**Chapter – 7 Alternating Current**

1. **Alternating current and voltage**:

(i) The alternating current changes in magnitude and direction periodically. It is represented by a sine or

cosine curve.

(ii) The instantaneous value of an AC is given by: I= Io sin*w*t ------------- (1);

and the alternating voltage is given by: V= Vo sin*w*t ------------- (2);

Here, *w* is the angular frequency of AC and (w/2π) is the frequency of AC. (2π/w) represents the time period

of AC.

(iii) In one cycle of AC, current increases from zero to a maximum, then decreases to zero and reverses in

direction, increases to maximum in the reverse direction and then decreases to zero. Thus, current is zero twice in one cycle and is numerically maximum also twice in one cycle, once in the forward direction and once in the backward direction in one cycle. Time taken to complete one cycle is called Time Period. The frequency of AC represents the number of cycles of AC completed in one second. AC supplied in India has a frequency of 50 Hz.

2. **Peak value, Mean value and RMS value of AC:**

(i) Peak value: Peak value of AC is the maximum value of current in either direction of the cycle. Io is the peak value of AC in equation (l).

(ii) Mean value:

(a) The mean value of AC represents by the equation, I= Io sin*w*t , is zero over one complete cycle and is meaningless. In practice, mean value of alternating current refers to its average value over either the first half cycle or the second half cycle.

Over first half cycle, Imean = 2Io/π Over second half cycle, Imean = - 2Io/π

Numerically, Imean = 2Io/π

(b) **A moving coil galvanometer, connected to an AC source of 50 Hz AC, shows a steady zero reading of the pointer. If the frequency is 2 Hz or,4Hz, the pointer oscillates with equal amplitude on either side of zero position.**

(iii) **RMS or Virtual value**: (a) The RMS value is defined as the square root of the mean of the squares of the instantaneous values of current over the complete cycle. It may also be defined as the direct current which produces the same heating effect in a resistor as the actual AC

Iv = Io/√2 =Irms

**(b) AC ammeter or voltmeter measures virtual current or virtual voltage.**

(c) For an AC mains of 220 volt, the peak value of the voltage is given by:V0 = Vv√2 =220 x 1.414 = 311 volt



3. **AC circuits containing different elements:**

(A) **AC through pure resistor R:**

(i) Alternating emf of the source: E = Eo sin *w*t

(ii) A resistance opposes current but does not oppose a change in current. Hence, current is in phase with emf.

(iii) The instantaneous value of the current is given by: I = E0sin*w*t/R

The virtual value of current Iv is given by: Iv = Ev/R

**(B) AC through pure inductor of inductance L:**

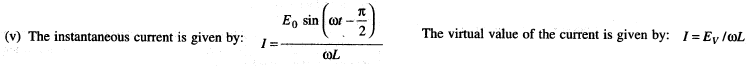
(i) Alternating emf of the source: E = Eo sin *w*t

(ii) An inductor opposes a change in current.

(iii) Since, the voltage changes continuously, hence, the current reacts to the change and inductive reactance

XL = L*w*

(iv) The current lags behind the voltage by π/2.

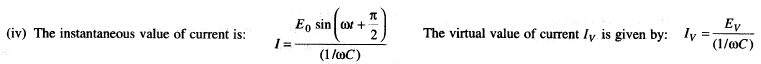
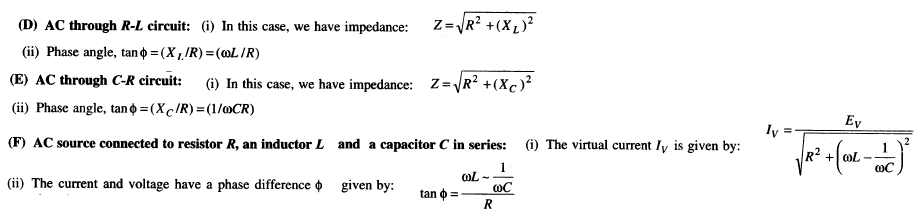


**(C) AC. through a pure capacitor of capacitance C:**

(i) Alternating emf of the source: E = Eo sin *w*t

(ii) A capacitor has infinite resistance for a DC source. With an AC source, voltage change hence charge on the plates of the capacitor changes with, time, i. e, there is a current, The current leads the voltage by π/2

(iii) The capacitor has a capacitive reactance XC, in AC circuit given by XC = 1/C*w*



(iii) The impedance which represents the effective resistance of the circuit to AC source is represented by Z. The impedance Z is the vector- sum of resistance and reactances in AC series circuit, i.e.,:



(iv) In AC series combination, virtual voltages are added using vector algebra i.e. Ev = √ [VR2 + (VL –VC)2 ]

where VR = IVR , VC =IV/Cw , VL = IVLw

4. Power in an AC circuit :

(i) The power in an electric circuit is the rate at which electric energy is consumed in the circuit :

**Pavg = Erms x Irms x cosϕ** ; So, the product of rms value of voltage and current when multiplied by cosϕ

gives the power dissipated



(ii) cosϕ is known as power factor. For an L-C-R series circuit:

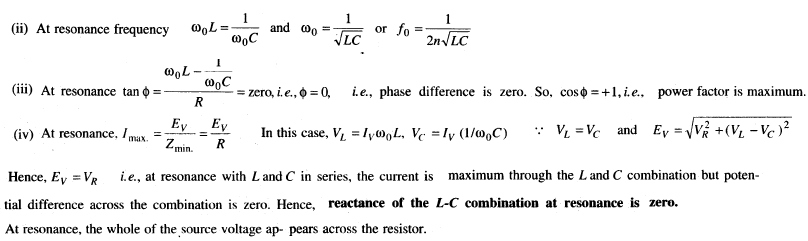
(iii) **Wattless current**: Consider the case of a circuit which contains either inductance only or the capacitance only, 1.e., ohmic resistance is zero. In such cases, phase difference between voltage and current is 900, i.e.,ϕ =900. Now, we know that the average power in a circuit is given by:

Pavg = Erms x Irms x cosϕ so, **Pavg = Erms x Irms x cos900 = 0**

This shows that **when ohmic resistance of an AC circuit is zero then average power remains zero though current flows in the circuit**. In this way, there is no dissipation of energy in the circuit. The current in such a circuit is called as wattless current

5. **Resonance: (A) Series resonant circuit:**

(i) A particular frequency of AC at which impedance of a series L-C-R circuit becomes minimum or the current becomes maximum, is called the resonant frequency and the circuit is called as series resonance circuit.



**(B) Parallel resonant circuit**:

(i) When an inductance L and a resistance R are connected in series in one branch and a condenser of capacity C in another branch and a source of alternating emf is applied to this circuit, then this is known as parallel resonant circuit.

(ii) The resonance frequency of parallel resonant circuit is given by:

(iii) For a parallel combination of R, L and C connected to the AC source at resonance, the current through the parallel combination of Land C is zero but potential difference across the combination is maximum. Hence, the reactance of the L and C combination is infinite and whole of the source current flows through the resistor.

If L and C are in parallel then impedance Z is found as



6. **Quality factor:**

(i) The quality factor is a measure of the efficiency of energy stored in an inductor or capacitor when an alternating current is applied

Q= 2π (Energy stored)/(energy lost per period)

(ii) Q= wL/R or 1/CwR ,i.e., the quality factor may also be defined as the ratio of reactance of either inductance or capacitance at resonance frequency to the resistance of the circuit.

7.**Choke coil:**

(i) We know that in purely resistive circuit, the power loss is maximum because power factor cosϕ = R/Z =1

( '.' Z = R). **Hence, the use of resistance is avoided in AC circuits.**

(ii) **A choke coil is a coil which has high inductance and negligible resistance**. Thus, the power factor is almost zero. So, a choke coil controls the alternating current without an appreciable energy loss. This is used in fluorescent tubes to control the current.

No power losses are associated with pure capacitors and pure inductors in an ac circuit.

To see why this is true, let us first analyze the power in an ac circuit containing only a generator and a capacitor.

-When the current begins to increase in one direction in an ac circuit, charge begins to accumulate on the capacitor, and a voltage drop appears across it. When this voltage drop reaches its maximum value, the energy stored in the capacitor is ½ C∆V2max .However, this energy storage is only momentary. The capacitor is charged and discharged twice during each cycle: Charge is delivered to the capacitor during two quarters of the cycle and is returned to the voltage source during the remaining two quarters. Therefore, the average power supplied by the source is zero. In other words, no power losses occur in a capacitor in an ac circuit.

-Similarly, the voltage source must do work against the back emf of the inductor. When the current reaches its maximum value, the energy stored in the inductor is a maximum and is given by ½ LI2max .When the current begins to decrease in the circuit, this stored energy is returned to the source as the inductor attempts to maintain the current in the circuit.

*Quiz:* An airport metal detector is essentially a resonant circuit. The portal you step through is an inductor (a large loop of conducting wire) that is part of the circuit. The frequency of the circuit is tuned to the resonant frequency of the circuit when there is no metal in the inductor. Any metal on your body increases the effective inductance of the loop and changes the current in it. If you want the detector to be able to detect a small metallic object, should the circuit have a high quality factor or a low one?

Solution : High. The higher the quality factor, the more sensitive the detector. when *Q=w0/∆w* is high, a slight change in the resonance frequency (as might happen when a small piece of metal passes through the portal) causes a large change in current that can be detected easily.

Question: Why does we use combination of thin wires ,rather than one single wire for AC transmission ?

Answer : Two reasons

1.Due to skin effect : Skin effect is the tendency of an [alternating electric current](http://en.wikipedia.org/wiki/Alternating_current) (AC) to become distributed within a [conductor](http://en.wikipedia.org/wiki/Conductor_%28material%29) such that the [current density](http://en.wikipedia.org/wiki/Current_density) is largest near the surface of the conductor, and decreases with greater depths in the conductor. The electric current flows mainly at the "skin" of the conductor, between the outer surface and a level called the skin depth. The skin effect causes the effective [resistance](http://en.wikipedia.org/wiki/Electrical_resistance) of the conductor to increase at higher [frequencies](http://en.wikipedia.org/wiki/Frequency) where the skin depth is smaller, thus reducing the effective cross-section of the conductor. The skin effect is due to opposing [eddy currents](http://en.wikipedia.org/wiki/Eddy_current) induced by the changing [magnetic](http://en.wikipedia.org/wiki/Magnetic) field resulting from the alternating current. At 60 [Hz](http://en.wikipedia.org/wiki/Hertz) in copper, the skin depth is about 8.5 mm. At high frequencies the skin depth becomes much smaller. Increased AC resistance due to the skin effect can be mitigated by using specially woven [litz wire](http://en.wikipedia.org/wiki/Litz_wire). Because the interior of a large conductor carries so little of the current, tubular conductors such as pipe can be used to save weight and cost.

2.Mechanically multiple small wires are much stronger than a single wire whose radius will make it a rod rather than a flexible wire.

Question : Why does a moving coil galvanometer shows a steady zero reading of the pointer when AC of 50Hz is supplied but it does show deflection when frequency is 2Hz or 4 Hz ?

Answer : At 50 Hz frequency the coil has to deflect from one side to the other side 100 times in one second. Due to inertia of coil and needle, the needle cannot follow such a rapid variation and thus both coil and needle remain stationary.

**Home assignment – Alternating Current**

1. Define Alternating current alongwith an expression?
2. What do you mean by transient currents ?
3. Derive an expression for growth of electric current thru an L-R circuit connected to a D.C. Source
4. Write an expression for decay of electric current thru an L-R circuit connected to a D.C. Source ?
5. What do you mean by time constant of an L-R circuit ?
6. Derive an expression for an instant value of charge in a C-R circuit connected to a D.C. Source while charging?
7. What do you mean by capacitive time constant of a C-R circuit ?
8. Write an expression for an instant value of charge in a C-R circuit connected to a D.C. Source while discharging?
9. What is the value of mean or average of A.C. during one full cycle ?
10. Derive an expression for mean or average of A.C. during positive half cycle ?
11. Derive an expression for mean or average of alternating emf during positive half cycle ?
12. Derive an expression for RMS value of A.C.?
13. Derive an expression for RMS value of alternating emf ?
14. Derive a phase relationship between alternating emf and current in a circuit containing resistor only?
15. Derive a phase relationship between alternating emf and current in a circuit containing inductor only?
16. What do you mean by Inductive reactance ? What would be it’s value in an A.c and in a DC circuit
17. Derive a phase relationship between alternating emf and current in a circuit containing capacitor only?
18. What do you mean by Capacitive reactance ? What would be it’s value in an A.c and in a DC circuit ?
19. Derive a phase relationship between alternating emf and current in a circuit containing resistor, an inductor and a Capacitor only?
20. What do you mean by Impedance and Impedance triangle?
21. Derive an expression for magnetic energy stored in an Inductor?
22. Write expressions for energy stored per unit volume in an inductor and in a capacitor?
23. What do you mean by L-C oscillations ?
24. Derive an expression for resonance frequency in series Resonance circuit?
25. Derive an expression for Q -factor in series Resonance circuit?
26. Derive an expression for resonance frequency in parallel Resonance circuit?
27. Derive an expression for average power associated with a resistive circuit?
28. Derive an expression for average power associated with a purely inductive circuit?
29. What do you mean by power factor of an A.C. circuit?
30. What do you mean by wattles current or idle current?
31. Differentiate A.C. and D.C ?
32. What is the principle of an electric generator ?
33. Explain working of an AC generator?
34. Derive an expression for emf produced in an AC generator?
35. What do you mean by multi phase AC generator?
36. What are the roles of carbon brushed and split rings?
37. What is the principle of an electric motor?
38. What do you mean by motor starter?
39. What is the principle and working of a transformer?
40. Derive a relation for the efficiency of a transformer?
41. What are different losses in a transformer?
42. What do you mean by choke coil?

**NCERT Solved**

1. A light bulb is rated at 100W for a 220 V supply. Find
   1. the resistance of the bulb; (b) the peak voltage of the source; and
   2. the rms current through the bulb.
2. A pure inductor of 25.0 mH is connected to a source of 220 V. Find the inductive reactance and rms current in the circuit if the frequency of the source is 50 Hz.
3. . A lamp is connected in series with a capacitor. Predict your observations for dc and ac connections. What happens in each case if the capacitance of the capacitor is reduced?
4. A resistor of 200 Ω and a capacitor of 15.0 μF are connected in series to a 220 V, 50 Hz ac source. (a) Calculate the current in the circuit; (b) Calculate the voltage (rms) across the resistor and the capacitor. Is the algebraic sum of these voltages more than the source voltage? If yes, resolve the paradox.
   1. For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain.
   2. Power factor can often be improved by the use of a capacitor of appropriate capacitance in the circuit. Explain.
5. At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work?
6. Show that in the free oscillations of an *LC* circuit, the sum of energies stored in the capacitor and the inductor is constant in time.

**NCERT UnSolved**

1. (a)The peak voltage of an ac supply is 300 V. What is the rms voltage?

(b) The rms value of current in an ac circuit is 10 A. What is the peak current?

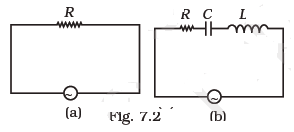
1. A series *LCR* circuit with *R* = 20 Ω, *L* = 1.5 H and *C* = 35 μF is connected to a variable-frequency 200 V ac supply. When the frequency of the supply equals the natural frequency of the circuit, what is the average power transferred to the circuit in one complete cycle?
2. A 100 Ω resistor is connected to a 220 V, 50 Hz ac supply.
   1. What is the rms value of current in the circuit?
   2. What is the net power consumed over a full cycle?
3. A circuit containing a 80 mH inductor and a 60 μF capacitor in series is connected to a 230 V, 50 Hz supply. The resistance of the circuit is negligible.
   1. Obtain the current amplitude and rms values.
   2. Obtain the rms values of potential drops across each element.
   3. What is the average power transferred to the inductor?
   4. What is the average power transferred to the capacitor?
   5. What is the total average power absorbed by the circuit? [‘Average’ implies ‘averaged over one cycle’.]
4. Answer the following questions:
   1. In any ac circuit, is the applied instantaneous voltage equal to the algebraic sum of the instantaneous voltages across the series elements of the circuit? Is the same true for rms voltage?
   2. A capacitor is used in the primary circuit of an induction coil.
   3. An applied voltage signal consists of a superposition of a dc voltage and an ac voltage of high frequency. The circuit consists of an inductor and a capacitor in series. Show that the dc signal will appear across *C* and the ac signal across *L*

(d) A choke coil in series with a lamp is connected to a dc line. The lamp is seen to shine brightly. Insertion of an iron core in the choke causes no change in the lamp’s brightness. Predict the corresponding observations if the connection is to an ac line.

(e) Why is choke coil needed in the use of fluorescent tubes with ac mains? Why can we not use an ordinary resistor instead of the choke coil?

1. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. What should be the number of turns in the secondary in order to get output power at 230 V?
2. At a hydroelectric power plant, the water pressure head is at a height of 300 m and the water flow available is 100 m3*s*–1. If the turbine generator efficiency is 60%, estimate the electric power available from the plant (*g* = 9.8 ms–2 ).

**Exemplar**

1. If a *LC* circuit is considered analogous to a harmonically oscillating spring block system, which energy of the *LC* circuit would be analogous to potential energy and which one analogous to kinetic energy?
2. Study the circuits (a) and (b) shown in Fig 7.2 and answer the following questions (a) Under which conditions would the rms currents in the two circuits be the same?

(b) Can the rms current in circuit (b) be larger than that in (a)?

1. Can the instantaneous power output of an ac source ever be negative? Can the average power output be negative?
2. How does the sign of the phase angle φ , by which the supply voltage leads the current in an *LCR* series circuit, change as the supply frequency is gradually increased from very low to very high values
3. Both alternating current and direct current are measured in amperes. But how is the ampere defined for an alternating current?
4. A coil of 0.01 henry inductance and 1 ohm resistance is connected to 200 volt, 50 Hz ac supply. Find the impedance of the circuit and time lag between max. alternating voltage and current.
5. A 60 W load is connected to the secondary of a transformer whose primary draws line voltage. If a current of 0.54 A flows in the load, what is the current in the primary coil? Comment on the type of transformer being used.
6. Explain why the reactance provided by a capacitor to an alternating current decreases with increasing frequency.
7. Explain why the reactance offered by an inductor increases with increasing frequency of an alternating voltage.



1. Consider the *LCR* circuit shown in Fig 7.6. Find the net

current *i* and the phase of *i*. Find the impedence Z for this circuit.

And Show that *I =v/Z ?*

**Objective Questions**

1.A direct current of 5 amp is superimposed on an alternating current I = 10 sinwt flowing through a wire. The effective value of the resulting current will be (in amp): (a) (15/2) (b) 5√3 (c) 5√5 (d) 15

2.In an AC circuit, a resistance of R ohm is connected in series with an inductance L. If phase angle between voltage and current is 450, the value of inductive reactance will be:

(a) R/4 (b) R/2 (c) R (d) cannot be found with the given data

3.ln L-C-R series AC circuit, the phase angle between current and voltage is:

(a) any angle between 0 and ±π/2 (b) π/2

(c) π (d) any Angle between 0 and π

4.In an AC circuit the potential differences across an inductance and resistance joined in series are respectively 16 V and 20 V. The total potential difference across the circuit is:

(a) 20 V (b) 25.6 V (c) 31.9 V (d) 53.5 V

5.An L-C-R circuit contains resistance of 100 ohm and a supply of 200 volt at 300 radian angular frequency. If only capacitance is taken out from the circuit and the rest of the circuit is joined, current lags behind the voltage by 600. If on the other hand, only inductor is taken out the current leads by 600 with the applied voltage. The current flowing in the circuit is:(a) 1 amp (b) 1.5 amp (c) 2 amp (d) 2.5 amp

6.A choke coil and capacitor are connected in series and the current through the combination is maximum for AC of frequency n. lf they are connected in parallel, at what frequency the current through the combination is minimum? (a) n (b) n/2 (c) 2n (d) None of these

7. A coil has an inductance of 0.7H and is joined in series with a resistance of 220 ohm. When an alternating emf of 220V at 50 cps is applied to it, then the wattless component of the current in the circuit is:

(a) 5 ampere (b) 0.5 ampere (c) 0.7 ampere (d) 7 ampere

8. A direct current of 2 A and an alternating current having a maximum value of 2 A flow through two identical resistances. The ratio of heat produced in the two resistances will be:

(a)1:1 (b)l:2 (c)2:1 (d)4:l

9.The armature of a DC motor has 20 ohm resistance. It draws current of 1.5 ampere when run by 220 volt DC supply. The value of back emf induced in it will be:

(a) 150 V (b) 170 V (c) 180 V (d) 190 V

10.The rms value of an AC of 50 Hz is 10 amp. The time taken by an alternating current in reaching from zero to maximum value and the peak value will be:

(a) 2x10-2 sec and 14.14 amp (b) 1 x l0-2 sec and 7.07 amp

(c) 5 x l0-3 sec and 7.07 amp (d) 5 x 10-3 sec and 14.14 amp

11.In a region of uniform magnetic induction B=10-2 T, a circular coil of radius 30 cm and resistance π2 ohm is rotated about an axis which is perpendicular to the direction of B and which forms a diameter of the coil. If the coil rotates at 200 rpm, the amplitude of the alternating current induced in the coil in milli amp is

(a) 4π2 (b) 30 (c) 6 (d) 200

12. An inductance and a resistance are connected in series with an AC potential. In this circuit:

(a) the current and the PD across the resistance lead the, PD across the inductance

(b) the current and the PD across the resistance lag behind the PD across the inductance by an angle π/2.

(c) the current and the PD across the resistance lag behind the PD across the inductance by an angle π.

(d) the PD across the resistance lag behind the PD across the inductance by an angle π/2 but the current in resistance leads the PD across the inductance by π/2.

13. Energy required to establish a current of 4 ampere in a, self inductance L=200 mH is:

(a) 0.16 J (b) 0.80 J (c) 0.40 J (d) 1.6 J

14. The peak value of alternating emf E (E =Eocos*w*t) is 10 volt and frequency is 50Hz.At time t =1/600 s,the instantaneous value of emf is (a) 10 V (b) 5√3 V (c) 5 V (d) 1 V

15. A group of electric lamps having a total power rating of 1000 watt is supplied by an AC voltage E = 200 sin(310t+600). Then the rms value of the electric current is(in amp) : (a) 10 (b) 10√2 (c) 20 (d) 20√2

16. A resistor and an inductor are connected to an AC supply of 120 volt and 50Hz. The current in the circuit is 3 ampere. If the power consumed in the circuit is 108 watt, then the resistance of the circuit in ohms is : (a) 12 (b) 40 (c) √(52 x28) (d) 360

17. When no power is drawn in the secondary coil of an ideal transformer, the power factor of the primary coil of an ideal transformer is : (a) 1 (b) 0 (c) ½ (d) ∞

18.When power is drawn from the secondary coil of the transformer, the dynamic resistance

(a) Increases (b) decreases (c) unchanged (d) changes erratically

19. What is the rms value of an alternating current which when passed thru a resistor produces heat, which is thrice that produced by a current of 2 ampere in the same resistor :

(a) 6 ampere (b) 2 ampere (c) 3.46 ampere (d) 0.65 ampere

20. An AC ammeter is used to measure current in a circuit. When a given direct current passes thru the circuit, the AC ammeter reads 3 ampere. When another alternating current passes thru the circuit, the AC ammeter reads 4 ampere. Then the reading of this ammeter if DC and AC flow thru the circuit simultaneously is: (a) 3 amp (b) 4 amp (c) 7 amp (d) 5 amp

21. A resistor and a capacitor are connected to an AC supply of 200volt,50Hz in series. The current in the circuit is 2 ampere. If the power consumed is 100 watt , then the resistance of the circuit in ohm is :

(a) 100 (b) 25 (c) √(125 x 75) (d) 400

22. A resistor and a capacitor are connected to an AC supply of 200volt,50Hz in series. The current in the circuit is 2 ampere. If the power consumed is 100 watt , then the capacitive reactance of the circuit in ohm is :(a) 100 (b) 25 (c) √(125 x 75) (d) 400

23. A resistor and a capacitor are connected to an AC supply of 200volt,50Hz in series. The current in the circuit is 2 ampere. If the power consumed is 100 watt , then the capacitance of the circuit in farad is :

(a) 100/100π (b) 25/100π (c) √(125 x 75) /100π (d) 1/100π√(125 x 75)

24. A transmitter transmits at a wavelength of 300 m. A condenser of capacitance 2.4μF is being used. The value of the inductance for the resonant circuit is approximately :

(a) l0-4 H (b) 10-6 H (c) 10-8 H (d) 10-10 H

25. An ideal choke takes a current of 8 ampere when connected to an AC supply of 100 volt and 50 Hz. A pure resistor under the same conditions takes a current of 10 ampere. If the two are connected to an AC supply of 150 volt and 40 Hz, then the current in a **series** combination of the above resistor and inductor in ampere is: (a) 10 (b) 8 (c) 18 (d) 15/√2

26.An ideal choke takes a current of 8 ampere when connected to an AC supply of 100 volt and 50 Hz. A pure resistor under the same conditions takes a current of 10 ampere. If the two are connected to an AC supply of 150 volt and 40 Hz, then the current in a **parallel** combination of the above resistor and inductor in ampere is: (a) 15 (b) 30 (c) 0 (d) 15√2

27. Alternating current cannot be measured by DC ammeter because [AIEEE 2004]

(a) AC cannot pass through DC ammeter (b) AC changes direction

(c) average value of current for complete Cycle is zero (d) DC ammeter will get damaged

28. The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : l. The iron losses at full load are 700 watt. The primary voltage is 1000 volt. The primary coil has a resistance of I ohm. Then the voltage in secondary coil is: (a) 1000 volt (b) 5000 volt (c) 200 volt (d) zero volt

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30. The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : l. The iron losses at full load are 700 watt. The primary voltage is 1000 volt. The primary coil has a resistance of I ohm. Then the

copper loss in the primary coil is:(a) 100 watt (b) 700 watt (c) 200 watt (d) 1000 watt

31. The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : l. The iron losses at full load are 700 watt. The primary voltage is 1000 volt. The primary coil has a resistance of I ohm. Then the

copper loss in the secondary coil is:(a) 100 watt (b) 700 watt (c) 200 watt (d) 1000 watt

32. The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : l. The iron losses at full load are 700 watt. The primary voltage is 1000 volt. The primary coil has a resistance of I ohm. Then the

current in the secondary coil is: (a) 45 amp (b) 46 amp (c) l0 amp (d) zero amp

33. The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : l. The iron losses at full load are 700 watt. The primary voltage is 1000 volt. The primary coil has a resistance of I ohm. Then the

resistance of the secondary coil in ohm is approx.: (a) 0.01 ohm (b) 0.1 ohm (c) 0.2 ohm (d) 0.4 ohm

34. You have two copper cables of equal length for carrying current. One of them has a single wire of area of

cross-section A, the other has ten wires of cross-section (A/10) each. Judge their suitability for transporting AC and DC: (a) only single strand for DC and only multiple strand for AC

(b) either for DC, only multiple strands for AC (c) only single strand for AC, either for DC

(d) only single strand for DC, either for AC

35.In non-resonant circuit, what will be the nature of the circuit for frequencies higher than the resonant frequency? (a) Resistive (b) Capacitive (c) Inductive (d) None of these

36. The resonant frequency of a circuit is *fo* . If the capacitance is made 4 times the initial value, then the resonant frequency becomes: (a) *fo* /2 (b) 2 *fo* (c) *fo* (d) *fo* /4

37. In an L-R circuit, the value of L is (0.4/π) henry and the value of R is 30 ohm. If in the circuit, an alternating emf of 200 V at 50 cycle per second is connected the impedance of the circuit and current will be : (a) 11.4 Ω,17.5 A (b) 30.7 Ω, 6.5 A (c) 40.4 Ω, 5 A (d) 50 Ω, 4 A

38.A capacitor of capacitance l μF is charged to a potential of 1V. It is connected in parallel to an inductor of inductance 10-3 H. The maximum current that will flow in the circuit has the value:

(a) √1000 mA (b) 1 mA (c) 1 μA (d) 1000 mA

39. When 100 volt DC is applied across a solenoid, a current of 1.0 amp flows in it. When 100 volt AC is applied across the same coil, the current drops to 0.5 amp. If the frequency of the AC source is 50 Hz the impedance and inductance of the solenoid in (Ω & H) are :

(a) 200 and 0.55 (b) 100 and 0.86 (c) 200 and 1 (d) 100 and 0.93

40. Using an AC voltmeter the potential difference in the electrical line in a house is read to be 234 volt. If the line frequency is known to be 50 cycle/second, the equation for the line voltage is:

(a) V= 165sin(100πt ) (b) V= 331sin(100πt ) (c) V= 220sin(100πt ) (d) V= 440sin(100πt )

41.In a series L-C-R circuit the voltage across the resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited, the voltage across the inductance will be:

(a) 10 V (b) 10√2 V (c) 10/√2 V (d) 20V

42.For the circuit shown in the fig(36.5) the current thru the inductor is 0.9 A while the current through the condenser is 0.4 A. Hence, the current drawn from the generator is :

(a) 1.13 amp (b) 0.9 amp (c) 0.5 amp (d) 0.6 amp

43. In the series L-C-R circuit(fig 36.6), the voltmeter and ammeter readings are:

(a) V=100 volt, I =2amp (b) V=100volt, I=5 amp

(c) V =1000 volt, I = 2 amp (d) V =300 volt, I = l amp

44. In a step-up transformer, the turn ratio is 1:2. A Leclanche cell (emf= 1.5 V) is connected across the primary. The voltage developed in the secondary would be: (a) 3.0 V (b) 0.75 V (c) 1.5 V (d) zero

45.The armature of DC motor has 20 Ω resistance. It draws current of 2.5 ampere when run by 220 volt DC supply. The value of back emf induced in it will be: (a) 150 V (b) 170 V (c) 180 V (d) 190 V

46. An ideal choke takes a current of 10 amp when connected to an AC supply of 125 volt and 50 Hz. A pure resistor under the same conditions takes a current of 12.5 amp. If the two are connected to an AC supply of 100√2 volt and 40 Hz, then the current in series combination of above resistor and inductor is:

(a) l0 amp (b) 12.5 amp (c) 20 amp (d) 25 amp

47. A Transformer of efficiency 90% draws an input power of 4 kW. An electrical appliance connected across the secondary draws a current of 6 A. The impedance of the device is:

(a) 60Ω (b)50 Ω (c) 80 Ω (d) 100 Ω (e) 120 Ω

48. The phase difference between the V and I of L-C-R circuit in series at resonance is:

(a) π (b) π/2 (c) 0 (d) π/4

49. The resonant frequency of a series L-C-R circuit, which comprises an inductance of 200 μH, a capacitance of 5 x 10-4 μF and a resistance of 10 Ω in **kHz** is: (a) 402 (b) 452 (c) 502 (d) 552

50. The voltage of an AC supply varies with time (r) as V =120 sin100πt cos100πt. The maximum voltage and frequency respectively are:

(a) 60 volt, 100 Hz (b) 120/√2 volt, 100 Hz (c) 120 volt, 100 Hz (a) 60 volt, 200 Hz

51. The impedance of an AC circuit containing a capacitive reactance of 5 ohm and inductive reactance of 8 ohm will be: (a) 1.6 ohm (b) 40 ohm (c) 3 ohm (d) 13 ohm

52. A 0.7 henry inductor is connected across a 120 V , 60 Hz AC source. The current in the inductor will be very nearly: (a) 4.55 amp (b) 0.355 amp (c) 0.455 amp (d) 3.55 amp

53. The coil of a choke in a circuit:(a) increases the current (b) decreases the current

(c) does not allow change in current (d) has high resistance to DC circuit

54. A current I=Io sin(wt –π/2) flows in an AC circuit. If potential of E = Eo sinwt has been applied, then the power consumption P in the circuit will be:

(a) EoIo/√2 (b) EI/√2 (c) EoIo/2 (d) 0

55. An AC source is rated at 220 V,50 Hz. The time taken for voltage to change from the peak value to zero is

(a) 50 sec (b) 0.02 sec (c) 5 sec (d) 5 x 10-3 sec

56. An ideal transformer has 500 and 5000 turns in primary and secondary winding respectively. If the primary voltage is connected to a 6 V battery, then the secondary voltage is:(a) 0 (b) 60 (c) 0.6 (d) 6.0

57. An AC voltage of V = 220√2 sin(wt + π/2) will be read as what in a DC voltmeter?

(a) 220√2 V (b) √2 V (c) 220V (d) 440V

58.In a transformer the output current and voltage are respectively 4 A and20 V. If the ratio of number of turns in the primary to secondary is 2 :1, what is the input current and voltage?

(a) 2 A and 40 V (b)1A and 20V (c)4A and l0V (d)8A and 40V

59. In an oscillating L-C circuit, maximum charge on the capacitor is Q. The charge on this capacitor, when the energy is stored equally between the electric and magnetic fields is:

(a) Q (b) Q/2 (c) Q√3 (d) Q/√2

60. A 220 volt, 1000 watt bulb is connected across a 110 volt mains supply. The power consumed will be:

(a) 1000 watt (b) 750 watt (c) 500 watt (d) 250 watt (AIEEE 2003)

61. The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of: (a) 1 μF (b) 2 μF (c) 4 μF (d) 8 μF (AIEEE 2005)

62. A circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be:(a) 1.25 (b) 0.125 (c) 0.8 (d) 0.4 (AIEEE 2005)

63. The phase difference between the alternating current and emf is π/2.Which of the following cannot be the constituent of the circuit? (a) L-C (b) L alone (c) C alone (d) R, L (AIEEE 2005)

64. A series resonant L-C-R circuit has a quality factor (Q factor) of 0.4 and a band width of 1.3 kHz. If R = 2kΩ & C = 0.l μF, then the value of inductance is : (a) 0.1 H (b) 0.64 H (c) 2 H (d) l0 H (e)5H

65. A coil of inductive reactance 31 Ω has a resistance of 8 Ω. It is placed in series with a condenser of capacitive reactance 25Ω. The combination is connected to an AC source of 110V. The power factor of the circuit is:(a) 0.33 (b) 0.56 (c) 0.64 (d) 0.80

66. In a series resonant LC-R circuit, the voltage across R is 100 volts and R = 1 kΩ with C = 2μF. The resonant frequency *w* is 200 rad/s. At resonance, the voltage across L is: (AIEEE 2006)

(a) 4x 10-3 volt (b) 2.5 x 10-2 volt (c) 40 volt (d) 250 volt

67. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency *w* in a magnetic field B. The maximum value of emf generated in the coil is : (AIEEE 2006)

(a) NAB*w* (b) NABR*w* (c) NAB (d) NABR

68. An alternating voltage of 220 V,50 Hz frequency is applied across a capacitor of capacitance 2μF. The impedance of the circuit is: (a) π/5000 (b) 1000/π (c) 500π (d) 5000/π

69.The instantaneous current in a circuit is, I= √2sin (wt + ϕ) ampere. The rms value of current (in ampere) is: (a) 2 (b) √2 (c)1 (d)1/√2

70. Which of the following statements is incorrect?

(a) In L-C-R series AC circuit, as the frequency of the source increases, the impedance of the circuit first decreases and then increases.

(b) If the net reactance of an L-C-R series AC circuit is same as its resistance, then the current lags behind the voltage by 00

(c) At resonance, the impedance of an AC circuit becomes purely resistive.

(d) At resonance in L-C-R series AC circuit, the potential drops across inductor and capacitor are equal in magnitude but opposite in sign.

(e) Below resonance, voltage leads the current while above it, current leads the voltage.

71. In the adjoining figure (36.10) a series L-C-R circuit is connected to a variable frequency 200 V source. L=5H,C =80μF and R = 40 ohm. Then, the source frequency which drive the circuit at resonance is: (VITEEE 2007)

(a) 25 Hz (b) 25/π Hz (c) 50 Hz (d) 50/π Hz

72.A voltage of peak value 283 V and varying frequency is applied to a series L-C-R combination in which R=3 ohm;, L = 25 mH and C = 400μF, Then, the frequency (in Hz) of the source at which maximum power is dissipated in the above, is: (a) 51.5 (b) 50.7 (c) 5l.l (d) 50.3

73.In L-C-R circuit if the resistance increases, the quality factor:

(a) increases finitely (b) decreases finitely (c) remains constant (d) none of these

74.The instantaneous voltage through a device of impedance 20 ohm is e = 80 sin 100πt. The effective value of the current is ;(a) 3A (b) 2.828 A (c) 1.732 A (d) 4 A (e) √2 A

75.An electric bulb has a rated power of 50 W at 100 V. If it is used on an AC source of 200 V, 50 Hz, a choke has to be used in series with it. This choke should have an inductance of

(a) 0.1mH (b) 1 mH (c) 0.1 H (d) 1.10 H

76. An inductance of 200/π mH, a capacitance, of l0-3/π F and a resistance of 10 ohm are connected in series with an AC source of 220 V, 50 Hz. The phase angle of the circuit is:

(a) π/6 (b) π/4 (c) π/2 (d) π/3

77.A step-down transformer reduces the voltage of a transmission line from 2200V to 22O V. The power delivered by it is 880 W and its efficiency is 88%. The input current is:

(a) 4.65 mA (b) 0.045 A (c) 0.45 A (d) 4.65 A

78. current in a coil changes from 4A to zero in 0.1 second and the emf induced is 100 V. The self inductance of the coil is: (a) 0.25 H (b) 0.4 H (c) 2.5 H (d) 4 H

79.A transformer has a efficiency of 80%.It is connected to a power input of 5 kW at 200 V. If the secondary voltage is 250V,the primary and secondary currents are respectively:(a) 25 A, 20 A (b) 20 A, 16 A

(c) 25 A, 16 A (d) 40 A, 25 A (e) 40 A, 16 A

80.When a DC voltage of 200 V is applied to a coil of self inductance(2√3/π) H, a current of I A flows through it. But by replacing DC source with AC source of 200 V, the current in the coil is reduced to 0.5 A. Then, the frequency of AC supply is: (a) 100 Hz (b) 75 Hz (c) 60 Hz (d) 30 Hz (e) 50 Hz

81. What is the value of inductance L for which the current is maximum in a series L-C-R circuit with C=l0μF and **w** = 1000 s-1

(a) I mH (b) cannot be calculated unless R is known (c) 10 mH (d) 100 mH

82. A choke is preferred to a resistance for limiting current in an AC circuit because:

(a) choke is cheap (b) there is no wastage of power

(c) choke is compact in size (d) choke is a good absorber of heat

83. An electric motor having a coil of n turns each of area A and carrying a current *i* is placed in a magnetic field **B**. if *f* be the frequency of rotation of the coil, what is the power output of the motor ?

(a) *f* n*i* ABπ (b) 2 *f* n *i* AB (c) *f*n *i* AB/2 (d) 4 *f*n *i* AB

84. If the angular speed of rotation of an armature of alternating current generator is doubled then how will the induced electromotive force change? (a) It will become twice (b) It will become four times

(c) There will be no change (d) It will become half



85. The value of alternating emf E in the given circuit (fig 36.12) will be:

(a) 220 V (b) 140 V (c) 100 V (d) 20 V

86. A current of 5 A is flowing at 220 V in the primary coil of a transformer. If the voltage produced in the secondary coil is 2200 V and 50% of power is lost, then the current in secondary will be:

(a) 2.5 A (b) 5 A (c) 0.25 A (d) 0.5A

87. A resistor 30 Ω, inductor of reactance 10 Ω and capacitor of reactance 10 Ω are connected in series to an AC voltage source e = 300√2 sin (wt). The current in the circuit is:

(a) 10√2 A (b) 10 A (c) 30√11 A (d) 30/√11 A (e) 5 A

88. The core of any transformer is laminated so as to [AIEEE 2OO3]

(a) reduce the energy loss due to eddy currents (b) make it light weight

(c) make it robust and strong (d) increase the secondary voltage

89. A transformer rated at l0 kW is used to connect a 5 KV transmission line to a 240 V circuit. The ratio of turns in the windings of the transformer is: (a) 5 (b) 20.8 (c) 104 (d) 40

90. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon

(a) the rates at which currents are changing in the two coils [AIEEE 2OO3]

(b) relative position and orientation of the two coils

(c) the materials of the wires of the coils (d) the currents in the naro coils

91. The power factor in a circuit connected to an AC power supply has a value which is:

(a) unity when the circuit contains only inductance (b) unity when the circuit contains only resistance

(c) zero when the circuit contains an ideal resistance only

(d) unity when the circuit contains an ideal capacitance only

92. A six pole generator with fixed field excitation develops an emf of 100 V, when operating at 1500 rpm. At what speed must it rotate to develop 120 V? (a) 1200 rpm (b) 1800 rpm (c) 1500 rpm (d) 400 rpm

93. An AC source of angular frequency *w* is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to *w*/3 (but maintaining the same voltage), the current in the circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency *w* : (a) √(3/5) (b) √(2/5) (c) √(1/5) (d) √(4/5)

94. The inductance of a coil is L =10 H and resistance R = 5Ω.If applied voltage of battery is 10 V (DC) and it switches-off in 1 millisecond, find induced emf of inductor:

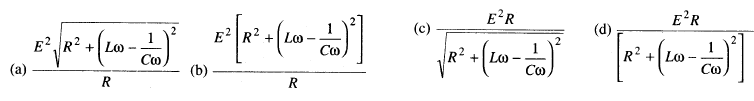
(a) 2 x 104 V (b) 1.2 x 104 V (c) 2 x 10-4 V (d) none of these

95. The values of L,C and R for a circuit are 1H,9F and 3Ω.What is the quality factor for the circuit at resonance? (a) 1 (b) 9 (c) 1/9 (d) 1/3

96. An AC voltage source has an output of ∆V= (200 V) sin2πft.This source is connected to a 100 Ω resistor. RMS current in the resistance is: (a) 1.41 A (b) 2.41 A (c) 3.41 A (d) 0.71 A

97.A generator at a utility company produces 100 A of current at 4000 V. The voltage is stepped upto 240000 V by a transformer before it is sent on a high voltage transmission line. The current in transmission line is: (a) 3.67 A (b) 2.67 A (c) 1.67 A (d) 2.40 A

98. Power dissipated in an L-C-R series circuit connected to an AC source of emf E is:





99. The following series L-C-R circuit( fig 36.14), when driven by an emf source of angular frequency 70 kilo-radians per second, the circuit effectively behaves like:

(a) purely resistive circuit (b) series R-L circuit

(c) series R-C circuit (d) series L-C circuit with R = 0

100. In an L-C-R series AC circuit the voltage across L, C and R is 10 V each. If the inductor is short circuited, the voltage across the capacitor would become

(a) 10V (b) 20/√2V (c) 20√2V (d) 10/√2 V (e)20V

101. A 220 volt input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is: (a) 3.6 ampere (b) 2.8 ampere (c) 2.5 ampere (d) 5.0 ampere

102. The power dissipated in an AC circuit is zero if the circuit is:

(a) purely resistive (b) purely inductive only (c) either purely inductive or purely capacitive

(d) purely capacitive only (e) L- C- R circuit

103. An L-C circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the instant the circuit is closed at t = 0. At what time is the energy stored completely magnetic?(a) t =0 (b) t =l.57ms (c) t=3.14ms (d)t =6.28ms



104. The instantaneous values of current and voltage in an AC circuit are given by

then : (a) current leads the voltage by 450

(b) voltage leads the current by 900 (c) current leads the voltage by 900 (d) voltage leads the current by 450

105. An AC voltage source of variable angular frequency *w* and fixed amplitude Vo is connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When *w* is increased:

(a) the bulb glows dimmer (b) the bulb glows brighter

(c) total impedance of the circuit is unchanged (d) total impedance of the circuit increases.

106. In a series L-C-R circuit R = 200 Ω and the voltage and the frequency of the main supply is 220 V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 300. On taking out the inductor from the circuit the current leads the voltage by 300. The power dissipated in the L-C-R circuit is:(a) 305 W (b) 210 W (c) zero (d) 242W

107. A 50 Hz AC current of peak value 2 A flows through one of the pair of coils. If the mutual inductance between the pair of coils is 150 mH, then the peak value of voltage induced in the second coil is:

(a) 30π V (b) 60π V (c) 15π V (d) 300π V (e) 3π V

108. A transformer is used to light a 100 W and 110 V lamp from a 22O V main supply. If the main current is 0.5 A, then the efficiency of the transformer is nearly: (a) 89% (b) 100% (c) 95% (d) 85% (e) 91%

109. In an AC generator, when the plane of the armature is perpendicular to the magnetic field:

(a) both magnetic flux and emf are maximum (b) both magnetic flux and emf are zero

(c) both magnetic flux and emf are half of their respective maximum value

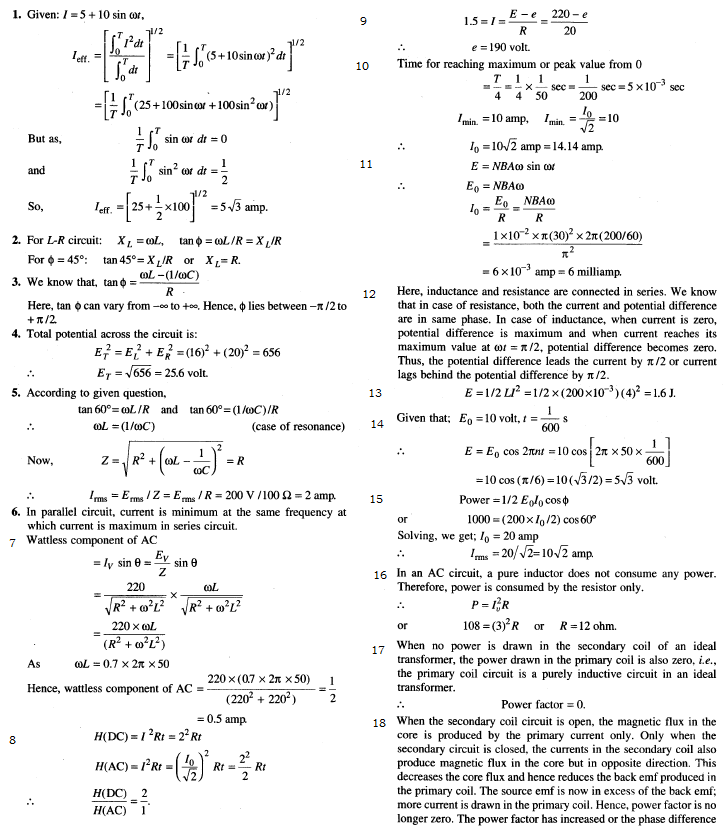
(d) magnetic flux is zero and emf is maximum (e) magnetic flux is maximum and emf is zero

110. An ideal choke draws a current of 8 A when connected to an AC supply of 100 V, 50 Hz. Apure resistor draws a current of l0 A when connected to the same source. The ideal choke and the resistor are connected in series and then connected to the AC source of 150 V, 40 Hz. The current in the circuit becomes :

(a) 15/√2 A (b) 8 A (c) 18 A (d) 10 A

**Answers Objective Alternating Current**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. B | 1. C | 1. A | 1. B | 1. C | 1. A |
| 1. B | 1. C | 1. D | 1. D | 1. C | 1. B |
| 1. D | 1. B | 1. B | 1. A | 1. B | 1. A |
| 1. C | 1. D | 1. B | 1. C | 1. D | 1. C |
| 1. D | 1. D | 1. C | 1. C | 1. B | 1. A |
| 1. C | 1. B | 1. B | 1. B | 1. C | 1. A |
| 1. D | 1. A | 1. A | 1. B | 1. B | 1. C |
| 1. A | 1. D | 1. B | 1. A | 1. D | 1. C |
| 1. C | 1. A | 1. C | 1. C | 1. C | 1. D |
| 1. D | 1. A | 1. C | 1. A | 1. D | 1. D |
| 1. A | 1. C | 1. D | 1. B | 1. D | 1. D |
| 1. A | 1. D | 1. C | 1. E | 1. B | 1. D |
| 1. B | 1. B | 1. D | 1. B | 1. C | 1. C |
| 1. C | 1. E | 1. D | 1. B | 1. A | 1. A |
| 1. C | 1. C | 1. B | 1. A | 1. B | 1. B |
| 1. B | 1. B | 1. A | 1. A | 1. C | 1. A |
| 1. C | 1. D | 1. C | 1. D | 1. D | 1. C |
| 1. B | 1. C | 1. B | 1. D | 1. A | 1. E |
| 1. E | 1. A |  |  |  |  |



**Explanations Objective Alternating Current**

