DC CIRCUITS

Theory Questions

1. State and explain Ohm's law and discuss its limitations.
2. Sate Kirchhoff's current and voltage law and explain them with the help of an example.

Numericals

1. Two resistors A & B are connected in series across a constant 100V supply. A voltmeter of resistance 10kΩ reads 70V when connected across A, and reads 20V when connected across B. Find the values of A & B using KCL. (Answer: 5kΩ, 1.43kΩ)

2. When a certain battery with internal resistance is loaded by 60Ω resistor, its terminal voltage is 98.4V. When it is loaded by a 90Ω resistor, its terminal voltage is 98.9V. What load resistance would give a terminal voltage of 90V. (Answer: 8.4Ω)

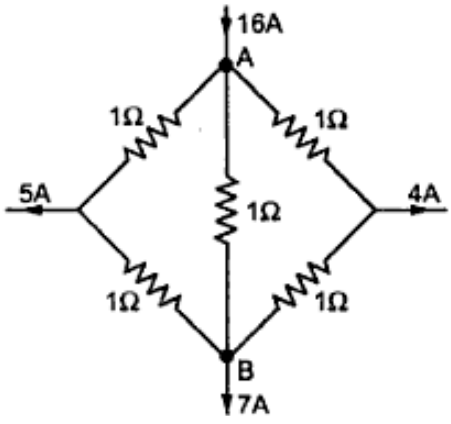
3. Two devices rated 60W, 110V and 40W, 110V are connected in series across 110V dc supply. Find the actual power consumed by each of the load and the total current drawn from the supply. If the loads were connected in parallel across the same supply, what would be the individual powers taken by each of the loads and the total power taken from the source. (Answer: 9.58W, 14.37W, 0.22A, 60W, 40W, 100W)

4. Two batteries of A & B are connected in parallel to supply a load resistance of 1.2Ω. Draw the circuit arrangement. Calculate current in the load and the current supplied by each battery if the emf of A & B are 12.5V & 12.8V respectively. The internal resistance of A being 0.05Ω and that of B is 0.08Ω. (Answer: 4A, 6.25A, 10.25A)

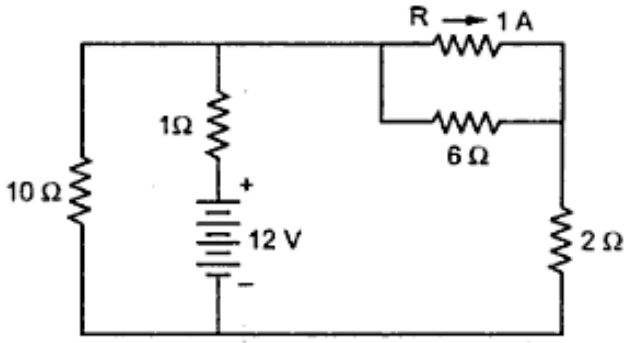
5. Two devices rated 500W, 100V and 256W, 80V has to be connected in parallel across a 100V dc supply. How to design a proper circuit including two safety devices in each branch with its current rating? What will be the total current supplied by the source. (Answer: 5A, 3.2A, 8.2A, 6.25Ω)

6. A 20Ω resistance is joined in parallel with a resistance of RΩ. This combination is then joined in series with a piece of apparatus A and the whole circuit connected to 100V mains. What must be the value of R so that A shall dissipate 600W with 10A passing through it. (Answer: 5Ω)

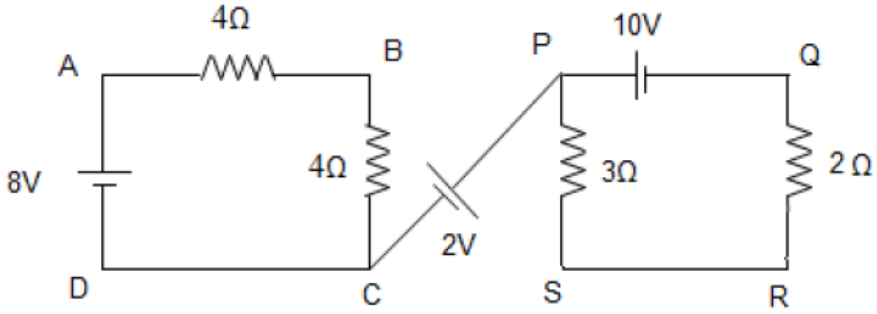
7. Find the current through branch A-B in the circuit shown in the following figure. (Answer: 5.75A)



8. Find the value of 'R' so that 1A would flow in it for the network shown in the following figure. (Answer: 5.38Ω)



9. Find V_{BS}, V_{AQ} and V_{DR} in the network shown in the following figure. (Answer: 8V, 16V, 4V)



10. Two resistive loads A& B of ratings 100V, 10W and 100V, 2.5W respectively are connected in series across a constant voltage supply of 100V. A voltmeter having an internal resistance of 12kΩ is connected across B. Calculate the voltage across B before and after voltmeter was connected. Also, find the change in supply current when voltmeter is connected. (Answer: 80V, 75V, 5mA)

11. A dc circuit comprises two resistors; resistor A of value 25Ω and resistor B of unknown value connected in parallel, together with a third resistor C of value 5Ω connected in series with the parallel branch. Find the voltage to be applied across the whole circuit and the value of resistor B if the potential difference across C is 90V, and the total power consumed is 4320W. (Answer: 240V, 12.5Ω)

SINGLE PHASE AC CIRCUITS

Theory Questions

1. Derive an expression for R.M.S value and average value of a sinusoidally varying alternating quantity.
2. Define form factor and peak factor.
3. With a neat diagram, derive an expression for the relationship between voltage and current in a pure inductive (pure capacitive) circuit and show that the average power dissipated is zero. Draw the waveforms of Voltage, Current and Power.
4. Define power factor of a circuit and mention its importance. What are the power factors of pure resistance, pure inductance and pure capacitance.
5. With a neat diagram, derive an expression for the relationship between voltage and current in a series RL (series RC circuit) and show that the average power dissipated is VIcosΦ. Draw the waveforms of Voltage, Current and Power.
6. Show that current in a series RL (series RC) circuit lags (leads) the supply voltage with an appropriate vector diagram. Hence, derive an expression for power consumed in the circuit and also draw the waveforms of Voltage, Current and Power.
7. With a neat diagram, derive an expression for the relationship between voltage and current in a series RLC circuit for XL = XC case and show that the average power dissipated is VI. Draw the waveforms of Voltage, Current and Power.
8. With a neat diagram, derive an expression for the relationship between voltage and current in a series RLC circuit for XL < XC (XL > XC) case and show that the average power dissipated is VIcosΦ. Draw the waveforms of Voltage, Current and Power.
9. Draw the impedance triangle, voltage triangle and power triangle of a series RL, RC and RLC circuit.

Numericals

1. The equation of an alternating current is i = 42.42sin(628t)A. Calculate i) its maximum value, ii) Frequency, iii) rms value, iv) average value and v) form factor. (Answer: 42.42A, 100Hz, 30A, 27A, 1.11)

2. In a series RL circuit, voltage and current are expressed by e = 15sin(314t+5π/6)V, i = 5sin(314t+2π/3)A. Find a) impedance, b) resistance, c) inductance, d) average power, e) power factor and f) voltage across R and X_L. (Answer: 3Ω, 2.6Ω,4.77mH, 32.5W, 0.866, 9.2V, 5.3V)

3. In a circuit supplied from 50Hz, the voltage and current have maximum values of 500V and 10A respectively. At t=0, their respective values are 400V and 4A both increasing positively. (i)Write expression for their instantaneous values, (ii) find the angle between V and I and (iii) find current at t=0.015s. (Answer: $v=500\sin(\omega t+53.13^0)$, $i=10\sin(\omega t+23.58^0)$, 29.55^0, -9.165A)

4. A coil connected to a 250V, 50Hz sinusoidal supply takes a current of 10A at a phase angle of 30^0. Calculate the resistance, inductance and power taken by the coil. (Answer: 21.65Ω, 39.8mH, 2165W)

5. An inductance coil connected in series with a resistance of 50Ω across a 230V, 50Hz a.c. supply. The Voltage across the coil is 180V and across the resistance is 130V. Calculate a) resistance and inductance of the coil, and b) power dissipated in the coil. Also, draw the vector diagram. (Answer: 5.32Ω, 220mH, 36W)

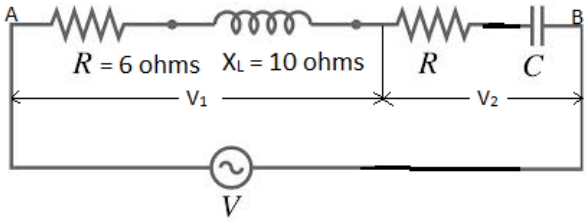
6. Two coils A & B are connected in series across a 240V, 50Hz supply. The resistance of coil A is 5Ω and the inductance of coil B is 0.015H. The input active and reactive powers from the supply is 3KW and 2KVAR respectively. Draw the power triangle. Find the inductance of coil A and resistance of coil B. Find voltage across each coil. (Answer: 0.013H, 8.33Ω, 96.84V, 143.56V)

7. Resistor R in series with a capacitor C is connected to a 50Hz, 240V supply. Find the value of C so that R absorbs 300W at 100V. (Answer: 43.76μF)

8. A series RLC circuit is composed of a 100Ω resistance, a 1H inductance and a 5μF capacitance. A Voltage v = 141.4cos377t V is applied to the circuit. Determine the current, p.f and Voltages V_R, V_L and V_C. (Answer: 0.55A, 0.55, 55V, 207.35V, 291.78V)

9. A coil of power factor 0.6 is in series with a 100μF capacitor. When it is connected to a 230V, 50Hz supply the potential difference across the coil is equal to the potential difference across the capacitor. Find the resistance and inductance of the coil. Also find the power consumed by the coil. (Answer: 19.1Ω, 81mH, 2495W)

10. With reference to the figure given below, find the values of R and C so that $V_1=3V_2$ and V_1 and V_2 are in quadrature. Applied Voltage across AB is 240V. (Answer: 3.34Ω, 1.59mF)



11. Two circuits A and B are connected in parallel across a 200V, 50Hz mains circuit. A consists of a resistance of 10Ω and an inductance of 0.12H connected in series circuit. B consists of a resistance 20Ω in series with a capacitance of 40μF. Calculate (a) current in each branch, (b) source current and (c) power factor. (Answer: (1.328-j4.96)A, (0.59+j2.36)A, $3.23|\underline{-53.58}^0$A, 0.59lag)

12. Two devices A and B are connected in parallel, rms current in A is 15A. If the current in B lags behind that in A by π/3 radians, and the total current is 23.4A, find I_B. (Answer: 11.96A)

13. Two circuits of impedance Z_1 = (10+j15)Ω and Z_2 = (6+j8)Ω are connected in parallel. If the total current is 15A, what will be the power taken by each branch. (Answer: 286W, 559W)

14. Two impedances (4+j10)Ω and (6+j4)Ω are connected in parallel across a.c. supply and dissipate 600W. Find the power taken when the impedances are connected in series across the same supply. (Answer: 134.7W)

15. How is a current of 10A shared by 3 circuits in parallel, the impedances of which are (2-j5)Ω, (6+j3)Ω and (3+j4)Ω. (Answer: $5.68|\underline{68}^0$A, $4.56|\underline{-26.56}^0$A, $6.12|\underline{-53.13}^0$A)

16. Two impedances $20|\underline{-45}$Ω and 30 $|\underline{30^o}$Ω are connected in series across a certain supply and the resulting current is found to be 10A. If the supply Voltage remains unchanged, calculate the supply current when the impedances are connected in parallel. (Answer: 26.84A)