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GATE 2019

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PREFACE

It is an immense pleasure to present topic wise previous years solved paper of GATE Exam. This booklet has come out after long observation and detailed interaction with the students preparing for GATE exam and includes detailed explanation to all questions. The approach has been to provide explanation in such a way that just by going through the solutions, students will be able to understand the basic concepts and will apply these concepts in solving other questions that might be asked in future exams.

GATE exam now a days has become more important because it not only opens the door for higher education in institutes like IIT, IISC, NIT's but also many of the PSUs have started inducting students on the basis of GATE score. In PSU's, which are not inducting through GATE route, the questions in their exams are asked from GATE previous year papers. Thus, availability of authentic solutions to the students is the need of the day. Towards this end this booklet becomes indispensable.

I am thankful to IES master team without whose support, I don't think, this book could have been flawlessly produced.

Every care has been taken to bring an error free book. However comments for future improvement are most welcome.

Mr. Kanchan Kumar Thakur
Director Ex-IES

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1 UNIT

Network Theory

Syllabus

Network solution methods : nodal and mesh analysis; Network theorem; superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for network

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Chapter 1

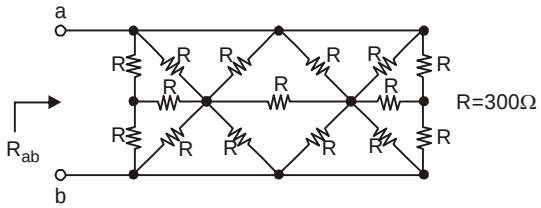
Basics of Network Analysis

1 – Mark

1. A connection is made consisting of resistance A in series with a parallel combination of resistances B and C. Three resistors of the value 10Ω, 5Ω, 2Ω are provided. Consider all possible permutations of the given resistors into the positions A, B, C, and identify the configurations with maximum possible overall resistance, and also the ones with minimum possible overall resistance. The ratio of maximum to minimum value of the resistances (upto second decimal place) is _____

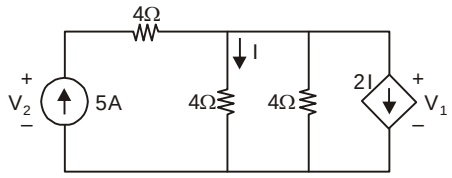
[GATE 2017]

2. In the network shown in the figure, all resistors are identical with $R = 300\Omega$. The resistance R_{ab} (in Ω) of the network is _____.



[GATE 2015]

3. In the given circuit, the values of V_1 and V_2 respectively are

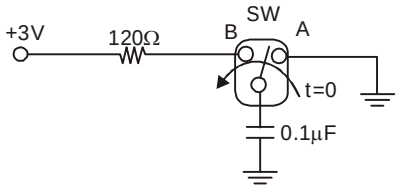


(a) 5V, 25V (b) 10V, 30V

(c) 15V, 35V (d) 0V, 20V

[GATE 2015]

4. In the circuit shown, the switch SW is thrown from position A to position B at time t = 0. The energy (in μJ) taken from the 3V source to charge the $0.1\,\mu F$ capacitor from 0V to 3V is

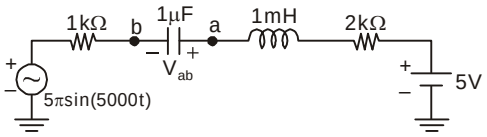


(a) 0.3 (b) 0.45

(c) 0.9 (d) 3

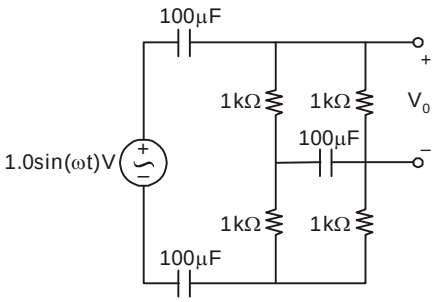
[GATE 2015]

5. In the circuit shown, the average value of the voltage V_{ab} (in Volts) in steady state condition is _____



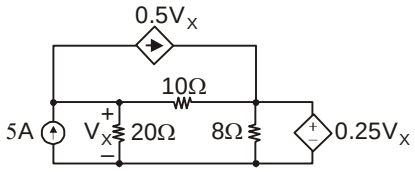
[GATE 2015]

6. At very high frequencies, the peak output voltage V_0(in Volts) is _____



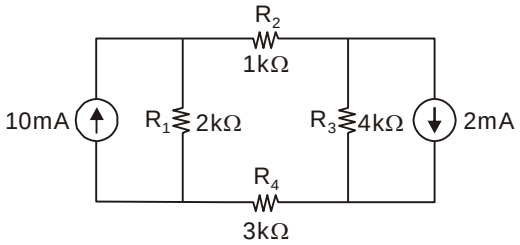
[GATE 2015]

7. In the circuit shown, the voltage V_x (in Volts) is _____



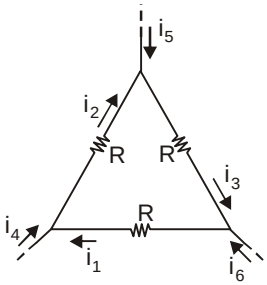
[GATE 2015]

8. The magnitude of current (in mA) through the resistor R_2 in the figure shown is ____.



[GATE 2014]

9. Consider the configuration in the figure which is a portion of a larger electrical network.



For $R = 1\Omega$ and currents $i_1 = 2A$, $i_4 = -1$ A, $i_5 = -4$A, which one of the following is TRUE ?

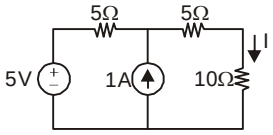
(a) i_6 = 5 A

(b) i_3 = –4A

(c) Data is sufficient to conclude that the supposed currents are impossible.

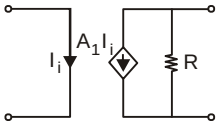
(d) Data is insufficient to identify the currents i_2, i_3 and i_6. **[GATE 2014]**

10. In the figure shown, the value of the current I (in Amperes) is _____.



[GATE 2014]

11. The circuit shown in the figure represents a



(a) voltage controlled voltage source

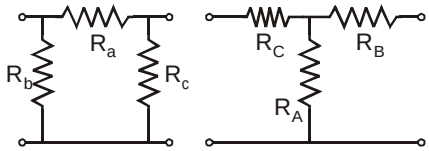
(b) voltage controlled current source

(c) current controlled current source

(d) current controlled voltage source

[GATE 2014]

12. Consider a delta connection of resistors and its equivalent star connection as shown below. If all elements of the delta connection are scaled by a factor 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) $\sqrt{k}$

[GATE 2013]

13. The average power delivered to an impedance $(4-j3)\Omega$ by a current $5\cos(100\pi t + 100)$ A is

(a) 44.2 W (b) 50 W

(c) 62.5 W (d) 125 W

[GATE 2012]

ANSWER KEY

1 Mark

1. (2.14)
2. (100)
3. (a)
4. (c)
5. (5)
6. (0.5)
7. (8)
8. (2.8)
9. (a)
10. (0.5)
11. (c)
12. (b)
13. (b)
14. (a)
15. (c)
16. (a)
17. (d)
18. (a)
19. (c)
20. (a)
21. (d)
22. (a)
23. (b)
24. (c)
25. (b)
26. (a)
27. (d)
28. (a)
29. (d)
30. (a & d)

2 Marks

1. (8.00)
2. (a)
3. (1)
4. (d)
5. (5)
6. (–1A)
7. (1.5)
8. (20)
9. (29.09)
10. (2.504)
11. (10)
12. (0.4083)
13. (2.618)
14. (c)
15. (d)
16. (c)
17. (a)
18. (a)
19. (c)
20. (b)
21. (a)
22. (None of these)
23. (d)
24. (d)
25. (d)
26. (d)
27. (b)
28. (b)
29. (d)
30. (a)

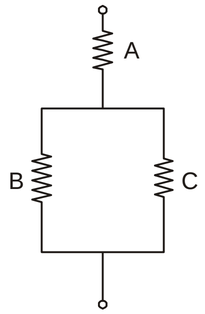
3 Marks

1. (c)

Solutions

1 – Mark

Sol–1:



Resistor are 2, 5 and 10Ω

For maximum resistance B = 2, C = 5, A = 10

$$R_{max} = \frac{80}{7}$$

for minimum resistance,

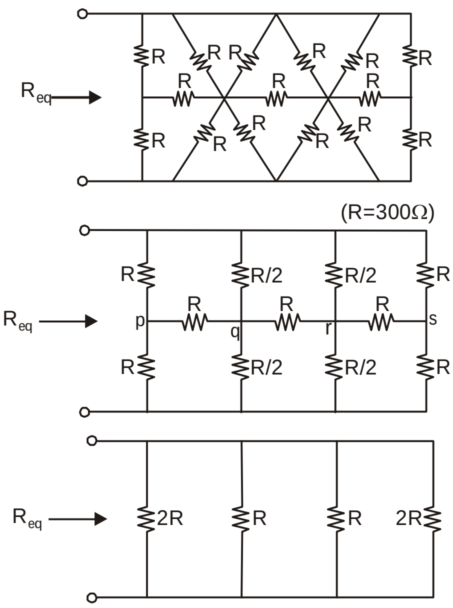
A = 2, B = 5, C = 10

$$R_{min} = \frac{16}{3}$$

$$\frac{R_{max}}{R_{min}} = \frac{(80/7)}{(16/3)}$$

$$= 2.14$$

Sol–2: (100)

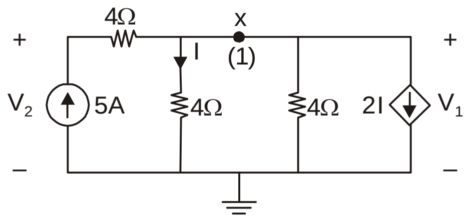


[Here, branch 'pqrs' is removed as no current flows through it, because it forms a balanced bridge]

$$\therefore \quad R_{eq} = (2R)\,\|\,(2R)\,\|\,R\,\|\,R$$

$$= R\|R\|R = \frac{R}{3} = 100\Omega$$

Sol–3: (a)



Applying nodal analysis at node (1), we get

$$5 = \frac{x}{4} + \frac{x}{4} + 2I$$

$$\Rightarrow \quad 5 = \frac{2x}{4} + 2\times\frac{x}{4} \qquad [\because x = 4I]$$

$$\therefore \quad x = 5$$

$$\text{Now,} V_1 = 5V \qquad [\because x = V_1]$$

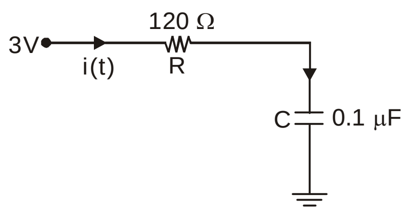
$$V_1 + 5\times 4 - V_2 = 0$$

[KVL in the outermost loop]

$$\Rightarrow \quad V_2 = 5 + 5 \times 4 = 25\ V$$

Sol–4: (c)

Initially capacitor is uncharged. For $t > 0$, the circuit will be :



Current in RC circuit while charging is given by :

$$i(t) = \frac{V_0}{R}e^{-t/RC} \quad \text{where } V_0 = 3V$$

Power delivered by the source = P

$$= 3i(t) \qquad [\because P = V.I]$$

Also, Energy = $\int_0^t P\,dt = \int_0^t 3i(t)\,dt$

Capacitor gets fully charged at steady state i.e $t = \infty$.

$$\therefore \quad E = \int_0^\infty 3.\frac{V_0}{R}e^{-t/RC}\,dt$$

$$= \frac{3V_0}{R} \times \frac{(-1)}{(1/RC)}\left[e^{-t/RC}\right]_0^\infty$$

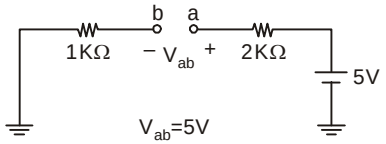
$$= -3V_0C\left[e^{-\infty} - e^0\right]$$

$$= -3 \times 3 \times 0.1[0-1]\mu J$$

$$E = 0.9\mu J$$

Sol–5: (5)

- For AC input voltage $5\pi\sin(5000t)$, voltage across capacitor (C) at steady state is also sinusoidal, whose average value is zero.
- For DC voltage = 5V, at steady state capacitor behaves as open circuit and inductor behaves as short circuit, therefore circuit is



Average value of voltage across capacitor is V_{ab} = 5V.

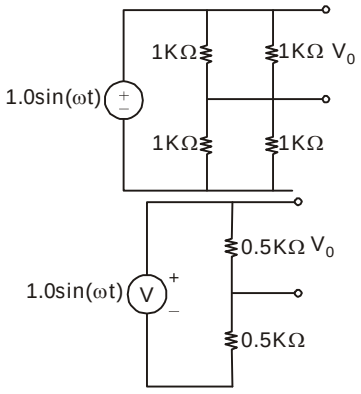
Sol–6: (0.5)

At very high frequencies, capacitor behaves as short-circuit.

$$\because \quad X_C = \frac{1}{j\omega C}$$

When $\omega \to \infty$, $X_C \to 0$[short circuit]

When all capacitors are replaced by short-circuit.



By voltage division rule

$$V_0 = \frac{0.5}{0.5+0.5}V$$

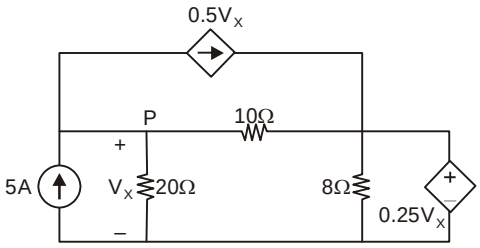
$$V_0 = \frac{V}{2}$$

$$V_0 = \frac{1}{2}[1.0\sin(\omega t)]$$

$$V_0 = 0.5\sin(\omega t)$$

$$(V_0)_{peak} = 0.5 \text{ Volts}$$

Sol–7: (8)



Apply KCL at point P

$$\frac{V_x}{20} + \frac{V_x - 0.25V_x}{10} + 0.5V_x = 5$$

$$V_x\left(\frac{1}{20} + \frac{75}{1000} + \frac{1}{2}\right) = 5$$

$$V_x\left(\frac{1}{20} + \frac{3}{40} + \frac{1}{2}\right) = 5$$

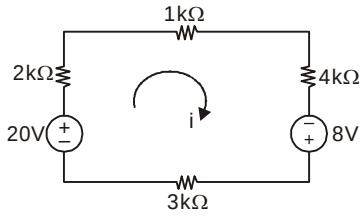
$$V_x\left(\frac{2+3+20}{40}\right) = 5$$

$$V_x\left(\frac{5}{8}\right) = 5$$

$\therefore$ V_x = 8 Volts

Sol–8: (2.8)

Transforming current sources into voltage sources, we get



$$i = \frac{20+8}{(2+1+4+3)k} = 2.8 \text{ mA}$$

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