Important Questions *for* GATE 2022

ELECTRICAL ENGINEERING

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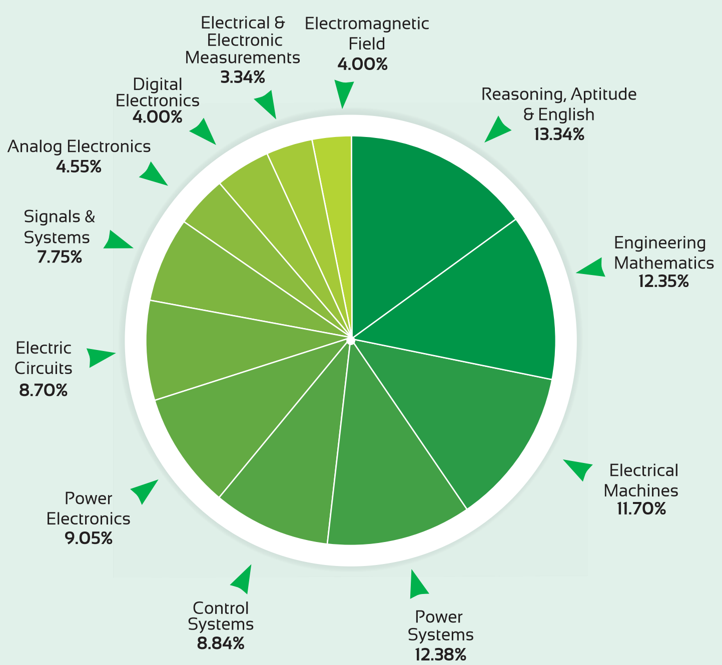
Day 6 of 8

Q.126 - Q.150 (Out of 200 Questions)

Electric Circuits & Digital Electronics

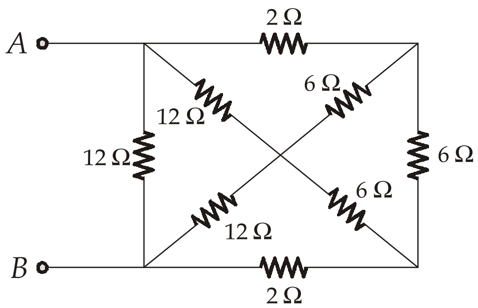
SUBJECT-WISE WEIGHTAGE ANALYSIS OF GATE SYLLABUS



Subject	Average % (last 5 yrs)
Reasoning, Aptitude & English	13.34%
Engineering Mathematics	12.35%
Electrical Machines	11.70%
Power Systems	12.38%
Control Systems	8.84%
Power Electronics	9.05%
Electric Circuits	8.70%
Signals & Systems	7.75%
Analog Electronics	4.55%
Digital Electronics	4.00%
Electrical & Electronic Measurements	3.34%
Electromagnetic Fields	4.00%
Total	**100%**

Electric Circuits & Digital Electronics

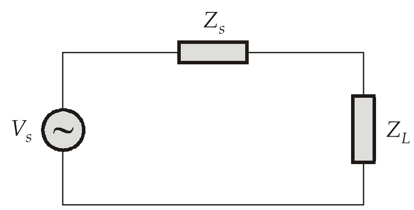
Q.126 The equivalent resistance seen across the terminal 'A' and 'B' in the figure given below is



(a) 2 Ω
(b) 4 Ω
(c) 6 Ω
(d) 8 Ω

Q.127 In a series RLC circuit, L = 40 mH is given. If the instantaneous voltage and current 100cos(314t – 5°) V and 10cos(314t – 50°) A, respectively, the value of R and C will be
(a) R = 10 Ω and C = 580 μF
(b) R = 7.07 Ω and C = 580 μF
(c) R = 7.07 Ω and C = 5.49 mF
(d) R = 14.14 Ω and C = 5.49 mF

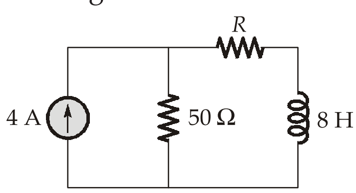
Q.128 Consider the circuit shown in the figure below,



Assume V_s = 250sin500t V and Z_s = (100 + j200) Ω. If Z_L to be a parallel combination of R and C, then the value of R and C such that the maximum power transfer takes from source to load are respectively.
(a) R = 8 Ω and C = 500 μF
(b) R = 100 Ω and C = 10 μF
(c) R = 250 Ω and C = 250 μF
(d) R = 500 Ω and C = 8 μF

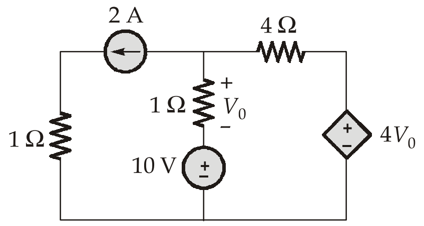
Q.129 Four resistors of equal value when connected in parallel across a supply dissipates 150 W. If the same resistors are now connected in series across the same supply, the power dissipated will be ________ W.

Q.130 Consider the circuit shown in the figure below:



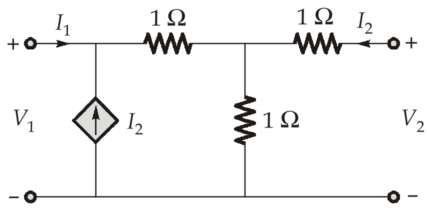
The value of resistor 'R' such that the energy stored in the inductor is 16 J is ______ Ω.

Q.131 Consider the circuit shown in the figure below:



The total power delivered by the dependent source is ___________ W.

Q.132 For the circuit shown in the figure below, The equivalent z-parameter matrix is



(a) $\begin{bmatrix} 2\,\Omega & 3\,\Omega \\ 1\,\Omega & 1\,\Omega \end{bmatrix}$
(b) $\begin{bmatrix} 2\,\Omega & 1\,\Omega \\ 1\,\Omega & 1\,\Omega \end{bmatrix}$
(c) $\begin{bmatrix} 2\,\Omega & 3\,\Omega \\ 1\,\Omega & 3\,\Omega \end{bmatrix}$
(d) $\begin{bmatrix} 2\,\Omega & 3\,\Omega \\ 1\,\Omega & 2\,\Omega \end{bmatrix}$

Q.133 The voltage equations for a two port network are given as

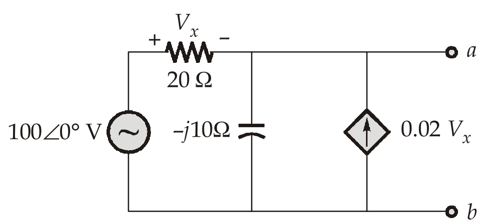
$$V_1 = 16I_1 + 24I_2 \text{ and } V_2 = 32I_1 + 14I_2$$

If a load of $R\angle 0°$ Ω is connected across the output port of this network, the input impedance becomes 8 Ω, then the value of R will be ______ Ω.

Q.134 A 4 A, current source, a 20 Ω resistor and a 5 μF capacitor are all in parallel. The amplitude of current source drops suddenly to zero at t = 0. The time taken by the capacitor voltage to drop one half of its initial value is

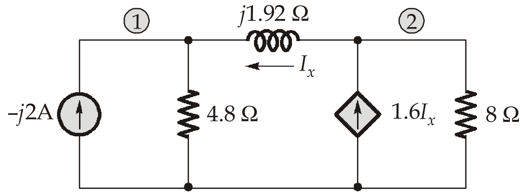
(a) 64.1 ms
(b) 64.1 μs
(c) 69.3 ms
(d) 69.3 μs

Q.135 The Thevenin's equivalent of the network shown below is,

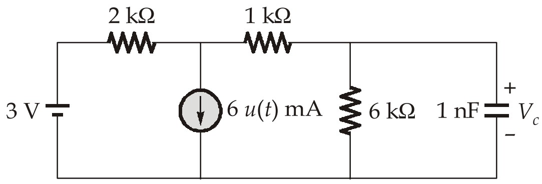


(a) 57.34∠–55° V and (4.7 – j6.7) Ω
(b) 57.34∠–61° V and (4.7 – j2.4) Ω
(c) 55∠57.3° V and (6.7 – j4.7) Ω
(d) 55∠–24° V and (4.2 – j6.7) Ω

Q.136 In the circuit given below, the average power supplied by the dependent source is ______ W.

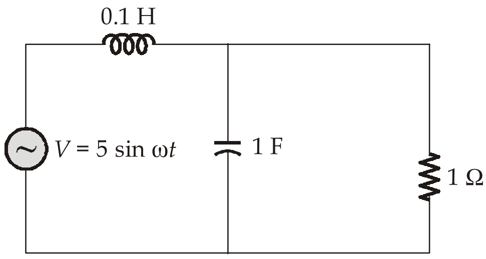


Q.137 A network circuit is shown below. The value of V_c at $t = 2$ μs is



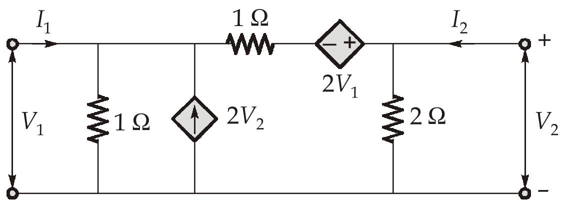
(a) –3.06 V
(b) 12.01 V
(c) –14.02 V
(d) 6.07 V

Q.138 For the network shown below, the source frequency ω at which applied voltage V and current I are in phase is



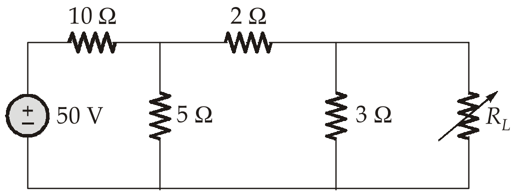
(a) 5 rad/sec
(b) 2 rad/sec
(c) 3 rad/sec
(d) 4 rad/sec

Q.139 The value of Z_{21} for network shown in figure below is

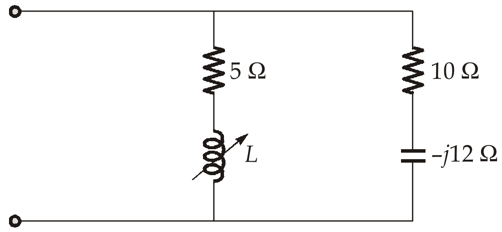


(a) –1 Ω
(b) –0.8 Ω
(c) 0.6 Ω
(d) 0.8 Ω

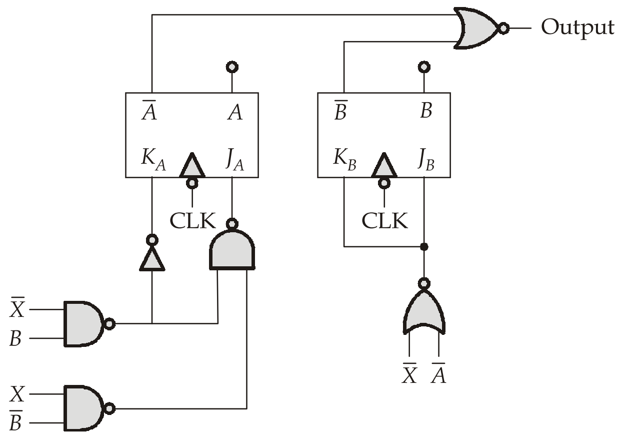
Q.140 The maximum power delivered to the load in the circuit shown below is ______ W.



Q.141 The minimum value of L at which the circuit resonates at a frequency of 1000 rad/sec in circuit shown below is _______ mH.



Q.142 Consider the following sequential circuit:



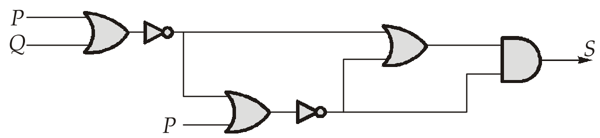
Which of the following represents correct output sequence, when input sequence is X = 01100? (Assume initially all flip-flops are in clear state).

(a) 01100
(b) 00101
(c) 10100
(d) 00110

Q.143 The number of minterms after minimizing the following Boolean expression is _________.

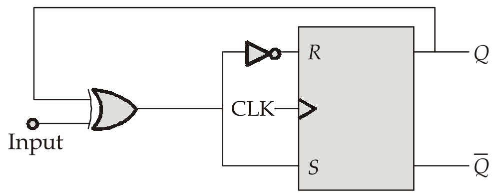
$$[D' + AB' + A'C + AC'D + A'C'D]'$$

Q.144 For the given circuit, which of the mentioned below input will give output as 1.



(a) $P = 0$; $Q = 0$
(b) $P = 1$; $Q = 0$
(c) $P = 0$; $Q = 1$
(d) Either $P = 1$ or $Q = 1$

Q.145 The sequential circuit shown below functions according to which of given below statement

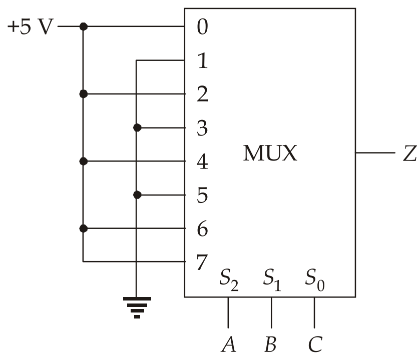


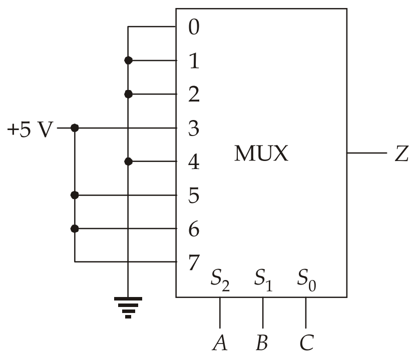
(a) It works as a D-flip-flop
(b) It works as a T-flip-flop
(c) Output remains stable at 1.
(d) Output remains stable at 0.

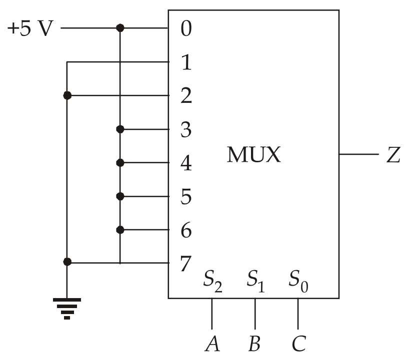
Q.146 An 8-bit successive approximation type ADC has a resolution of 30 mV. The digital output for an analog input of 2.86 V is

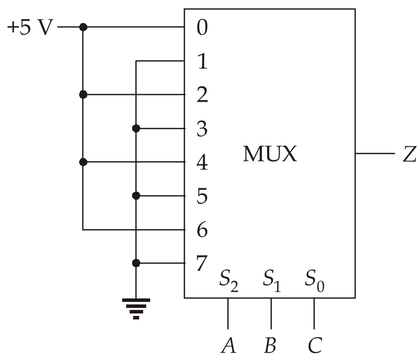
(a) 01011111_2
(b) 01101100_2
(c) 01100000_2
(d) 01110011_2

Q.147 Which of the following is realization of $Z = AB + BC + CA$?

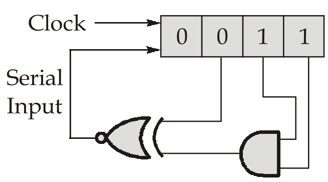
(a) 

(b) 

(c) 

(d) 

Q.148 The shift register shown in figure is initially loaded with the bit pattern 0011. Subsequently the shift register is clocked and with each clock pulse the pattern gets shifted by one bit position to the right. With each shift, the bit at the serial input is pushed to the left most position (MSB). Clock pulses taken by the shift register to get the content 0011 again are _______.



Q.149 The next state table of a 2-bit counter is given below.

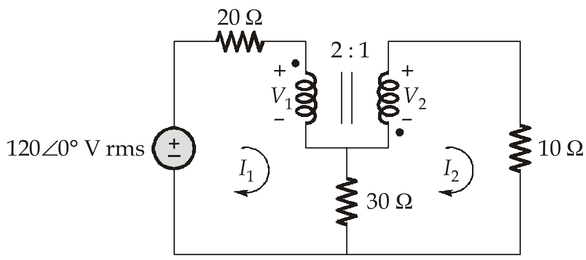
Q_1	Q_0	Q_1^+	Q_0^+
0	0	1	0
0	1	0	0
1	0	1	1
1	1	0	1

The counter is built as a synchronous sequential circuit using T-flip flops. The expressions for T_1 and T_0 are

(a) $T_1 = Q_1 Q_0 ; T_0 = \bar{Q}_1 \bar{Q}_0$
(b) $T_1 = Q_1 \odot Q_0 ; T_0 = Q_1 \oplus Q_0$
(c) $T_1 = Q_1 \oplus Q_0 ; T_0 = Q_1 \odot Q_0$
(d) $T_1 = Q_1 \odot Q_0 ; T_0 = \bar{Q}_1 \bar{Q}_0$

Multiple Select Questions (MSQ)

Q.150 A circuit is shown in the figure below.



Which of the following is/are correct?

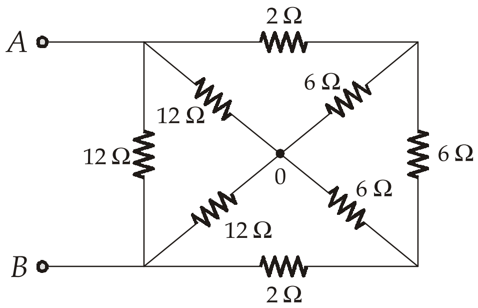
(a) The current I_1 is $\frac{4}{11}$ A.
(b) The current I_2 is $\frac{-16}{11}$ A.
(c) The voltage V_1 is 80 V.
(d) Power absorbed by 10 Ω resistor is 5.29 W.

■■■■

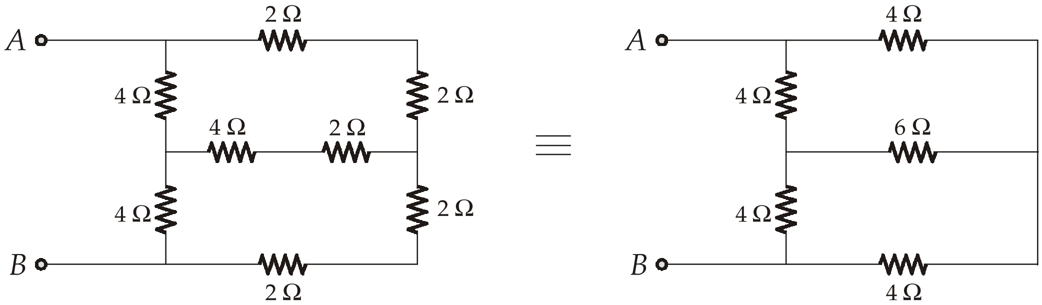
Detailed Explanations

126. **(b)**

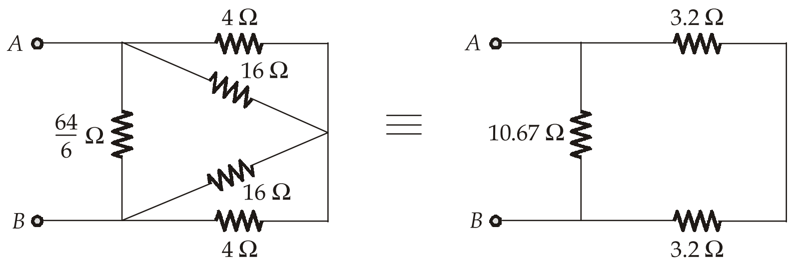
Redrawing the given circuit, we get,



Using Δ to Y conversion, we get,



Again using Y to Δ conversion, we have



or, $$R_{AB} = 10.67\ \Omega \,||\, (3.2\ \Omega + 3.2\ \Omega)$$

$$= \frac{10.67 \times 6.4}{10.67 + 6.4} = 3.99\ \Omega \approx 4\ \Omega$$

127. **(b)**

The current lags the voltage by 50° – 5° = 45°

∴ $$\omega L > \frac{1}{\omega C}$$

$$\tan 45° = 1 = \frac{\omega L - \frac{1}{\omega C}}{R}$$

and $$\frac{V_m}{I_m} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = \sqrt{R^2 + R^2}$$

$$\frac{100}{10} = \sqrt{2}\,R$$

or $R = 7.07\ \Omega$

$\because$ $R = \omega L - \dfrac{1}{\omega C}$

$$\frac{1}{\omega C} = 314 \times 40 \times 10^{-3} - 7.07$$

$$\frac{1}{\omega C} = 12.56 - 7.07 = 5.49$$

or $C = \dfrac{1}{314 \times 5.49} \approx 580\ \mu F$

128. (d)

$$Z_L = R \,\|\, (-jX_C) = \frac{R(-jX_C)}{R - jX_C} = \frac{R(-jX_C)}{R - jX_C} \times \frac{R + jX_C}{R + jX_C}$$

$$= \frac{RX_C^2}{R^2 + X_C^2} - j\frac{R^2 X_C}{R^2 + X_C^2} \qquad \text{...(i)}$$

For maximum power transfer $Z_L = Z_s^*$

$\because$ $Z_s = 100 + j200$

$\therefore$ $Z_L = 100 - j200$ ...(ii)

On comparing equation (i) and (ii), we get,

$$\frac{RX_C^2}{R^2 + X_C^2} = 100 \quad \text{and} \quad \frac{R^2 X_C}{R^2 + X_C^2} = 200$$

on solving, we get, $X_C = 250\ \Omega$

$$C = \frac{1}{500 X_C} = 8\ \mu F$$

and $R = 500\ \Omega$

129. 9.375 (9.10 to 9.50)

Let 'R' be the value of each resistor,

When connected in parallel, the equivalent resistor is given by

$$R_{eq} = \frac{1}{\frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R}} = \frac{R}{4}\ \Omega$$

$\therefore$ Power dissipated by the circuit,

$$P = \frac{V^2}{R_{eq}}$$

$$150 = \frac{V^2}{R/4}$$

or $\dfrac{V^2}{R} = \dfrac{150}{4}$ ...(i)

Now, the resistors are connected in series,

The equivalent resistor is given by,

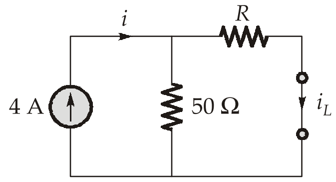
$$R_{eq} = R + R + R + R = 4R$$

∴ Power dissipated by the circuit,

$$P = \frac{V^2}{R_{eq}} = \frac{V^2}{4R} = \frac{1}{4}\left(\frac{150}{4}\right) = \frac{150}{16} = 9.375 \text{ W}$$

130. (50)

Under steady state, inductor behaves as a short circuit as shown in figure below,



Energy stored in inductor,

$$E = \frac{1}{2}Li_L^2 = 16 \text{ J}$$

$$\therefore \quad i_L = 2 \text{ A}$$

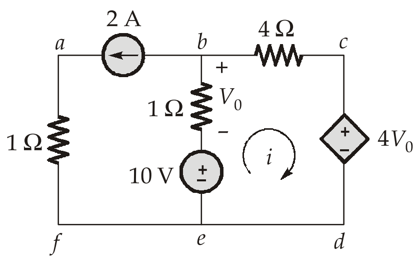
Applying current division,

$$2 = \frac{4 \times 50}{50 + R}$$

$$R = 50\ \Omega$$

131. (1152)

Redrawing the given circuit, we get,



In loop *bcdeb*,

$$-10 - V_0 + 4i + 4V_0 = 0$$

$$3V_0 + 4i = 10 \qquad \text{...(i)}$$

But, $V_0 = -(i + 2)1 = -i - 2$ ...(ii)

Using the above relation, we get,

$$3(-i - 2) + 4i = 10$$

$$-3i + 4i = 16$$

$$i = 16 \text{ A}$$

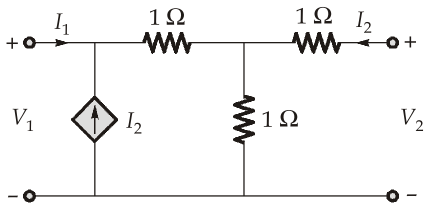
$$\therefore \quad V_0 = -i - 2 = -16 - 2 = -18 \text{ V}$$

∴ Power absorbed by dependent source = $4V_0 \times i = 4(-18) \times (16) = -1152$ W

(Here negative sign indicates that the depended source deliveres the power)

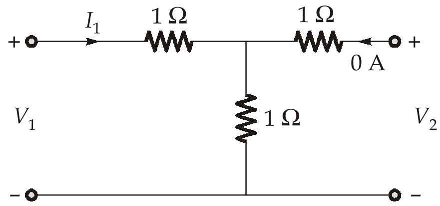
132. **(c)**

Let us first calculate z_{11} and z_{21} by open circuiting the output port,



$\because \quad I_2 = 0$

$\therefore$ The circuit can be redrawn as



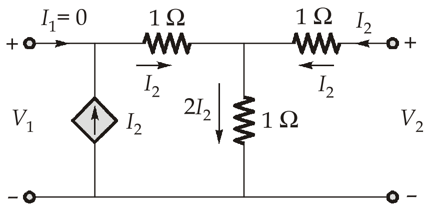
$$V_1 = 2I_1$$

and $$V_2 = I_1$$

$\therefore$ $$z_{11} = \frac{V_1}{I_1} = 2\ \Omega$$

and $$z_{21} = \frac{V_2}{I_1} = 1\ \Omega$$

Similarly z_{22} and z_{12} can be obtained by open circuiting the input port as,



$$V_1 = I_2 + 2I_2 = 3I_2$$

and $$V_2 = I_2 + 2I_2 = 3I_2$$

$\therefore$ $$z_{22} = \frac{V_2}{I_2} = 3\ \Omega$$

and $$z_{12} = \frac{V_1}{I_2} = 3\ \Omega$$

$\therefore$ $$z\text{-parameter matrix} = \begin{bmatrix} 2\ \Omega & 3\ \Omega \\ 1\ \Omega & 3\ \Omega \end{bmatrix}$$

133. **(82)**

Given equations,

$$V_1 = 16I_1 + 24I_2 \quad \text{...(i)}$$

$$V_2 = 32I_1 + 14I_2 \quad \text{...(ii)}$$

Also, $$V_2 = -I_2 \times R$$

$\therefore$ $$32I_1 = -(14 + R)I_2$$

or, $$I_2 = \frac{-32}{(R+14)} I_1 \quad \text{...(iii)}$$

Using equation (i) and (iii), we get,

$$V_1 = 16I_1 + 24\left(\frac{-32}{R+14}\right)I_1$$

or $$\frac{V_1}{I_1} = 16 - \frac{24\times 32}{R+14} = 8$$

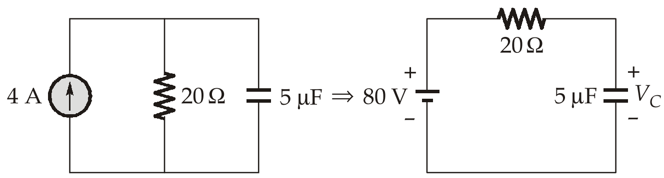
$$8 = \frac{24\times 32}{R+14}$$

$$96 = R + 14$$

or, $$R = 96 - 14 = 82\ \Omega$$

134. (d)

The circuit that exists for $t < 0$ is,



$$V = IR = 4 \times 20 = 80\text{ V}$$

∴ $$V_c(0^+) = V_c(0^-) = 80\text{ V}$$

Time constant, $$\tau = RC = 20 \times 5 \times 10^{-6} = 10^{-4}\ s$$

After $t = 0$, $$V_c(t) = V_\infty - (V_\infty - V_0)\, e^{-t/\tau}$$

$$= 0 - (0 - 80)\, e^{-t/\tau}$$

$$V_c(t) = 80e^{-10^4 t}$$

The half of initial voltage,

$$\frac{80}{2} = 40\text{ V}$$

∴ $$40 = 80e^{-10^4 t}$$

$$0.5 = e^{-10^4 t}$$

Time, $$t = 69.3\ \mu\text{s}$$

135. (a)

$$V_{ab} = V_{\text{Th}}$$

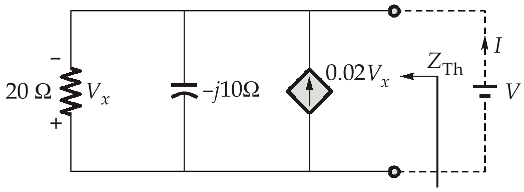
By applying KCL,

$$\frac{V_{Th}-100}{20} + \frac{V_{Th}}{-j10} = 0.02\, V_x$$

Where, $$V_x = 100 - V_{\text{Th}}$$

$$\frac{V_{Th}-100}{20} + \frac{V_{Th}}{-j10} = 0.02(100 - V_{Th})$$

$$V_{\text{Th}} = \frac{7}{0.07 + j0.1} = 57.34\angle{-55^\circ}\text{ V}$$



$$Z_{Th} = \frac{V}{I}$$

By apply KCL in the circuit gives,

$$\frac{V}{20} + \frac{V}{-j10} - 0.02V_x = I$$

and, $$V_x = -V$$

$$\therefore \quad \frac{V}{20} + \frac{V}{-j10} + 0.02V = I$$

$$Z_{Th} = \frac{V}{I} = \left[\frac{1}{\frac{1}{20} + \frac{1}{-j10} + 0.02}\right]$$

$$= (4.7 - j6.7)\Omega$$

136. 192.00 (190.00 to 194.00)

$$I_x = \frac{V_2 - V_1}{j1.92}$$

$$j2 + \frac{V_1}{4.8} + \frac{V_1 - V_2}{j1.92} = 0$$

$$V_1\left(\frac{1}{4.8} + \frac{1}{j1.92}\right) - \frac{V_2}{j1.92} = -j2$$

$$V_1\left(\frac{j1.92}{4.8} + 1\right) - V_2 = -j2 \times j1.92$$

$$V_1(1 + j0.4) - V_2 = 3.84$$

$$1.6\ I_x = I_x + \frac{V_2}{8}$$

$$0.6\ I_x = \frac{V_2}{8}$$

$$\frac{V_2 - V_1}{j1.92} = \frac{V_2}{8} \times \frac{1}{0.6}$$

$$V_2 - V_1 = j0.4\ V_2$$

$$V_2(1 - j0.4) = V_1$$

$$\therefore \quad V_2[1 + 0.16] - V_2 = 3.84$$

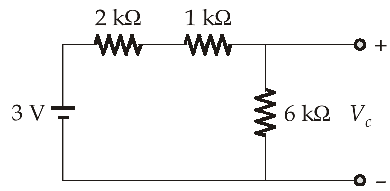
$$V_2 = 24\text{ V}$$

$$I_x = \frac{V_2}{4.8} = 5\text{A}$$

$$P = 1.6\ I_x \times V_2 = 8 \times 24 = 192\text{ W}$$

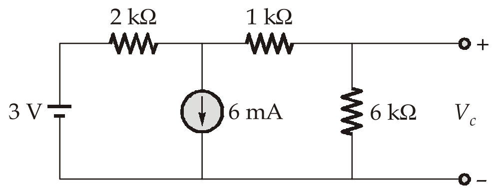
137. (a)

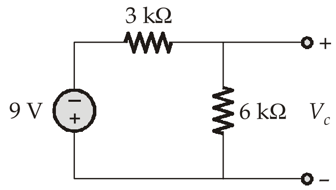
At $t < 0$,



$$V_c(0^-) = 3 \times \frac{6}{(6+3)} = \frac{18}{9} = 2\text{ V}$$

At $t > 0$,





$$v_c(\infty) = \frac{6}{9} \times (-9) = -6\text{ V}$$

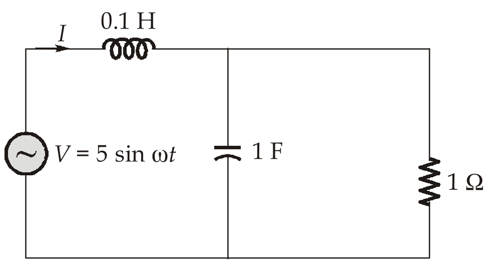
$$v_c(t) = -6 + (2 + 6)e^{-t/\tau}$$

$$\tau = \frac{18}{9} \times 1 = 2\ \mu\text{s}$$

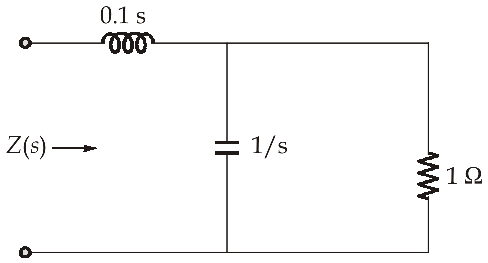
$$V_c(t) = -6 + 8e^{-\frac{t}{2}}$$

$$V_c(2\ \mu\text{s}) = -6 + 8e^{-1} = -3.06\text{ V}$$

138. (c)



For V and I in phase imaginary part of $Z(s)$, should be zero,



$$Z(s) = \frac{\frac{1}{s}\times 1}{\frac{1}{s}+1} + 0.1s = \frac{1+0.1s+0.1s^2}{s+1}$$

multiplying numerator and denominator by (s – 1)

$$Z(s) = \frac{(0.1s^2+0.1s+1)(s-1)}{(s+1)(s-1)}$$

$$= \frac{0.1s^3+0.1s^2+s-0.1s^2-0.1s-1}{s^2-1}$$

Put $s = j\omega$

$$Z(j\omega) = \frac{0.1(j\omega)^3+0.9(j\omega)-1}{(j\omega)^2-1} = \frac{j(0.9\omega-0.1\omega^3)-1}{-\omega^2-1}$$

Equating imaginary part to zero,

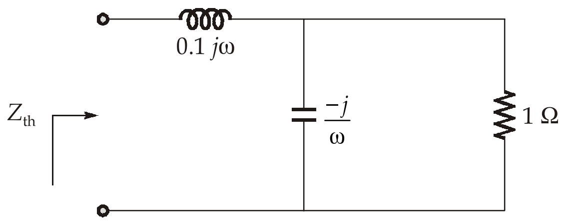
$$0.9\,\omega - 0.1\,\omega^3 = 0$$

$$\omega^2 = 9$$

$$\omega = \pm 3 \text{ rad/sec}$$

Alternative Solution:

In frequency domain,



$$Z_{th} = \frac{(1)(-j/\omega)}{1-j/\omega} + 0.1j\omega$$

$$\Rightarrow \quad \frac{j}{j-\omega} + 0.1j\omega = 0$$

$$\Rightarrow \quad \frac{j(j+\omega)}{(j-\omega)(j+\omega)} + 0.1j\omega = 0$$

$$\Rightarrow \quad \frac{1-j\omega}{1+\omega^2} + 0.1j\omega = 0$$

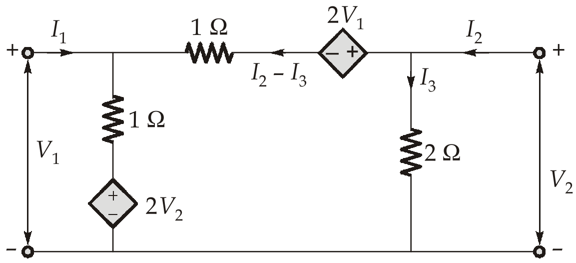
For V and I in phase, imaginary term = 0

Thus, $$\frac{-\omega}{1+\omega^2} + 0.1\omega = 0$$

$$\Rightarrow \quad \omega = 3 \text{ rad/s}$$

139. **(a)**

Transforming the dependent current source in to voltage source, the network is shown as,



Let I_3 be the current through 2 Ω

Apply KVL in outer loop,

$$-V_2 + 2V_1 + I_2 - I_3 + V_1 = 0$$

$$-V_2 + 3V_1 + I_2 - I_3 = 0 \quad ...(i)$$

Also,

$$-V_1 + I_1 + I_2 - I_3 + 2V_2 = 0 \quad ...(ii)$$

$$V_1 = I_1 + I_2 - I_3 + 2V_2$$

From equation (i) and (ii), we get

$$5V_2 + 3I_1 + 4I_2 - 4I_3 = 0$$

Where, $$I_3 = \frac{V_2}{2}$$

$$V_2 = -I_1 - \frac{4}{3}I_2$$

Hence, $$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = -1\Omega$$

140. **4.67 (4.5 to 4.8)**

The Thevenin's equivalent circuit across AB as shown in figure below,

The total resistance is

$$R_T = [\{(3 + 2)||5\} + 10]$$

$$= [2.5 + 10] = 12.5\ \Omega$$

Total current drawn by the circuit is,

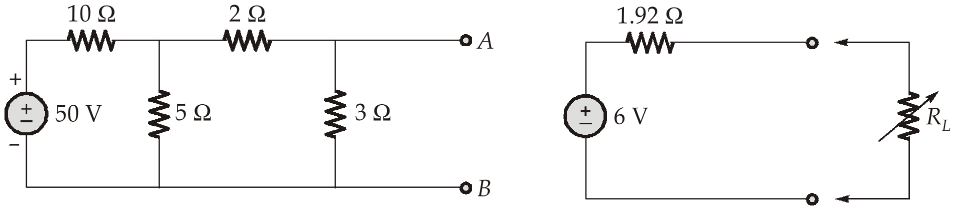
$$I_T = \frac{50}{12.5} = 4\text{ A}$$

The current in the 3 Ω-resistor is

$$I_3 = \frac{I_T \times 5}{5+5} = \frac{4 \times 5}{10} = 2\text{ A}$$

Thevenin's voltage, $V_{AB} = V_3 = 3 \times 2 = 6$ V

Thevenin's resistance, $R_{th} = R_{AB} = \left[((10 \,||\, 5) + 2) \,||\, 3\right]\Omega = 1.92\ \Omega$



(a) (b)

From figure (b) and maximum power transfer theorem,

$$R_L = 1.92\ \Omega$$

∴ current drawn by load resistance R_L

$$I_L = \frac{6}{1.92+1.92} = 1.56\ \text{A}$$

$$P_{\text{load}} = I_L^2 R_L = (1.56)^2 \times 1.92 = 4.67\ \text{W}$$

141. 1.32 (1.25 to 1.40)

$$Y = \frac{1}{10-j12}+\frac{1}{5+jX_L}$$

$$Y = \frac{10+j12}{10^2+12^2}+\frac{5-jX_L}{25+X_L^2}$$

$$= \frac{10}{10^2+12^2}+\frac{5}{25+X_L^2}+j\left[\frac{12}{10^2+12^2}-\frac{X_L}{25+X_L^2}\right]$$

At resonance the susceptance becomes zero,

Then, $$\frac{X_L}{25+X_L^2} = \frac{12}{10^2+12^2}$$

On solving, $$X_L = 18.98\ \Omega \text{ or } 1.32\ \Omega$$

Hence, $$L = \frac{18.98}{1000}\ \text{(or)}\ \frac{1.32}{1000} = 18.98\ \text{mH or } 1.32\ \text{mH}$$

Hence, 1.32 mH.

142. (b)

In the given circuit, the output Z is

$$Z = \overline{(\bar{A}+\bar{B})} = AB$$

Truth table is as given below:

X	$B \oplus X$ J_A	$B\bar{X}$ K_A	AX J_B	AX K_B	A	B	Z	
–	–	–	–	–	0	0	0	Initial
0	0	0	0	0	0	0	0	
1	1	0	0	0	1	0	0	
1	1	0	1	1	1	1	1	
0	1	1	0	0	0	1	0	
0	1	1	0	0	1	1	1	

Hence the sequence of output Z is 00101.

143. (1)

[D′ + AB′ + A′C + AC′D + A′C′D]′

= [D′ + AC′D + AB′ + A′C + A′C′D]′

= [D′ + AC′ + AB′ + A′ [C + C′D]]′

= [D′ + AC′ + AB′ + A′ [C + D]]′

= [D′ + AC′ + AB′ + A′C + A′D]′

(∵ D′ + A′D = D′ + A′)

= [D′ + A′ + AC′ + AB′ + A′C]′

(∵ A′ + A′C = A′)

(∵ A′ + AC′ + AB′ = A′+A(C′+B′) = A′ + C′ + B′)

= [D′ + A′ + C′ + B′]′

= ABCD

Hence, only 1 minterm is required.

144. (c)

$$S = \left[\overline{(P+Q)} + \overline{(P+(\overline{P+Q}))}\right]\overline{(P+(\overline{P+Q}))}$$

Considering, $\overline{P+Q} = X$ and $\overline{P+(\overline{P+Q})} = Y$

Then, $S = (X+Y)Y = XY + Y = Y$

$$S = \overline{P+(\overline{P+Q})} = \bar{P}.(P+Q) = \bar{P}Q$$

So for, $S = 1, P = 0, Q = 1$

145. (b)

From the combinational logic.

Assuming D is input, Q_n is present state.

Q_{n+1} is the next state, then

$$R = \overline{D \oplus Q} \quad , \qquad S = D \oplus Q$$

Characteristic equation of $R - S$ flip flop

$$Q_{n+1} = S + \bar{R}Q_{in}$$

So,

$$Q_{n+1} = (D \oplus Q_n) + (\overline{\overline{D \oplus Q_n}})Q_n$$

$$= (D \oplus Q_n) + (D \oplus Q_n)Q_n$$

$$= (D \oplus Q_n)[1 + Q_n]$$

$$= D \oplus Q_n$$

$$= D\bar{Q}_n + \bar{D}Q_n$$

For, $D = 0\,;\ Q_{n+1} = Q_n$

$D = 1\,;\ Q_{n+1} = \bar{Q}_n$

So the circuit functions as a T-flip flop.

146. **(a)**

$$\frac{2.86\text{V}}{30\text{ mV}} = 95.3$$

The step 95 would produce 2.85 V and step 96 would produce 2.88 V. The successive approximation type *ADC* always produces a final output, i.e., a step below the analog input.

∴ The digital result would be

$$95_{10} = 01011111_2$$

147. **(b)**

We have the logic function,

$$Z = AB + BC + CA$$

For the function, we form the K-map as shown below:

A \ BC	00	01	11	10
0	0	0	1	0
1	0	1	1	1

∴ $Z(A, B, C) = \Sigma m(3, 5, 6, 7)$

Therefore, during implementation of the function *Z*-using 8 to 1 MUX, inputs I_3, I_5, I_6 and I_7 will be at high logic (1) and rest inputs remain at logic (0).

Hence option (b) is correct.

148. **(5)**

	0	0	1	1
1st clock →	0	0	0	1
2nd clock →	1	0	0	0
3rd clock →	1	1	0	0
4th clock →	0	1	1	0
5th clock →	0	0	1	1

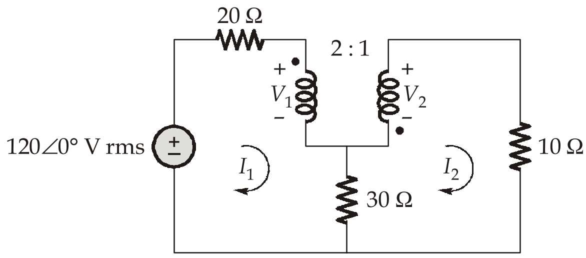
149. **(b)**

Q_1	Q_0	Q_1^+	Q_0^+	$T_1 = Q_1 \oplus Q_1^+$	$T_0 = Q_0 \oplus Q_0^+$
0	0	1	0	1	0
0	1	0	0	0	1
1	0	1	1	0	1
1	1	0	1	1	0

∴ $T_1 = \bar{Q}_1\bar{Q}_0 + Q_1Q_0 = Q_1 \odot Q_0$

$T_0 = \bar{Q}_1Q_0 + Q_1\bar{Q}_0 = Q_1 \oplus Q_0$

150. (a, c, d)



$$V_1 = -2V_2; \qquad I_2 = -2I_1$$

Apply KVL,

$$-120 + 20I_1 + 30(I_1 - I_2) + V_1 = 0$$
$$V_1 + 50I_1 - 30I_2 = 120$$
$$0.1\ V_1 + 5I_1 - 3I_2 = 12$$
$$V_1 + 5I_1 + 6I_1 = 12$$
$$0.1\ V_1 + 11I_1 = 12 \qquad \text{...(i)}$$
$$30(I_2 - I_1) - V_2 + 10I_2 = 0$$
$$-30I_1 + 40 \times (-2I_1) + \frac{V_1}{2} = 0$$
$$V_1 = 220I_1 \qquad \text{...(ii)}$$
$$0.1 \times 220I_1 + 11I_1 = 12$$
$$I_1 = \frac{4}{11}$$
$$I_2 = \frac{-8}{11} = -0.7272 \text{ A}$$

Power absorbed by 10 Ω resistor is,

$$= I_2^2 R$$
$$= (-0.7272)^2 \times 10 = 5.29 \text{ W}$$

■■■■