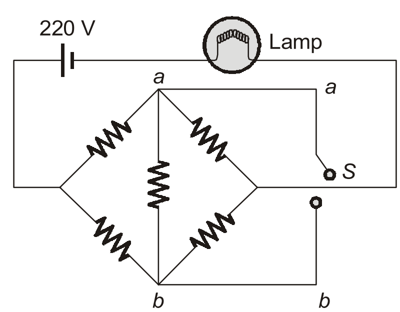
Q.13 The incandescent bulbs rated respectively as P_1 and P_2 for operation at a specified mains voltage are connected in series across the mains as shown in the below figure. Then the total power supplied by the mains to the two bulbs are



(a) $\frac{P_1P_2}{P_1+P_2}$ (b) $\sqrt{P_1^2+P_2^2}$

(c) $(P_1 + P_2)$ (d) $\sqrt{P_1 \times P_2}$

Q.14 All resistances in the circuit in figure are of R ohms each. The switch is initially open. What happens to the lamp's intensity when the switch is closed?



(a) increases

(b) decreases

(c) remains the same

(d) answer depends on the value of R

Q.15 A practical current source is usually represented by

(a) a resistance in series with an ideal current source.

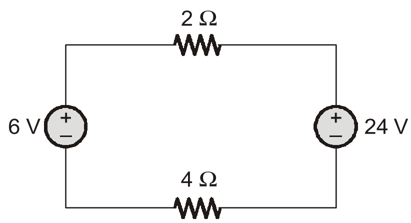
(b) a resistance in parallel with an ideal current source.

(c) a resistance in parallel with an ideal voltage source.

(d) none of these

Multiple Select Questions (MSQs)

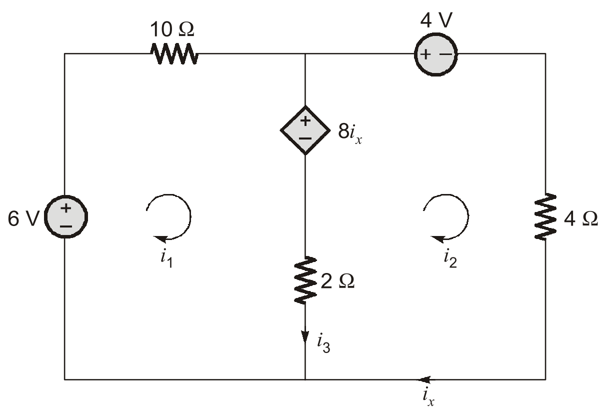
Q.24 For the circuit shown below :



Which of the following is correct?

(a) Power delivered by 24 V source is 72 W.
(b) Power absorbed by 4 Ω resistance is 36 W.
(c) Power delivered by 24 V source is 0 W.
(d) Power delivered by 6 V source is 18 W.

Q.25 For the circuit shown below :



Which of the following is correct?

(a) $i_1 = -1$ A (b) $i_2 = -3$ A
(c) $i_3 = 4$ A (d) $i_x = 3$ A

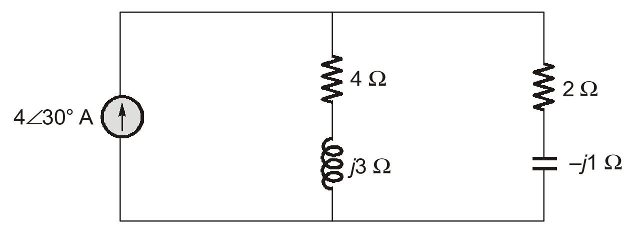
Q.26 A series circuit containing passive elements has the following current and applied voltage :

$$V = A\sin\left(\omega t + \frac{\pi}{4}\right)\text{V} \quad ; \quad i = B\sin\left(\omega t - \frac{\pi}{6}\right)\text{A}$$

The circuit elements :

(a) may be resistance and inductance.
(b) may be inductance, capacitance and resistance.
(c) may be resistance.
(d) may be resistance and capacitance.

Q.27 Consider the circuit shown in the figure below :



Which of the following statement is correct?

(a) The power supplied by the current source is 14 W.
(b) The average power absorbed by the capacitor is 0 W.
(c) The average power absorbed by the 4 Ω resistor is 4 W.
(d) The average power absorbed by the 2 Ω resistor is 11 W.

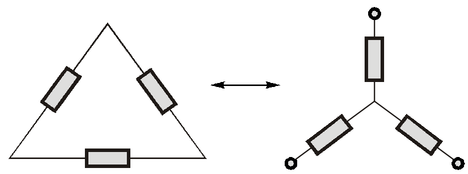
■■■■

Answers Circuit Element and Energy Sources

1.	(b)	2.	(c)	3.	(c)	4.	(b)	5.	(a)	6.	(2.67)	7.	(b)
8.	(c)	9.	(b)	10.	(b)	11.	(c)	12.	(d)	13.	(a)	14.	(c)
15.	(b)	16.	(c)	17.	(a)	18.	(a)	19.	(d)	20.	(d)	21.	(c)
22.	(a)	23.	(a)	24.	(a, b)	25.	(a, d)	26.	(a, b)	27.	(a, b, c)		

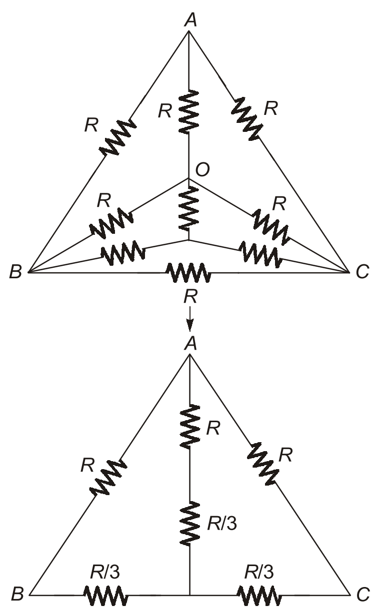
Explanations — Circuit Element and Energy Sources

1. (b)



$$Z' = \frac{Z \times Z}{3Z} = \frac{Z}{3} = \frac{6 + j9}{3} = 2 + j3\ \Omega$$

2. (c)



$$R_{AB} = R \left\| \left(\frac{R}{3} + \left(\frac{4R}{3} \middle\| \frac{4R}{3} \right) \right) \right. = \frac{R}{2}$$

3. (c)

Since the network contains only independent current sources, so changing resistors in the same proportion the current through each branch will remain same but node voltages will change in the same proportion. Hence, doubling all resistors, node voltages will be doubled.

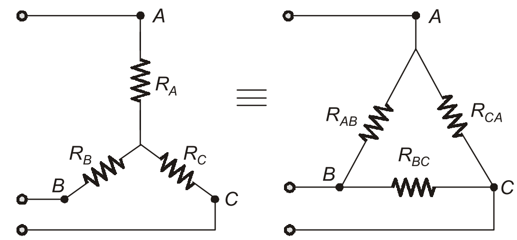
4. (b)

$$R_1 = \frac{4 \times 6}{4 + 6 + 6} = \frac{24}{16} = 1.5\ \Omega$$

$$R_2 = \frac{6 \times 4}{16} = 1.5\ \Omega$$

$$R_3 = \frac{6 \times 6}{16} = 2.25\ \Omega$$

5. (a)



$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$R_{AB} = 3 + 1.5 + \frac{3 \times 1.5}{9}$$

$$= 3 + 1.5 + 0.5 = 5\ \Omega$$

$$R_{BC} = 9 + 1.5 + \frac{9 \times 1.5}{3}$$

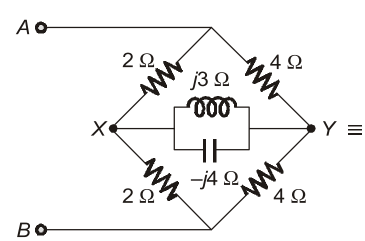
$$= 9 + 1.5 + 4.5 = 15\ \Omega$$

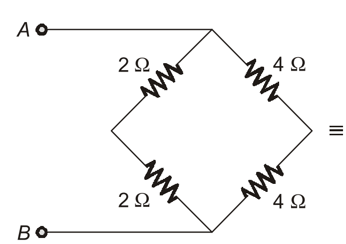
$$R_{CA} = R_A + R_C + \frac{R_A R_C}{R_B}$$

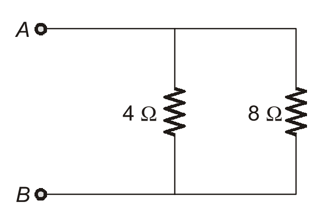
$$= 3 + 9 + \frac{3 \times 9}{1.5} = 30\ \Omega$$

6. Sol.

The above circuit is a Wheatstone bridge circuit, thus no current will flow through branch XY.

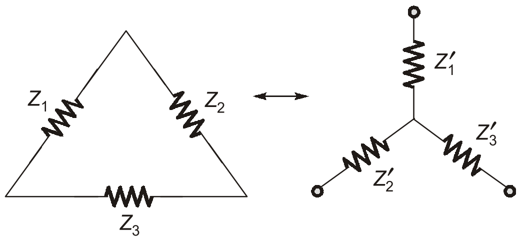






$$Z_{eq} = 8 \,||\, 4 = \frac{8 \times 4}{12} = \frac{8}{3} = 2.67\ \Omega$$

7. (b)



$$Z_1' = \frac{Z_1 Z_2}{Z_1 + Z_2 + Z_3}$$

$$Z_2' = \frac{Z_1 Z_3}{Z_1 + Z_2 + Z_3}$$

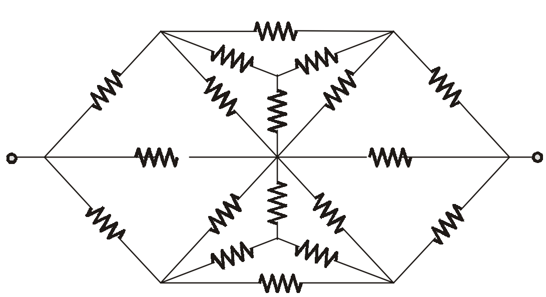
$$Z_3' = \frac{Z_2 Z_3}{Z_1 + Z_2 + Z_3}$$

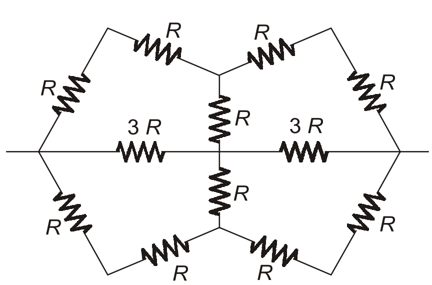
$$Z_1' = \frac{\frac{Z}{\sqrt{3}} \times \frac{Z}{\sqrt{3}}}{\frac{Z}{\sqrt{3}} + \frac{Z}{\sqrt{3}} + \frac{Z}{\sqrt{3}}}$$

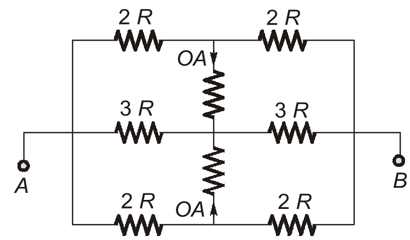
$$= \frac{\frac{Z^2}{(\sqrt{3})^2}}{\frac{3Z}{\sqrt{3}}} = \frac{Z^2\sqrt{3}}{3Z \times 3}$$

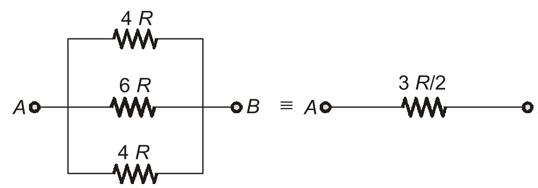
$$\Rightarrow \quad Z'_1 = \frac{Z}{3\sqrt{3}}$$

8. (c)









9. (b)

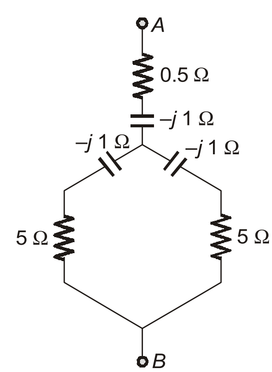
$$R_A = \frac{R_b R_c}{R_a + R_b + R_c} = K \cdot \left(\frac{R_c R_b}{R_a + R_b + R_c}\right)$$

$$R_B = \frac{R_a R_c}{R_a + R_b + R_c} = K \cdot \left(\frac{R_a R_c}{R_a + R_b + R_c}\right)$$

$$R_C = \frac{R_a \cdot R_b}{R_a + R_b + R_c}$$

$$= \frac{K^2 \cdot R_a R_b}{K(R_a + R_b + R_c)} = \frac{K \cdot R_a R_b}{R_a + R_b + R_c}$$

10. (b)

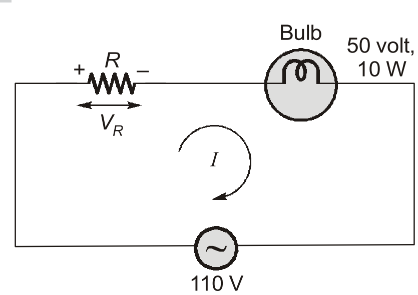


$$Z_{AB} = [(5 - j) \parallel (5 - j)] + (0.5 - j)$$

$$= [2.5 - j/2] + (0.5 - j)$$

$$= (3 - j\,1.5)\ \Omega$$

11. (c)



CONTROL SYSTEMS

OBJECTIVE PRACTICE SETS

Page No. 123 - 230

1 CHAPTER Introduction

MCQ and NAT Questions

Q.1 A control system is represented by $y(t) = x(t + T)$ with $T > 0$. Is the system causal?
(a) Yes (b) No
(c) Not necessarily (d) None of these

Q.2 $s(t)$ is step response and $h(t)$ is impulse response of a system. Its response $y(t)$ for any input $u(t)$ is given by

(a) $\frac{d}{dt}\int_0^t s(t-\tau)\,u(\tau)\,d\tau$

(b) $\int_0^t s(t-\tau)\,u(\tau)\,d\tau$

(c) $\int_0^t \int_0^t s(t-\tau_1)\,u(\tau_1)d\tau_1\,d\tau$

(d) $\int_0^t h(t-\tau)u(\tau)d\tau$

Q.3 When a human being tries to approach an object, his brain acts as
(a) an error measuring device
(b) a controller
(c) an actuator
(d) an amplifier

Q.4 Which one of the following is an example of open loop system
(a) Washing machine
(b) Respiratory system of animal
(c) Stablisation of air pressure entering into mask
(d) Execution of program by computer

Q.5 Which is not an example of closed loop system?
(a) Radar tracking system
(b) Electric iron
(c) Missile launching system
(d) Traffic light controller

Q.6 Consider the following statements:
Statement 1: The difference between the output response and the reference signal is called actuating signal.
Statement 2: If the initial conditions for a system are inherently zero, it means system is at rest or no energy stored in any of its parts.
(a) Statement 1 is wrong, 2 is correct
(b) Statement 1 is correct, 2 is wrong
(c) Both the statement are correct
(d) Both the statements are wrong

Q.7 The Laplace transform at a transportation lag of 2 seconds is given as :
(a) $\frac{1}{s+2}$ (b) e^{2s}
(c) e^{-2s} (d) $e^{2/s}$

Q.8 A certain LTI system has input $r(t)$ and output $c(t)$. If the input is first passed through a block whose T.F. is e^{-s} and then applied to system. The modified output will be
(a) $c(t)\,u(t-1)$ (b) $c(t-1)\,u(t)$
(c) $c(t-1)\,u(t-1)$ (d) none of these

Q.9 Let $F(s)$ be the Laplace transform of a signal $f(t)$.
If $F(s) = \frac{K}{(s+1)(s^2+4)}$, then $\lim_{t\to\infty} f(t)$ is given by
(a) $K/4$ (b) zero
(c) infinite (d) undefined

Q.10 For the given transfer function what will be the initial value $F(s) = \frac{(2s+1)}{s(4s+3)}$?
(a) $\frac{1}{3}$ (b) $\frac{1}{2}$
(c) $\frac{2}{3}$ (d) 0

Q.11 The compensator $G(s) = \dfrac{16(1+30s)}{(1+5s)}$ would provide gain at high frequency,

(a) 24.08 dB (b) 55.45 dB
(c) 91.28 dB (d) 39.65 dB

Q.12 The final value of the function $F(s) = \dfrac{5}{s(s^2+s+2)}$ is equal to ________.

Q.13 The voltage across an element in a circuit is given by $V(s) = \dfrac{1}{s(s+\alpha)}$. If $v(\infty)$ is equal to 4 V then the value of $v(t)$ at t = 1 sec is __________ V.

Q.14 **Assertion (A):** A linear system gives a bounded output if the input is bounded.
Reason (R): The roots of the characteristic equation have all negative real parts and response due to initial conditions decay to zero as time t tends to infinity.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are 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

■■■■

Answers Introduction

1. (b)	2. (d)	3. (b)	4. (a)	5. (d)	6. (d)	7. (c)	8. (c)	9. (b)
10. (b)	11. (d)	12. (2.5)	13. (0.885)	14. (d)				

Explanations Introduction

1. (b)

$$y(t) = x(t+T)$$

Taking Laplace transform,

$$Y(s) = X(s)e^{sT}$$

$$H(s) = \frac{Y(s)}{X(s)} = e^{sT}$$

Taking inverse Laplace transform

$$h(t) = \delta(t+T),\ T > 0$$

Thus, $h(t) \neq 0$, $t < 0$, its an impulse at $t = -T$.
System is causal if $h(t) = 0$, $t < 0$.

2. (d)

$$y(t) = x(t) \otimes h(t)$$

$$y(t) = u(t) \otimes h(t)$$

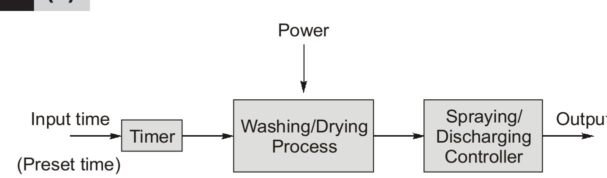
$$y(t) = \int_{-\infty}^{\infty} h(t-\tau)\, u(\tau) dt$$

$$y(t) = \int_{0}^{t} h(t-\tau)\, u(\tau) d\tau$$

3. (b)

When a human being tries to approach an object, his brain acts as a controller because his brain controls the activity of the human.

4. (a)

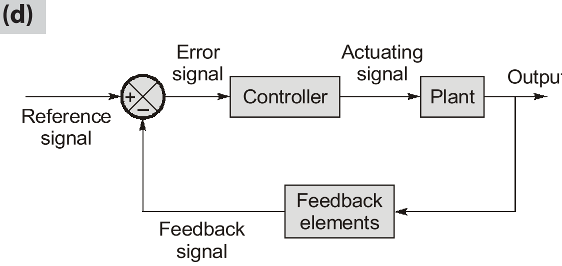


In the block diagram of a washing machine, input and output are unrelated, in the above. Thus washing machine is an example of open loop system.

5. (d)

Since all the system except (d) depend on the target or output.
Hence, output/target provides feedback to the system. While traffic light controller does not take any output consideration.

6. (d)



$$\text{Error signal} = \text{Reference} - \text{Output}$$

7. (c)

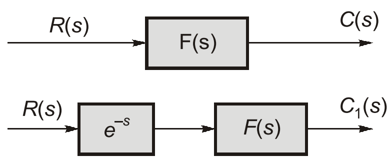
Transportation lag = e^{-st_d}

where t_d is time delay

Here, $t_d = 2$ sec

Thus, lag = e^{-2s}

8. (c)



$$C(s) = F(s)\,R(s)$$

$$C_1(s) = R(s)\cdot e^{-s}\cdot F(s)$$

$$C_1(s) = C(s)\,e^{-s}$$

$\because$ $L^{-1}[F(s)\,e^{-as}] = f(t-a)\,u(t-a)$

$\therefore$ $c_1(t) = c(t-1)\,u(t-1)$

9. (b)

$$F(s) = \frac{K}{(s+1)(s^2+4)}$$

We know by Final value theorem

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$$

$$= \lim_{s\to 0} \frac{sK}{(s+1)(s^2+4)} = 0$$

10. (b)

By initial value theorem $\lim_{t\to 0} f(t) = \lim_{s\to\infty} sF(s)$

where $F(s)$ is Laplace transform of $f(t)$.

So, Initial value $= \lim_{s\to\infty} \frac{s(2s+1)}{s(4s+3)}$

$$= \lim_{s\to\infty} \frac{2\left(1+\frac{1}{s}\right)}{4\left(1+\frac{3}{4s}\right)} = \frac{2}{4}\frac{(1+0)}{(1+0)}$$

$$= \frac{1}{2}$$

11. (d)

Sinusoidal transfer function is given by

$$G(j\omega) = \frac{16(1+j30\omega)}{(1+j5\omega)}$$

Solving, we get

$$G(j\omega) = \frac{16\times j\omega\left(\frac{1}{j\omega}+30\right)}{j\omega\left(\frac{1}{j\omega}+5\right)}$$

At $\omega\to\infty$ (high frequency)

$$G(j\omega)_{\omega\to\infty} = \frac{16\times\left(\frac{1}{\infty}+30\right)}{\left(\frac{1}{\infty}+5\right)} = 96$$

Gain in dB = 20 log 96

gain = 39.65 dB

12. (2.5)

$$F(s) = \frac{5}{s(s^2+s+2)}$$

$$\text{Final value} = \lim_{s\to 0} s\,F(s)$$

$$= \lim_{s\to 0} \frac{5s}{s(s^2+s+2)} = \frac{5}{2}$$

13. (0.885)

$$V(s) = \frac{1}{s(s+\alpha)}$$

By $v(\infty) = \lim_{t\to\infty} v(t) = \lim_{s\to 0} sV(s)$

By final value theorem

$$v(\infty) = \frac{1}{\alpha} = 4$$

$$\alpha = \frac{1}{4}$$

Now, $V(s) = \frac{1}{s(s+\alpha)}$

By partial fraction

$$V(s) = \frac{1}{\alpha}\left[\frac{1}{s}-\frac{1}{s+\alpha}\right]$$

$$V(s) = 4\left[\frac{1}{s}-\frac{1}{s+\alpha}\right]$$

By inverse Laplace transform

$$v(t) = 4[1-e^{-\alpha t}] = 4[1-e^{-t/4}]$$

$$v(t = 1\text{ sec}) = 4[1-e^{-1/4}]$$

$$= 0.885\text{ V}$$

14. (d)

Assertion is wrong as it is applicable only for the BIBO (Bounded Input Bounded Output) stable system.

Moreover if the system is unbounded then assertion will be wrong.

■■■■

ELECTRONIC DEVICES AND CIRCUITS

OBJECTIVE PRACTICE SETS

Page No. 231 - 290

1 CHAPTER Semiconductor Physics

MCQ and NAT Questions

Q.1 A conductor carries a current of 4 A and if magnitude of charge of an electron e = 1.6×10^{-19} Coulomb, then the number of electrons which flow past the cross-section per second is

(a) 2.5×10^{19} (b) 1.6×10^{19}
(c) 6.4×10^{19} (d) 0.4×10^{19}

Q.2 Long wavelength threshold for Si at room temperature is

(a) 1.13 mm (b) 1.73 mm
(c) 1 mm (d) 1.21 mm

Q.3 Given that the band gap of cadmium sulphide is 2.5 eV, the maximum photon wavelength, for electron-hole pair generation will be

(a) 4968 μm (b) 496 μm
(c) 4968 Å (d) 496 Å

Q.4 Doping of semiconductors is

(a) the process of purifying semiconductor materials
(b) the process of adding certain impurities to the semiconductor material
(c) the process of converting a pure semiconductor material into some form of an active device like diode, transistor, FET etc.
(d) one of the processes used in the fabrication of ICs

Q.5 The conductivity of a semiconductor crystal due to any current carrier is NOT proportional to

(a) mobility of the carrier
(b) effective density of states in the conduction band
(c) electronic charge
(d) surface states in the semiconductor

Q.6 Consider the following statements for an *n*-type semiconductor:

1. Donor level ionization decreases with temperature
2. Donor level ionization increases with temperature.
3. Donor level ionization in independent of temperature.
4. Donor level ionization increases as E_D (donor energy) moves towards the conduction band at a given temperature.

Which of these statement(s) is/are correct?

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

Q.7 Electron mobility and life-time in a semiconductor at room temperature are respectively 0.36 m^2/(V-s) and 340 μs. The diffusion length is

(a) 3.13 mm (b) 1.77 mm
(c) 3.55 mm (d) 3.13 cm

Q.8 The ratio of minority to majority diffusion coefficient D_p / D_n for germanium is approximately

(a) 2 (b) 0.5
(c) 3 (d) 0.33

Q.9 The concentration of minority carriers in an extrinsic semiconductor under equilibrium is

(a) directly proportional to the doping concentration
(b) inversely proportional to the doping concentration
(c) directly proportional to the intrinsic concentration
(d) inversely proportional to the intrinsic concentration

Q.10 The bonding forces in compound semiconductor, such as GaAs, arises from

(a) Ionic bonding
(b) Metallic bonding
(c) Covalent bonding
(d) Combination of ionic and covalent bonding

Q.11 Mobility μ varies as T^{-m} over a temperature range of 100 to 400° k. For silicon, m = ____ for holes.

(a) 2.5 (b) 2.7
(c) 1.66 (d) 2.33

Q.12 The ratio of mobility to the diffusion coefficient in a S.C. has the unit
(a) V^{-1} (b) cm – V^{-1}
(c) V – cm^{-1} (d) V - sec

Q.13 **Assertion (A):** Gallium arsenide is a direct band semiconductor having faster switching capabilities and high temperature operating capabilities.
Reason (R): A substance for which the width of the forbidden energy region is relatively small is called a semiconductor.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are 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.14 The intrinsic carrier concentration of silicon sample at 300 K is $1.5 \times 10^{16}/m^3$. If after doping, the number of majority carriers is $5 \times 10^{20}/m^3$, the minority carrier density is
(a) $4.50 \times 10^{11}/m^3$ (b) $3.33 \times 10^{4}/m^3$
(c) $5.00 \times 10^{20}/m^3$ (d) $3.00 \times 10^{-5}/m^3$

Q.15 Consider the following statements:
Impurity diffusion is used in semiconductor to control the conductivity. The nature of the impurity profile should be such that the
1. impurity concentration decreases with diffusion depth.
2. profile results in an internal electric field.
3. impurity concentration is homogeneous with no internal electric field.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 1 and 3
(c) 2 and 3 (d) 1 and 2

Q.16 The drift velocity of electrons in silicon varies with applied electric field in which one of the ways?
(a) It monotonically increases with increasing field
(b) It first increases linearly, then sub linearly increases and finally attains saturation with increasing field
(c) It first increases, then decreases showing a negative differential region, again increases and finally saturates
(d) The drift velocity remains unchanged with increase in field

Q.17 In degenerately doped *n*-type semiconductor, the Fermi level lies in conduction band when
(a) concentration of electrons in the conduction band exceeds the density of states in the valence band.
(b) concentration of electrons in the valence band exceeds the density of states in the conduction field.
(c) concentration of electrons in the conduction band exceeds the product of the density of states in the valence band and conduction band.
(d) None of the above

Q.18 A Ge sample at room temperature has intrinsic carrier concentration $n_i = 1.5 \times 10^{13}$ cm^{-3} and is uniformly doped with acceptor of 3×10^{16} cm^{-3} and donor of 2.5×10^{15} cm^{-3}. Then, the minority charge carrier concentration is
(a) 0.918×10^{10} cm^{-3} (b) 0.818×10^{10} cm^{-3}
(c) 0.918×10^{12} cm^{-3} (d) 0.818×10^{12} cm^{-3}

Q.19 **Assertion (A):** At low temperature, the conductivity of a semiconductor increases with increase in the temperature.
Reason (R): The breaking of the covalent bonds increases with increase in the temperature, generating increasing number of electrons and holes.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are 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.20 The electrical resistivity of sodium silicate glass is 10^5 Ωm whereas that of pure silicate glass is 10^{17} Ωm. This vast difference of 12 orders of magnitude is due to which one of the following reasons?
(a) The loosely-bound sodium ions in the silicate
(b) The impurities in silica
(c) The difference in the crystal structures
(d) The presence of free electrons in the silicate

Q.21 In an *n*-type Si sample, the drift velocity of electrons is 50 m/s. Then the time taken for the electrons to travel 20 μm distance in the Si sample is equal to
(a) 0.4 μs (b) 0.8 μs
(c) 2 μs (d) 4 μs

Answers Semiconductor Physics

1. (a)	2. (a)	3. (c)	4. (b)	5. (d)	6. (c)	7. (b)
8. (b)	9. (b)	10. (c)	11. (b)	12. (a)	13. (b)	14. (a)
15. (d)	16. (b)	17. (b)	18. (b)	19. (a)	20. (b)	21. (a)
22. (b)	23. (d)	24. (a)	25. (b)	26. (b)	27. (c)	28. (c)
29. (a)	30. (b)	31. (b)	32. (c)	33. (a)	34. (b)	35. (d)
36. (d)	37. (a)	38. (b)	39. (c)	40. (b)	41. (c)	42. (b)
43. (a)	44. (a)	45. (d)	46. (b)	47. (a)	48. (b)	49. (d)
50. (c)	51. (c)	52. (d)	53. (b)	54. (d)	55. (c)	56. (b)
57. (c)	58. (c)	59. (d)	60. (d)	61. (225.2)	62. (0.52)	63. (16.25)
64. (134)	65. (b, c)	66. (a, b, d)	67. (a, c)	68. (b, d)	69. (a, c, d)	70. (b, c)
71. (a, b)	72. (a, c)	73. (b, d)	74. (b, c)	75. (a, c, d)	76. (a, c)	

Explanations Semiconductor Physics

1. (a)

$$I = ne \text{ C/sec}$$

$$\Rightarrow \quad n = \frac{I}{e} = \frac{4}{1.6\times10^{-19}} = 2.5\times10^{19}/\text{sec}$$

2. (a)

$$E = \frac{1.24}{\lambda_g(\text{in } \mu\text{m})}\text{eV}$$

$$\therefore \quad \lambda = \frac{1.24}{E}$$

for E = 1.1 eV at room temperature

$$= \frac{1.24}{1.1} = 1.127\ \mu\text{m}$$

3. (c)

$$\lambda = \frac{hc}{E_g} = \frac{1.242\text{ eV-}\mu\text{m}}{2.5\text{ eV}} = 0.4968\ \mu\text{m} = 4968\ \text{Å}$$

4. (b)

Doping is process of adding impurities to the pure sc. It increases carrier concentration and therefore increases the conductivity.

5. (d)

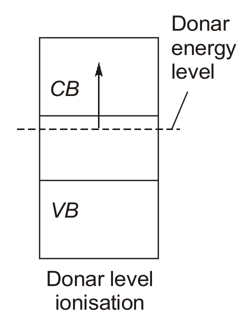
Conductivity, $\sigma = nq\mu_n$

μ_n : mobility of carrier

q : electron charge

n : effective density of states in conduction band

6. (c)



Donor energy level is a discrete energy level and is created just below the conduction band.

Donor energy level represents the energy level of all pentavalent atoms added to the pure *sc*.

Donor level ionisation increases with temperature. It also increases if donar energy increases.

Generally, E_D = 0.01 eV for Ge

= 0.05 eV for si

7. (b)

$$L_n = \sqrt{D_n\tau_n} \quad ; \quad \frac{D_n}{\mu_n} = V_T$$

$$\therefore \quad D_n = \mu_n V_T = 0.36\times0.025$$

$$L_n = \sqrt{0.36\times0.025\times340\times10^{-6}} = 1.77\text{ mm}$$

8. (b)

Since $\frac{D}{\mu}$ α constant

$\therefore$ D $\propto \mu$

For Ge $\frac{D_p}{D_n} \propto \frac{\mu_p}{\mu_n} = \frac{1800}{3800} \simeq 0.5$

9. (b)

According to mass action law

$$np = n_i^2$$

ANALOG CIRCUITS

OBJECTIVE PRACTICE SETS

Page No. 291 - 382

1 CHAPTER Diode Circuit and Power Supply

MCQ and NAT Questions

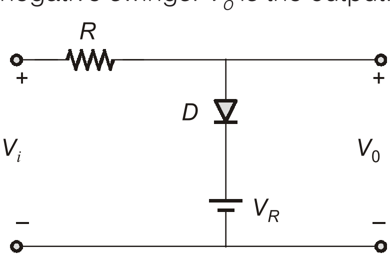
Q.1 The voltage across diode at temperature T_1 is 0.76 V. If temperature is increased by 20°C at constant current the new voltage across diode is

(a) 0.65 V (b) 0.81 V
(c) 0.71 V (d) 0.7 V

Q.2 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

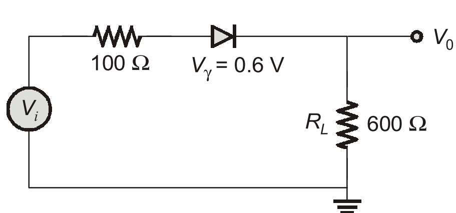
(a) 12.5 Ω (b) 50 Ω
(c) 6.25 Ω (d) 25 Ω

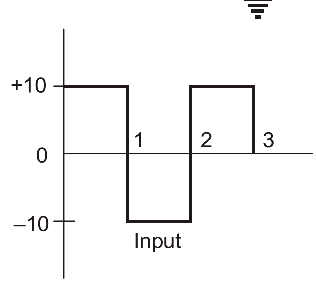
Q.3 In the circuit shown below the input V_i has positive and negative swings. V_o is the output.



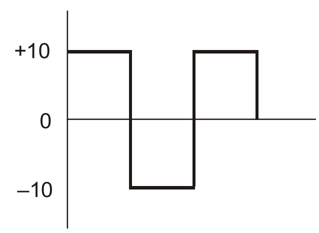
(a) V_o = 0 for negative V_i
(b) $V_o = V_R$ for positive V_i
(c) $V_o = V_R$ for $V_i > V_R$
(d) $V_o = V_R$ for all V_i

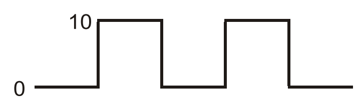
Q.4

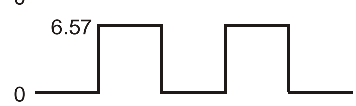


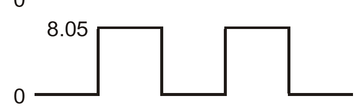


The output waveform is

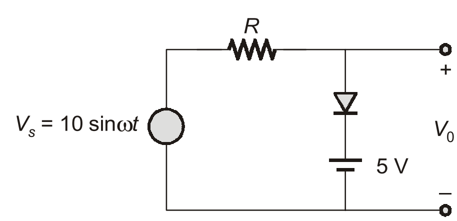
(a)


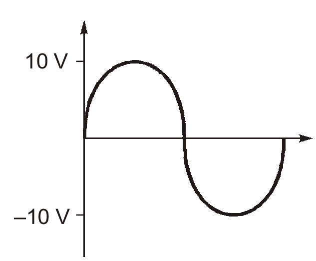
(b)


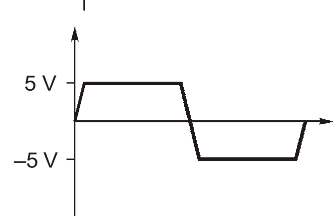
(c)


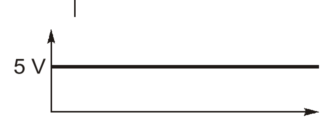
(d)


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

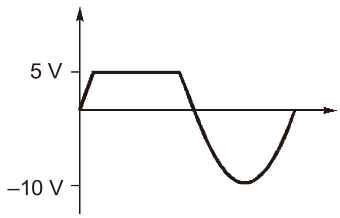


(a)


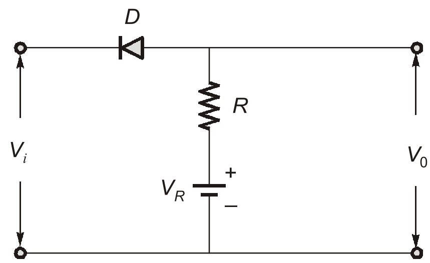
(b)


(c)


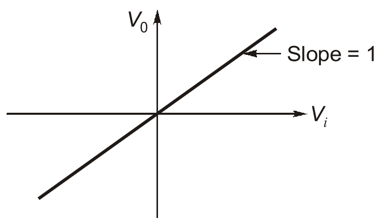
(d)



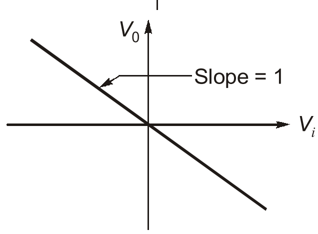
Q.6 The transfer characteristic of the network shown below is represented as



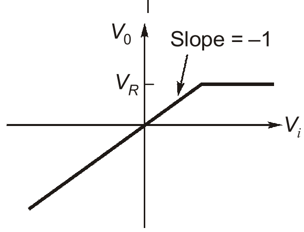
(a)



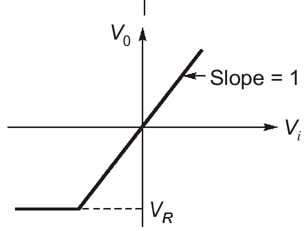
(b)



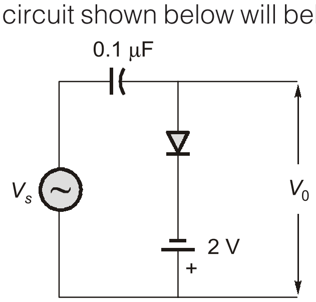
(c)



(d)

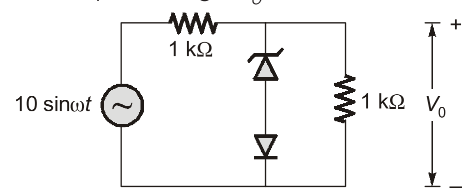


Q.7 For an input of $V_s = 5\sin\omega t$, (assuming ideal diode), circuit shown below will behave as a



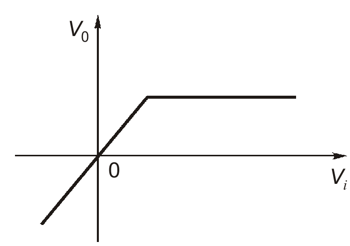
(a) clipper, sine wave clipped at –2 V
(b) clamper, sine wave clamped at –2 V
(c) clamper, sine wave clamped at zero volt
(d) clipper, sine wave clipped at 2 V

Q.8 The cut-in voltage of diode *D* shown in figure is 0.65 V, while breakdown voltage of the Zener Diode 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 The voltage transfer characteristic as shown in the figure will relate to a

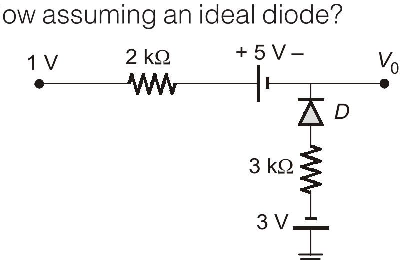


1. voltage regulator
2. half-wave rectifier
3. full-wave rectifier

Which of the above is/are correct?

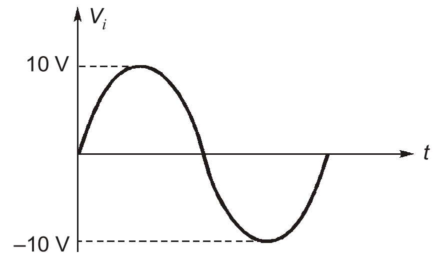
(a) 1 only (b) 2 only
(c) 1 and 2 (d) 1 and 3

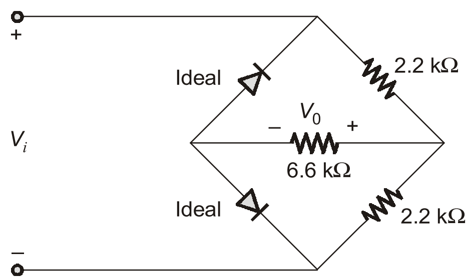
Q.10 What is the output voltage V_0 for the circuit shown below assuming an ideal diode?



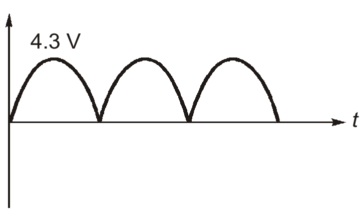
(a) $-\frac{18}{5}$ V (b) $\frac{18}{5}$ V
(c) $-\frac{13}{5}$ V (d) $\frac{13}{5}$ V

Q.11 The correct waveform for output (V_0) for below network is

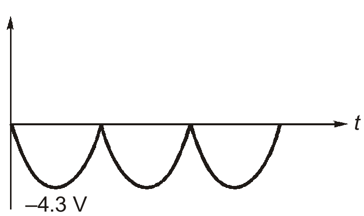




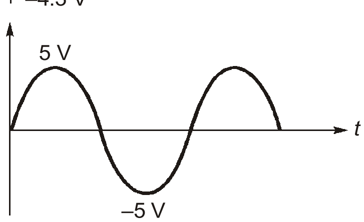
(a)



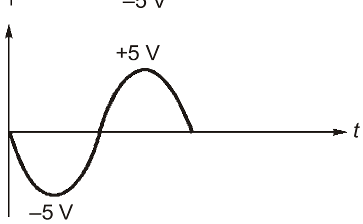
(b)



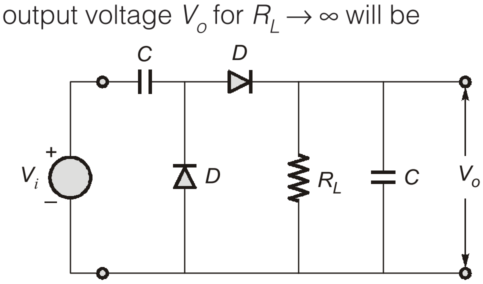
(c)



(d)

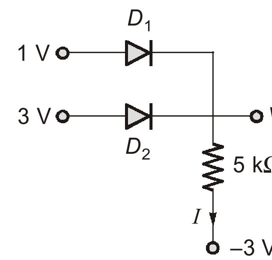


Q.12 Consider the below circuit, for $V_i = V_m \sin \omega t$, the output voltage V_o for $R_L \to \infty$ will be



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

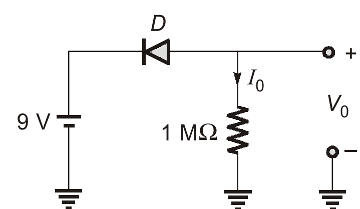
Q.13 Consider the circuit shown in the figure below



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

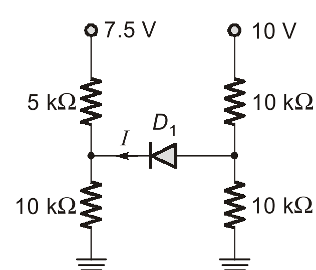
(a) 0.46 mA (b) 0.99 mA
(c) 0.59 mA (d) 1.06 mA

Q.14 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.15 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.16 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

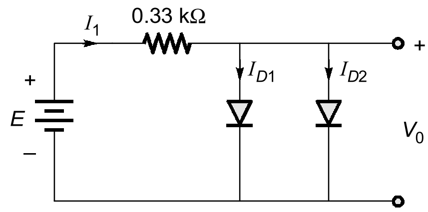
(a) 700 mA (b) 714 mA
(c) 1 A (d) 1 mA

Q.35 A full wave rectifier delivers DC power of 50 W to a load of 200 Ω. If the ripple factor is 1%, the AC ripple voltage across the load is

(a) $\frac{1}{2}$ V
(b) 1 V
(c) $\frac{2}{3}$ V
(d) $\frac{3}{2}$ V

Multiple Select Questions (MSQs)

Q.36 For the circuit shown below :

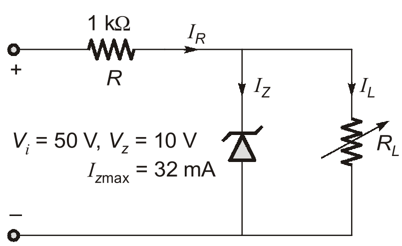


(where $E = 10$ V)

Which of the following statement is correct?

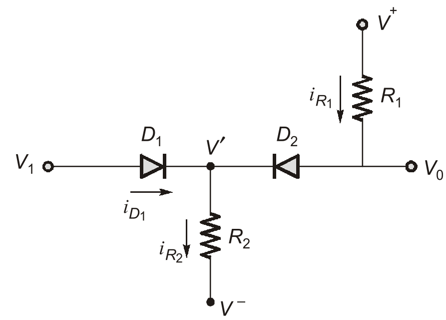
(a) $I_1 > I_{D1} > I_{D2}$
(b) $I_{D1} < I_{D2} < I_1$
(c) $I_{D1} = I_{D2} = \frac{I_1}{2}$
(d) $I_1 = 28.18$ mA

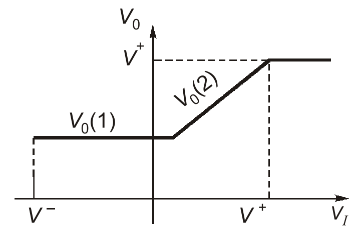
Q.37 For the network shown below, which of the following option(s) is/are correct regarding the range of R_L and I_L that will result in V_{R_L} being maintained at 10 V.



(a) $R_{L\ min} = 250\ \Omega$
(b) $I_{L\ min} = 8$ mA
(c) $R_{L\ max} = 1.25$ kΩ
(d) $I_R = 40$ mA

Q.38 For the circuit shown below :

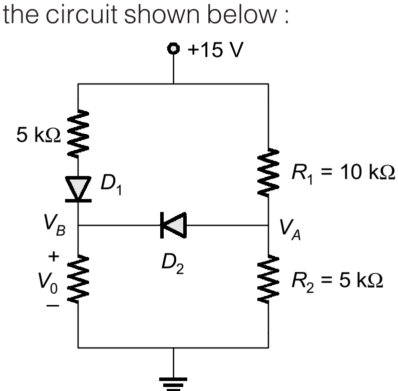




Assume the circuit parameters are R_1 = 5 kΩ, R_2 = 10 kΩ, V_γ = 0.7 V, V^+ = +5 V and V^- = – 5V

(a) For $V_1 = 0$, $i_{R1} = 0.62$ mA
(b) For $V_1 = 4$ V, $i_{R1} = 0.2$ mA
(c) For $V_1 = 4$ V, $i_{R2} = 0.83$ mA
(d) For $V_1 = 4$ V, $i_{D1} = 0.63$ mA

Q.39 For the circuit shown below :



Which of the following are correct?

(a) $V_A = 7.62$ V
(b) $V_B = 6.92$ V
(c) $V_A = 5$ V
(d) $V_B = 9.53$ V

Answers Diode Circuit and Power Supply

1. (c)	2. (c)	3. (c)	4. (d)	5. (d)	6. (c)	7. (b)
8. (b)	9. (a)	10. (a)	11. (a)	12. (c)	13. (d)	14. (4)
15. (0)	16. (b)	17. (a)	18. (a)	19. (c)	20. (c)	21. (a)
22. (b)	23. (b)	24. (b)	25. (a)	26. (d)	27. (c)	28. (a)
29. (c)	30. (c)	31. (d)	32. (c)	33. (d)	34. (c)	35. (b)
36. (c, d)	37. (a, b, c, d)	38. (a, b, c, d)	39. (c , d)			

Explanations **Diode Circuit and Power Supply**

1. (c)

$$\frac{dV_D}{dT} = -2.5 \text{ mV/°C}$$

$$\Delta V_D = 20 \times (-2.5 \text{ mV}) = -0.05 \text{ V}$$

$$\therefore \quad V_D + \Delta V_D = V_2 = 0.71 \text{ V}$$

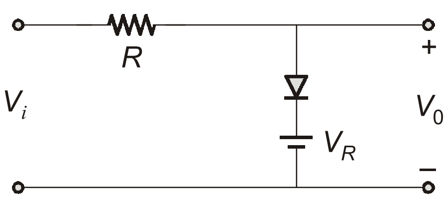
2. (c)

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

r_d : dynamic resistance.

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

3. (c)



Considering ideal diode :

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

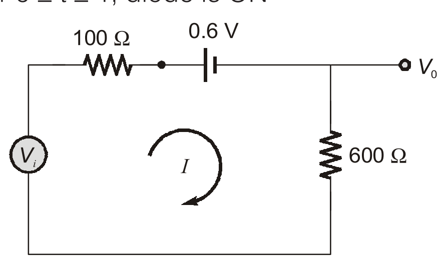
For $V_i > V_R$, diode is ON hence

$$V_0 = V_R$$

(as diode will act as short circuit)

4. (d)

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



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

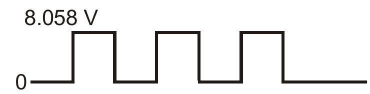
$$= 0.01343 \text{ A}$$

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

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:

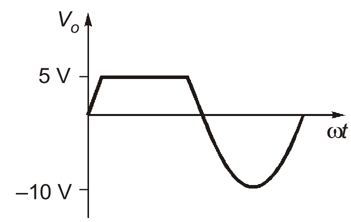


5. (d)

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

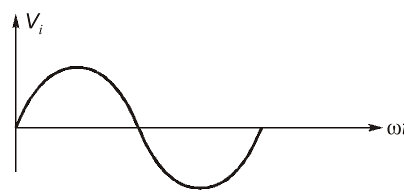


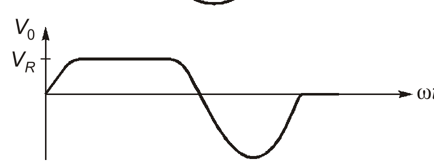
6. (c)

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

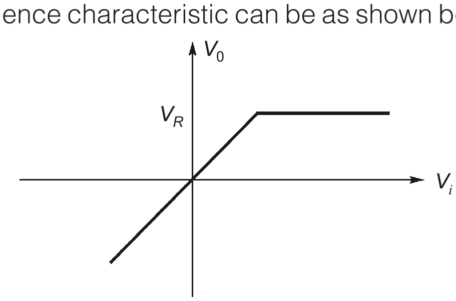
For $V_i > V_R$ = Diode is ON $\Rightarrow V_0 \simeq V_R$

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

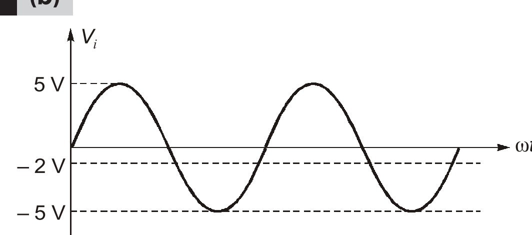




Hence characteristic can be as shown below



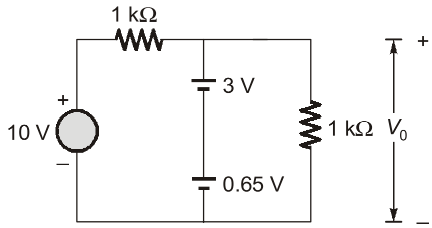
7. (b)



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

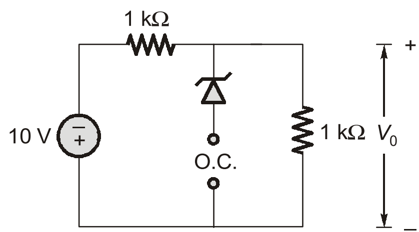
8. **(b)**

For positive half cycle:



So, $V_o = 3.65$ V

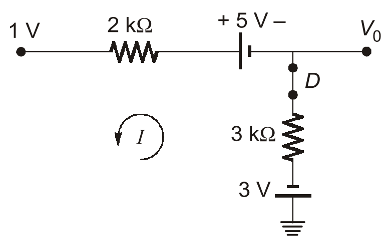
In negative half cycle:



So, $V_o = -5$ V

10. **(a)**

∵ Diode is forward bias (short circuit)



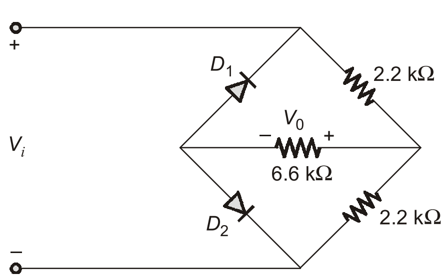
By applying KVL,

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

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

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

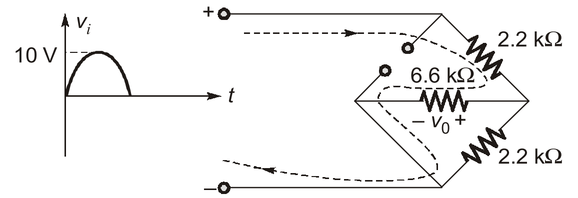
11. **(a)**



For positive half cycle of input voltage

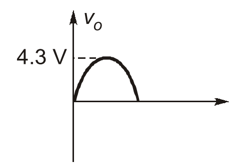
$D_1 \rightarrow$ OFF

$D_2 \rightarrow$ ON

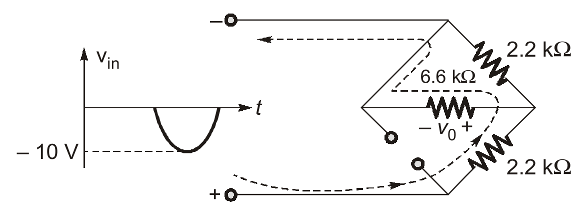


$$V_{o\max} = \frac{[6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]}{2.2\text{ k}\Omega + [6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]} V_{i\max}$$

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

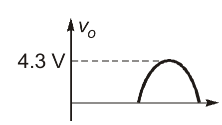


For negative half cycle of input voltage

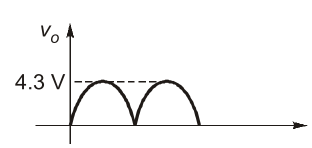


$$V_{o\max} = \frac{[6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]}{2.2\text{ k}\Omega + [6.6\text{ k}\Omega \,||\, 2.2\text{ k}\Omega]} V_{i\max}$$

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



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



12. **(c)**

The given circuit is a voltage doubler. Hence,

$$V_o = 2\,V_m$$

13. **(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.