Code : 100306

B. Tech 3rd Semester Exam., 2019
(New Course)

ELECTRICAL CIRCUIT ANALYSIS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any *seven* of the following as directed : 2×7=14

(a) Using the superposition theorem, determine the current through resistor R_2 for the network shown in Fig. 1 :

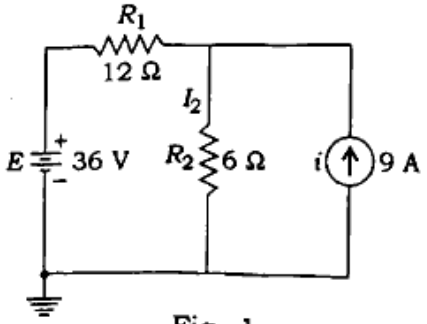


Fig. 1

(b) Demonstrate why superposition theorem is not used for power calculation. Take Fig. 1 to justify your answer.

(c) A passive network in the *s*-domain is shown in Fig. 2 :

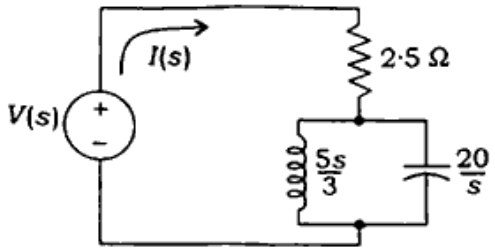


Fig. 2

Obtain the network function for the current $I(s)$ due to an input voltage $V(s)$.

(d) Find the Thévenin equivalent circuit for the network in the shaded area of the Fig. 3 shown below :

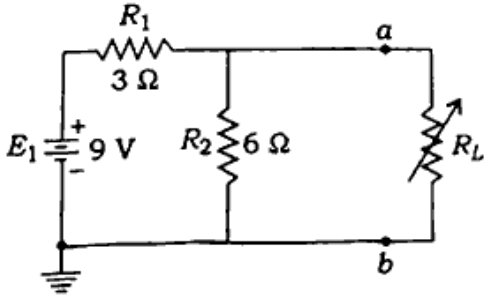


Fig. 3

(e) Find the Norton equivalent circuit for the network external to the 9 Ω resistor shown in Fig. 4 :

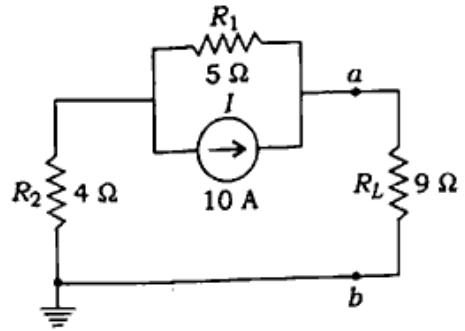


Fig. 4

(f) Show that $AD - BC = 1$.

(g) A network with 5 independent loops and 7 nodes will have ____ number of branches in the electrical network.

(Fill in the blank)

(h) The time-constant of the circuit shown in Fig. 5 is RC sec.

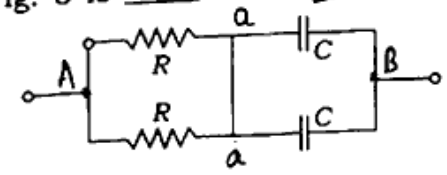


Fig. 5

(Fill in the blank)

(i) In the circuit shown in Fig. 6, the initial voltage across the capacitor is 4 V. Switch S_1 is closed at $t = 0$. The charge (in μC) lost by the capacitor from $t = 25\ \mu s$ to $t = 100\ \mu s$ is ____.

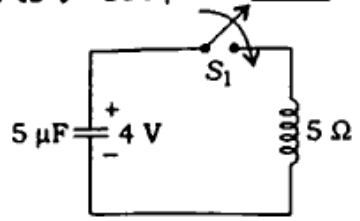


Fig. 6

(Fill in the blank)

(j) The Z-matrix of a two-port network is given as

$$Z = \begin{bmatrix} 0{\cdot}9 & 0{\cdot}2 \\ 0{\cdot}2 & 0{\cdot}6 \end{bmatrix}$$

Find the parameters Y_{21} and Y_{22}.

2. (a) Find the Thévenin circuit for the network within the shaded area of Fig. 7 shown below : 7

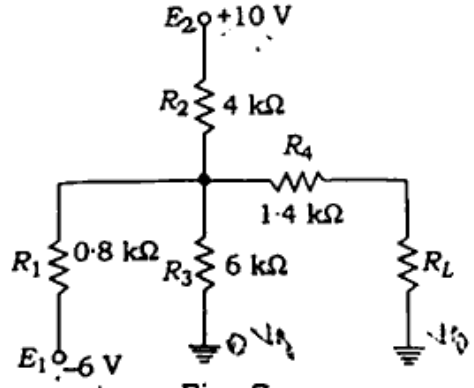


Fig. 7

(b) State maximum power transfer theorem. Prove that efficiency of the circuit under maximum power transfer condition is 50%. 2+5

3. (a) A voltage $v = 140\cos(\omega t)$ is connected across an impedance $Z = 5\angle -60°$. The voltage v results in a current $i = 28\cos(\omega t + 60°)$. Calculate the power $p(t)$. 3

(b) Define complex power, apparent power and power triangle. 3

(c) Define half-power frequency. Find the condition of resonance in a parallel *R-L-C* circuit. 1+3

(d) For the series *R-L-C* circuit show in Fig. 8, find the resonant frequency $\omega_0 = 2\pi f_0$:

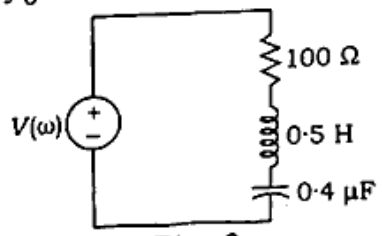


Fig. 8

Also obtain the half-power frequencies and the bandwidth. 4

4. (a) State reciprocity theorem. Verify the reciprocity theorem for the circuit shown in Fig. 9 : 2+5

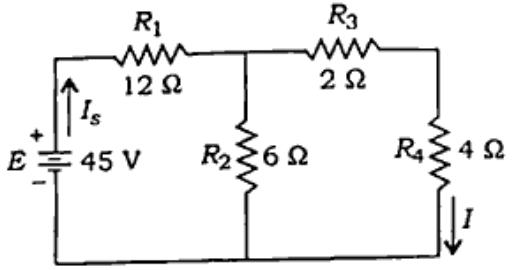


Fig. 9

(b) The analysis of a transistor network resulted in the reduced equivalent in Fig. 10 shown below :

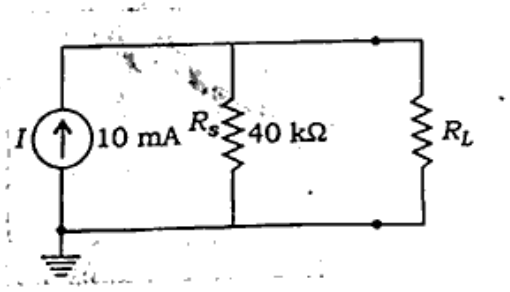


Fig. 10

Find the load resistance that will result in maximum power transfer to the load, and also find the maximum power delivered. 5

(c) Define supermesh and supernode. 2

5. (a) Derive an expression of r.m.s. value of a half-wave rectified voltage output. 3

(b) $E = 150\sin(314t)$ is applied to a device which offers a resistance of 20 Ω to the flow of current in one direction while preventing the flow of current in opposite direction. Calculate the r.m.s., average value and form factor for the current over one cycle. 7

(c) A coil takes a current of 2 A when connected to 240 V, 50 Hz sinusoidal supply and consumes 200 watt power. Calculate the resistance, inductance and impedance of the coil. 4

6. (a) A circuit consists of series combination of resistance of 6 Ω, inductance of 0·4 H, and a variable capacitor across 100 V, 50 Hz supply. Calculate the *(i)* value of capacitor at resonance, *(ii)* voltage drop across capacitor and *(iii)* Q-factor of the coil. 6

(b) Find the Laplace transform of $f(t) = 1 - e^{-at}$, where a is a constant. 3

(c) Find inverse Laplace of

$$F(s) = \frac{(s+1)}{s(s^2+4s+4)}$$ 5

7. (a) In the series *R-L-C* circuit shown in Fig. 11, there is no initial charge on the capacitor :

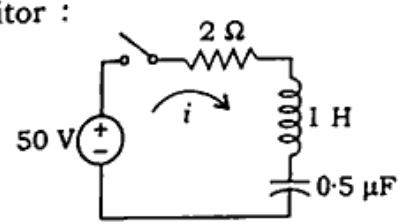


Fig. 11

If the switch is closed at $t = 0$, determine the resulting current. 5

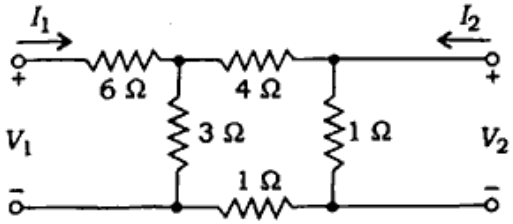
(b) Define transfer function. What are the significances of poles and zeroes? 2+2

(c) Derive the impulse response of series *R-L* circuit. 4

(d) Draw the phasor diagram of an ideal transformer. 1

8. (a) Define transmission parameter. Find the condition of reciprocity of *h*-parameters. 1+3

(b) Find the *Z*-parameters of the circuit shown in Fig. 12 : 5



(All resistances are in ohm)

Fig. 12

(c) Two two-port networks a and b, with open-circuit impedances Z_a and Z_b, are connected in series. Derive the Z-parameters equations. 5

9. (a) Find the incidence matrix of the network shown in Fig. 13 : 5

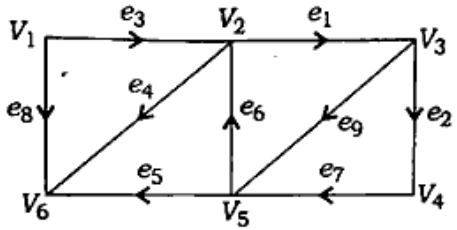


Fig. 13

(b) Find out the cut-set matrix of the network shown in Fig. 14 : 5

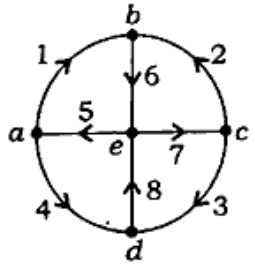


Fig. 14

(c) Show that the steady-state errors of a first-order system with ramp input is equal to its time constant (T). 4

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