

3.9 Questions

[Passive sign convention is assumed throughout]

1. What is meant by *linearity* of an electrical element? Show that a resistor satisfying Ohm's law is a linear element.
2. What are series equivalent and parallel equivalent of n equal resistors?
3. Show that a resistor in parallel with a short-circuit is a short-circuit.
4. Show that a resistor in series with an open-circuit is an open-circuit.
5. Show that the parallel equivalent of a set of resistors will be less than the resistor with the least value among them.
6. How many different values of resistance can be obtained by using 5 resistors of equal value in series-parallel combinations? Enumerate them.
7. Explain why an inductor needs an initial condition specification whereas a resistor does not.
8. The voltage across a 0.1 H inductor is seen to be 7.5 V at $t = 7$ ms. What is the current in the inductor at that instant?
9. The voltage across a 0.1 H inductor is seen to be a constant at 10 V between 10 ms and 15 ms. The current through the inductor was 0.3 A at 12 ms. What is the current at 13.5 ms?
10. The area under voltage waveform applied to a 10 mH inductor is 5 mV-sec between 7 ms and 9 ms. If the current at 7 ms was 1 A how much is it at 9 ms?
11. An inductor of 0.2 H has current of 2 A at $t = 0^-$ in it. The voltage applied across it is $3\delta(t-2)$. Find the current in it (a) at 1 s (b) at 3 s.
12. An inductor of 2 H undergoes a flux linkage change of 7 Wb-T between 15 sec and 17 sec. What is the average voltage applied to the inductor during that interval?
13. Two identical inductors L_1 and L_2 undergo a flux linkage change by 10 Wb-T. L_1 takes 2 sec for this change and L_2 takes 20 sec. What is the ratio of average voltage applied to the inductors during the relevant intervals?
14. A 10 H has an initial energy equivalent to the energy consumed by a 40 W lamp in 1 hour. Find the initial current in the inductor.
15. A dc voltage source of 24 V is switched on to an initially relaxed inductor of 4 H through a 48 A fuse. Assume that the fuse acts instantaneously when current through it touches 48 A. How much time do we have to open the switch before the fuse blows?
16. A dc source of 12 V is switched on to an inductor of 0.5 H at $t = 0$. The current in it is found to be 0 A at 5 sec. Was there any initial stored energy in the inductor? If yes, how much?
17. A symmetric triangular voltage waveform with a peak-to-peak value of 20 V and frequency 1 kHz is applied to an inductor from 0 sec onwards. The inductor was carrying an initial current of 10 A. The inductor current is found to vary within $\pm 3\%$ of its initial current subsequently. What is the value of inductance?
18. Two inductors of 1 H and 1.8 H with initial currents of 5 A and 2 A respectively are connected in parallel. How much energy can be taken out from this parallel combination?
19. Three inductors are connected in series and the current in the circuit is found to vary at the rate of 7 A/s at an instant when the applied voltage was at 14 V. The value of voltage measured across the third inductor at the same instant was 4 V. What is the value of the third inductor?
20. Two inductors with zero initial energy were paralleled at $t = 0$ and a voltage source was applied across them. The rate of change of source current at 2 sec is 5 A/s and the source voltage at that time was 2.5 V. It was also found that the first inductor had a stored energy which twice that of the second inductor. Find the inductance values.
21. How much time is required to charge a 10 mF capacitor with an initial voltage of -100V to $+100\text{V}$ using a dc current source of value 10 mA ?
22. The voltage rating of a 10 μF capacitor is 100 V. It is being charged by a 100 μA pulse current source. Its initial voltage was -75V . What is the maximum pulse width the current source can have if we do not want to end up with a blown capacitor?
23. The dc power supply in a PC uses 470 μF capacitor across its dc output. The dc output value is normally 320 V. The PC can function without rebooting till the dc voltage across falls to 220 V. If the PC takes a constant current of 0.5 A from the dc output while it is functioning, find out how long it will continue running after the ac mains goes off.
24. A 5 mF capacitor undergoes a change in its voltage by 25 V in 10 ms. What is the average value during that interval of the current source output used to charge this capacitor?
25. A symmetric triangular current waveform with a peak-to-peak value of 20 mA and frequency 10 kHz is applied to a capacitor from 0 sec onwards. The capacitor was carrying an initial voltage of 10V. The capacitor voltage is found to vary within $\pm 5\%$ of its initial voltage subsequently. What is the value of capacitance?
26. A dc current source of 12 mA is switched on to an capacitor of 0.5mF at $t = 0$. The voltage in it is found to be 0 V at 5 sec. Was there any initial stored energy in the capacitor? If yes, how much?
27. A sinusoidal current source $2 \sin 200t$ A is applied to three capacitors – 0.1 mF , 0.2 mf and 0.05 mF in series. What is the peak-to-peak voltage developed across the combination? Which capacitor has highest peak-to-peak voltage across it ?
28. Three capacitors – 10 μF , 22 μF and 33 μF – are in parallel. The circuit is driven by a ac current source $10 \cos 300t$ A. What is the peak-to-peak voltage developed across the combination?