Sample Question Solution
Course Title: Circuit Theory and Analysis

PART-A

Set-01(Chapter: 4,5)

a) Define the following terms: Ohm’s law, Circuit, Power, Energy and Efficiency.

Ohm’s Law: The law states that for a fixed resistance, the greater the voltage (or pressure) across a resistor, the more the current, and the more the resistance for the same voltage, the less the current.

In other words, the current is proportional to the applied voltage and inversely proportional to the resistance.By simple mathematical manipulations, the voltage and resistance can be found in terms of the other two quantities:

$$\boldsymbol{E = IR}$$

$$\boldsymbol{R = \frac{E}{R}}$$

Circuit: A circuit is a closed loop that electrons can flow through. A simple circuit consists of a current source, conductors and a load.

Power: The term power is applied to provide an indication of how much work (energy conversion) can be accomplished in a specified amount of time; that is, power is a rate of doing work. It is measured in joules/second (J/s) or watts (W).

Power is determined by, $\boldsymbol{P = \frac{W}{t} = I^2R = EI = \frac{V^2}{R}}$

Energy: A quantity whose change in state is determined by the product of the rate of conversion (P) and the period involved (t). It is measured in joules (J) or wattseconds (Ws). Energy is determined by,

$$\boldsymbol{W = Pt}$$

Efficiency: A ratio of output to input power that provides immediate information about the energy-converting characteristics of a system.

$$Efficiency = \frac{Power\ output}{Power\ input}$$

$$\eta\% = \frac{P_o}{P_i} \times 100\%$$

$$\eta\% = \frac{W_o}{W_i} \times 100\%$$

b) Write down the Kirchhoff’s voltage law.

KIRCHHOFF’S VOLTAGE LAW (KVL):

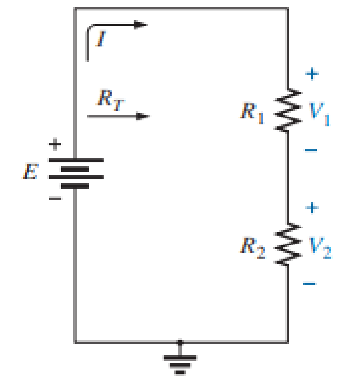
The algebraic sum of the potential rises and drops around a closed path (or closed loop) is zero. The sum of the voltage rises around a closed path will always equal the sum of the voltage drops.

$$\sum V_{rises} = \sum V_{drops}$$

c) State and explain the Voltage Divider Rule (VDR) with suitable diagram.

Voltage Divider Rule (VDR):

The voltage divider rule States that the voltage across a resistor in a series circuit is equal to the value of that resistor multiplied by the total voltage divided by the total resistance of the series configuration.



First,determine the total resistance,

$$R_T = R_1 + R_2$$

Then, $I_s = I_1 = I_{2=} \frac{E}{R_T}$

Apply Ohm’s law to each resistor:

$$V_1 = I_1R_1 = \left(\frac{E}{R_T}\right)R_1 = R_1\frac{E}{R_T}$$

$$V_2 = I_2R_2 = \left(\frac{E}{R_T}\right)R_2 = R_2\frac{E}{R_T}$$

The final result is the voltage divider rule is

$$V_x = R_x\frac{E}{R_T}$$

d) What do you understand by notation or Double-Subscript Notation or Single-Subscript Notation?

Notation: Notation plays an increasingly important role in the analysis to follow.

Double-Subscript Notation: The double-subscript notation $\boldsymbol{V_{ab}}$ specifies point a as the higher potential. If this is not the case, a negative sign must be associated with the magnitude of $\boldsymbol{V_{ab}}$.In other words, the voltage $\boldsymbol{V_{ab}}$ is the voltage at point a with respect to (w.r.t.) point b.

Single-Subscript Notation: The single-subscript notation V_a specifies the voltage at point a with respect to ground (zero volts). If the voltage is less than zero volts, a negative sign must be associated with the magnitude of V_a.

In other words, if the voltage at points a and b is known with respect to ground, then the voltage Vab can be determined.

$$V_{ab} = V_a - V_b$$

e) See all highlighted math from reference book.

Examples: Chapter 4 (1,9,15,16,17) ,Chapter 5 (1-9,13,16-19,21,22,23,26,27).

Problems: Chapter 5 (2,7,10).

Set-02 (Chapter: 6,7)

a) Define parallel circuit, Open and Short circuits.

Parallel circuit: A parallel circuit can be established by connecting a supply across a set of parallel resistors. In general, the voltage is always the same across parallel elements. if two elements are in parallel, the voltage across them must be the same. However, if the voltage across two elements is the same, the two elements may or may not be in parallel.

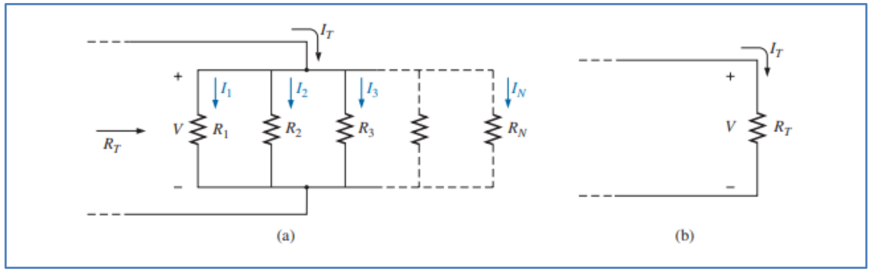
Open circuit: An open circuit is two isolated terminals not connected by an element of any kind. an open circuit can have a potential difference (voltage) across its terminals, but the current is always zero amperes.

Short circuit: A short circuit is a very low resistance, direct connection between two terminals of a network. A short circuit can carry a current of a level determined by the external circuit, but the potential difference (voltage) across its terminals is always zero volts

b) State and explain current divider rule with suitable diagram.

Current Divider Rule (VDR):

The current divider rule States that the current through any branch of a parallel resistive network is equal to the total resistance of the parallel network divided by the resistance of the resistor and multiplied by the total current entering the parallel configuration.



First,determine the total resistance,

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + - - -$$

The current I_T can then be determined using Ohm's law:

$$I_T = \frac{V}{R_T}$$

Since the voltage V is the same across parallel resistance

$$V = I_1R_1 = I_2R_2 = I_3R_3 = I_xR_x$$

$$I_T = \frac{I_xR_x}{R_T}$$

The final result is the voltage divider rule is

$$I_x = I_T \frac{R_T}{R_x}$$

c) Write down the Kirchhoff's current law.

KIRCHHOFF'S CURRENT LAW (KCL):

The algebraic sum of the currents entering and leaving a junction (or region) of a network is zero. The sum of the currents entering a junction (or region) of a network must equal the sum of the currents leaving the same junction (or region).

$$\sum I_i = \sum I_o$$

d) See all highlighted math from reference book.

Examples: Chapter 6 (1-25,28), Chapter 7 (1-4,6,7,8).

Set-03 (Chapter: 8)

a)Explain source conversion procedure.

1. a current source determines the direction and magnitude of the current in the branch where it is located.
2. the magnitude and the polarity of the voltage across a current source are each a function of the network to which the voltage is applied.
3. the equivalence between a current source and a voltage source exists only at their external terminals.
4. a source and its equivalent will establish current in the same direction through the applied load.

b) Write down the steps of Branch-Current analysis procedure.

The first approach to be introduced is called the branch-current method because we will define and solve for the currents of each branch of the network.

Branch-Current Analysis Procedure:

1. Assign a distinct current of arbitrary direction to each branch of the network.
2. Indicate the polarities for each resistor as determined by the assumed current direction.
3. Apply Kirchhoff's voltage law around each closed, independent loop of the network.
4. Apply Kirchhoff's current law at the minimum number of nodes that will include all the branch currents of the network.
5. Solve the resulting simultaneous linear equations for assumed branch currents.

c) Write down the steps of Mesh Analysis procedure.

The number of mesh currents required to analyze a network will equal the number of "windows" of the configuration.

Mesh Analysis Procedure:

1. Assign a distinct current in the clockwise direction to each independent, closed loop of the network.
2. Indicate the polarities within each loop for each resistor as determined by the assumed direction of loop current for that loop.
3. Apply Kirchhoff's voltage law around each closed loop in the clockwise direction. Again, the clockwise direction was chosen to establish uniformity and prepare us for the method to be introduced in the next section.

d) Write down the steps of Nodal Analysis procedure.

Nodal Analysis Procedure:

the number of nodes for which the voltage must be determined using nodal analysis is 1 less than the total number of nodes.

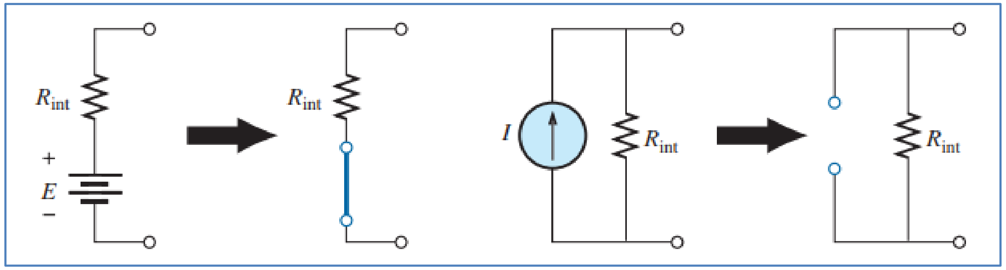
1. Determine the number of nodes within the network.
2. Pick a reference node, and label each remaining node with a subscripted value of voltage: V_1, V_2, and so on.
3. Apply Kirchhoff's current law at each node except the reference. Assume that all unknown currents leave the node for each application of Kirchhoff's current law. In other words, for each node, don't be influenced by the direction that an unknown current for another node may have had. Each node is to be treated as a separate entity, independent of the application of Kirchhoff's current law to the other nodes.
4. Solve the resulting equations for the nodal voltages.

e) See all highlighted math from reference book.

Examples: Chapter 8 (6-13,16,19,20,27-29).

Set-04 (Chapter: 9)

a) State and explain Superposition's theorem with a suitable illustration.



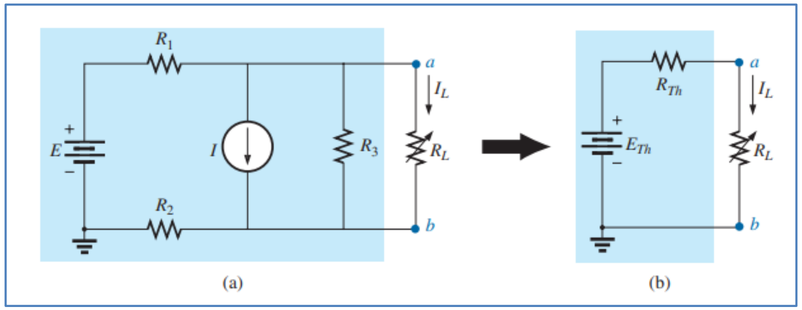
The superposition theorem state and explain the following:

The current through, or voltage across, any element of a network is equal to the algebraic sum of the currents or voltages produced independently by each source.

1. When removing a voltage source from a network schematic, replace it with a direct connection (short circuit) of zero ohms. Any internal resistance associated with the source must remain in the network.
2. When removing a current source from a network schematic, replace it by an open circuit of infinite ohms. Any internal resistance associated with the source must remain in the network.
3. Since the effect of each source will be determined independently, the number of networks to be analyzed will equal the number of sources.

b) State and explain Thévenin's network theorem with a suitable illustration.

The Thévenin's theorem state and explain the following:



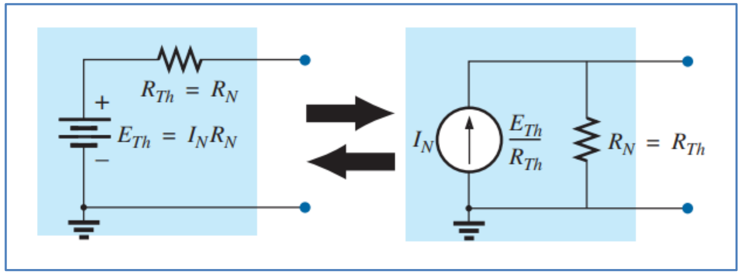
(a) (b)

Any two-terminal dc network can be replaced by an equivalent circuit consisting solely of a voltage source and a series resistor.

1. Remove that portion of the network where the Thévenin equivalent circuit is found.
2. Mark the terminals of the remaining two-terminal network.
3. Calculate R_{th} by first setting all sources to zero and then finding the resultant resistance between the two marked terminals.
4. Calculate E_{th} by first returning all sources to their original position and finding the open-circuit voltage between the marked terminals.
5. Draw the Thévenin equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equivalent circuit.

c) State and explain Norton's network theorem with a suitable illustration.

The Norton's **theorem state and explain the following:**



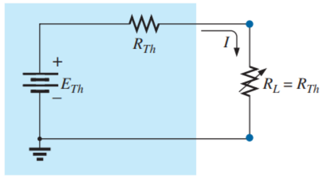
Any two-terminal linear bilateral dc network can be replaced by an equivalent circuit consisting of a current source and a parallel resistor.

1. Remove that portion of the network across which the Norton equivalent circuit is found.
2. Mark the terminals of the remaining two-terminal network.
3. Calculate R_N by first setting all sources to zero and then finding the resultant resistance between the two marked terminals.
4. Calculate I_N by first returning all sources to their original position and then finding the short-circuit current between the marked terminals.
5. Draw the Norton equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equivalent circuit.

d) State Maximum Power Transfer theorem. What load should be applied to a system to ensure that the load is receiving maximum power from the system? Or Drive the expression to ensure that the load is receiving maximum power from the network. (answer: equation 9.3)

The maximum power transfer theorem states the following:

A load will receive maximum power from a network when its resistance is exactly equal to the Thévenin resistance of the network applied to the load.



That is,

$$R_L = R_{Th}$$

with $R_L = R_{Th}$, the maximum power delivered to the load can be determined by first finding the current:

$$I_L = \frac{E_{Th}}{R_{Th} + R_L} = \frac{E_{Th}}{R_{Th} + R_{Th}} = \frac{E_{Th}}{2R_{Th}}$$

Then substitute into the power equation:

$$P_L = I_L^2 R_L = \left(\frac{E_{Th}}{2R_{Th}}\right)^2 (R_{Th}) = \frac{E_{Th}^2 R_{Th}}{4R_{Th}^2}$$

$$P_{L\,max} = \frac{E_{Th}^2}{4R_{Th}}$$

e) See all highlighted math from reference book.

Examples: Chapter 9 (1,2,4,6-8,11,12,15,18).

PART-B

Set-05 (Chapter: 13)

a) Define the following terms: Waveform, Instantaneous value, Peak Amplitude. Peak Value, Peak-to-Peak Value, Periodic Waveform, Period and Cycle.

Waveform : The path traced by a quantity, plotted as a function of some variable such as position, time, degrees, temperature, and so on.

Instantaneous value : The magnitude of a waveform at any instant of time, denoted by lowercase letters.

Peak amplitude : The maximum value of a waveform as measured from its average, or mean, value, denoted by uppercase letters.

Peak value : The maximum value of a waveform, denoted by uppercase letters.

Peak-to-peak value : The magnitude of the total swing of a signal from positive to negative peaks. The sum of the absolute values of the positive and negative peak values.

Periodic waveform : A waveform that continually repeats itself after the same time interval.

Period (T) : The time interval necessary for one cycle of a periodic waveform.

Cycle : A portion of a waveform contained in one period of time.

Frequency (f) : The number of cycles of a periodic waveform that occur in 1 second

b) What do you mean by Leading and Lagging Waveform?

Leading waveform : A waveform that crosses the time axis at a point in time ahead of another waveform of the same frequency.

Lagging waveform : A waveform that crosses the time axis at a point in time later than another waveform of the same frequency.

The terms leading and lagging are used to indicate the relationship between two sinusoidal waveforms of the same frequency plotted on the same set of axes. In Fig. 13.29, the cosine curve is said to lead the sine curve by 90°, and the sine curve is said to lag the cosine curve by 90°.

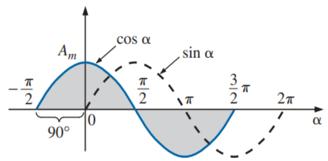


FIG. 13.29
Phase relationship between a sine wave and a cosine wave.

c) Give the concepts of average value with suitable example.

Average value : The level of a waveform defined by the condition that the area enclosed by the curve above this level is exactly equal to the area enclosed by the curve below this level.

d) Define rms or effective value. Show that the equivalent dc value of a sinusoidal current or voltage is $I_{dc} = \frac{I_m}{\sqrt{2}}$, where the symbols have their usual meaning. (answer: book, page: 567).

EFFECTIVE(rms)VALUE : The equivalent dc value of any alternating voltage or current.

The power delivered by the ac supply at any instant of time is

$$P_{ac} = (i_{ac})^2 R = (I_m \sin\omega t)^2 R = (I_m^2 \sin^2\omega t) R$$

However,

$$\sin^2\omega t = \frac{1}{2}(1 - \cos 2\omega t)$$

Therefore,

$$P_{ac} = I_m^2 [\tfrac{1}{2}(1 - \cos 2\omega t)] R$$

$$P_{ac} = \frac{I_m^2 R}{2} - \frac{I_m^2 R}{2} \cos 2\omega t$$

The average power delivered by the ac source is just the first term, **since the average value of a cosine wave is zero** even though the wave may have twice the frequency of the original input current waveform. Equating the average power delivered by the ac generator to that delivered by the dc source,

$$P_{av(ac)} = P_{dc}$$

$$\frac{I_m^2 R}{2} = I_{dc}^2 R$$

$$I_{dc} = \frac{I_m}{\sqrt{2}} = 0.707 I_m$$

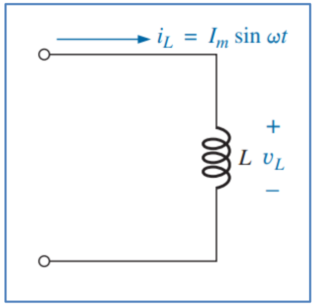
e) See all highlighted math from reference book.

Examples: Chapter 13 (1-18,20-22).

Set-06 (Chapter: 14)

a) Show that the inductive reactance of an inductor in ac sinusoidal network is $X_L = \omega L$, where the symbols have their usual meaning.

For the inductor in figure,



$$v_L = L\frac{di_L}{dt}$$

Applying differentiation,

$$\frac{di_L}{dt} = \frac{d}{dt}(I_m sin\omega t) = \omega I_m \cos \omega t$$

Therefore,

$$v_L = L\frac{di_L}{dt} = L(\omega I_m \cos \omega t) = \omega L I_m \cos \omega t$$

Or, $\qquad v_L = V_m \sin(\omega t + 90°)$

Where, $\qquad V_m = \omega L I_m$

Sinusoidal expression for $\qquad i_L = I_m \sin(\omega t \pm \theta)$

Then $\qquad v_L = \omega L I_m \sin(\omega t \pm \theta + 90°)$

$$Opposition = \frac{cause}{effet}$$

$$\text{Opposition} = \frac{V_m}{I_m} = \frac{\omega L I_m}{I_m} = \omega L$$

The quantity ωL, called the reactance (from the word reaction) of an inductor, is symbolically represented by X_L and is measured in ohms; that is

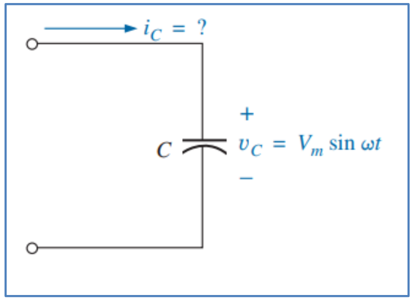
$$X_L = \omega L$$

In an Ohm's law format, its magnitude can be determined from

$$X_L = \frac{V_m}{I_m}$$

b) Show that the capacitive reactance of a capacitor in ac sinusoidal network is $X_C = \frac{1}{\omega C}$, where the symbols have their usual meaning.

For the capacitor in figure,



$$i_C = C\frac{dv_C}{dt}$$

Applying differentiation,

$$\frac{dv_C}{dt} = \frac{d}{dt}(V_m sin\omega t) = \omega V_m \cos \omega t$$

Therefore,

$$i_C = L\frac{dv_C}{dt} = C(\omega V_m \cos \omega t) = \omega C V_m \cos \omega t$$

Or, $\qquad i_C = I_m \sin(\omega t + 90°)$

Where, $\qquad I_m = \omega C V_m$

Sinusoidal expression for $\qquad v_C = V_m \sin(\omega t \pm \theta)$

Then $\qquad i_C = \omega C V_m \sin(\omega t \pm \theta + 90°)$

$$Opposition = \frac{cause}{effet}$$

$$\text{Opposition} = \frac{V_m}{I_m} = \frac{V_m}{\omega C V_m} = \frac{1}{\omega}$$

The quantity $1/\omega C$, called the reactance of a capacitor, is symbolically represented by X_C and is measured in ohms; that is

$$X_C = \frac{1}{\omega C}$$

In an Ohm's law format, its magnitude can be determined from

$$X_C = \frac{V_m}{I_m}$$

c) Deduce the expression for average power delivered to a load for sinusoidal voltage and current.

Power is being delivered to the load at each instant of time of the applied sinusoidal voltage and current.

$$P_{av} = \frac{V_m I_m}{2} = \frac{(\sqrt{2}V_{rms})(\sqrt{2}I_{rms})}{2} = \frac{2\,V_{rms}\,I_{rms}}{2}$$

we find that the average or real power delivered to a resistor takes on the following very convenient form : $P_{av} = V_{rms}\,I_{rms}$

The magnitude of average power delivered is independent of whether v leads i or i leads v. $P = \frac{V_m I_m}{2} cos\theta$

Where P is the average power in watts. This equation can also be written

$$\boldsymbol{P = \left(\frac{V_m}{\sqrt{2}}\right)\left(\frac{I_m}{\sqrt{2}}\right) cos\theta}$$

Or, since $\boldsymbol{V_{eff} = \frac{V_m}{\sqrt{2}} \text{ and } I_{eff} = \frac{I_m}{\sqrt{2}}}$

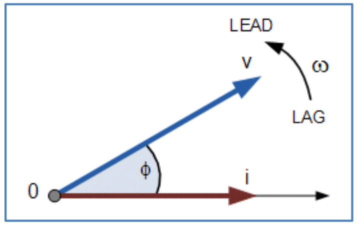
d) Explain the terms: (i) Power factor (ii) Phasor (iii) Phasor diagram with suitable figure.

Power factor (F_P) : An indication of how reactive or resistive an electrical system is. The higher the power factor, the greater the resistive component.

$$\textbf{Power factor} = \boldsymbol{F_P = cos\theta}$$

Phasor : A radius vector that has a constant magnitude at a fixed angle from the positive real axis and that represents a sinusoidal voltage or current in the vector domain.

Phasor diagram : A "snapshot" of the phasors that represent a number of sinusoidal waveforms at t = 0.

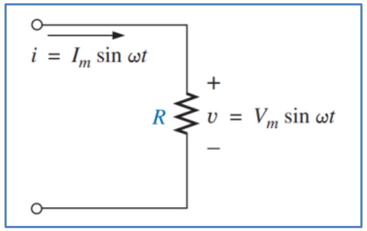


e) See all highlighted math from reference book.

Examples: Chapter 14 (1,2,4,5,7-13,15-18,27-29).

Set-07 (Chapter: 15)

a) Briefly explain the impedance of a resistive element in ac network with suitable illustration. Or Show that the impedance of a resistive element in ac network is $Z_R = R\angle 0°$,where the symbols have their usual meaning. (answer: book, equation: 15.1).



From Fig, v and i were in phase, and the magnitude

$$I_m = \frac{V_m}{R} \text{ or } V_m = I_m R$$

$$v = V_m \sin \omega t$$

$$\text{Or, } \boldsymbol{V} = V\angle 0°$$

$$\text{Where } V = 0.707 V_m$$

Applying Ohm's law and using phasor algebra, we have

$$\mathbf{I} = \frac{V\angle 0°}{R\angle\theta_R} = \frac{V}{R} \underline{/0° - \theta_R}$$

Since i and v are in phase, . Substituting $\theta_R = 0°$. We find

$$\mathbf{I} = \frac{V\angle 0°}{R\angle 0°} = \frac{V}{R} \underline{/0° - 0°} = \frac{V}{R}\angle 0°$$

So that in the time domain,

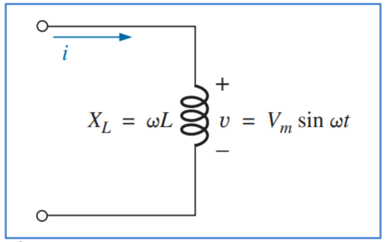
$$i = \sqrt{2}\left(\frac{\boldsymbol{V}}{\boldsymbol{R}}\right) \boldsymbol{sin\omega t}$$

The proper phase relationship between the voltage and current of a resistor:

$$Z_R = R\angle 0°$$

b) Briefly explain the impedance of an inductive element in ac network with suitable illustration. Or Show that the impedance of an inductive element in ac network is $Z_L = X_L\angle 90°$, where the symbols have their usual meaning. (answer: book, equation: 15.2).

From Fig,



$$v = V_m \sin \omega t$$

$$\text{Phasor form } \boldsymbol{V} = V\angle 0°$$

Where $V = 0.707V_m$

Applying Ohm's law and using phasor algebra, we have

$$\mathbf{I} = \frac{V\angle 0°}{X_L\angle\theta_L} = \frac{V}{X_L}\angle 0° - \theta_L$$

Since v leads i by 90°. Substituting $\theta_L = 90°$. We find

$$\mathbf{I} = \frac{V\angle 0°}{X_L\angle 90°} = \frac{V}{X_L}\angle 0° - 90° = \frac{V}{X_L}\angle -90°$$

So that in the time domain,

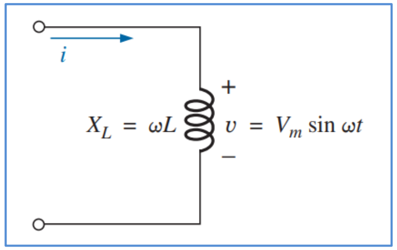
$$i = \sqrt{2}\left(\frac{V}{X_L}\right)\sin(\omega t - 90°)$$

The proper phase relationship between the voltage and current of a inductor:

$$Z_L = X_L\angle 90°$$

c) Briefly explain the impedance of a capacitive element in ac network with suitable illustration. Or Show that the impedance of a capacitive element in ac network is $Z_C = X_C\angle -90°$, where the symbols have their usual meaning. (answer: book, equation: 15.3).

From Fig,



$$v = V_m \sin \omega t$$

$$\text{Phasor form } \boldsymbol{V} = V\angle 0°$$

Where $V = 0.707V_m$

Applying Ohm's law and using phasor algebra, we have

$$\mathbf{I} = \frac{V\angle 0°}{X_C\angle\theta_C} = \frac{V}{X_C}\angle 0° - \theta_C$$

Since i leads v by 90°. Substituting $\theta_C = -90°$. We find

$$\mathbf{I} = \frac{V\angle 0°}{X_C\angle -90°} = \frac{V}{X_C}\angle 0° - (-90°) = \frac{V}{X_C}\angle 90°$$

So that in the time domain,

$$i = \sqrt{2}\left(\frac{V}{X_C}\right)\sin(\omega t + 90°)$$

The proper phase relationship between the voltage and current of capacitor :

$$Z_C = X_C\angle -90°$$

d) Define Admittance and Susceptance.

Admittance (Y): Admittance is a measure of how easily an electrical circuit or component allows current to flow through it, and is the reciprocal of impedance (Z). It is defined as:

$$Y = \frac{1}{Z}$$

where Z is the impedance of the circuit or component, and Y is measured in siemens (S).

Susceptance (B): Susceptance is a measure of the reactive component of admittance and represents the ability of a circuit or component to store or release energy. It is defined as:

$$B = \frac{1}{X}$$

where X is the reactance of the circuit or component, and B is measured in siemens (S).

e) See all highlighted math from reference book.

Examples: Chapter 15 (1-10,16,17).

Set-08 (Chapter: 20)

a) Define resonance and Quality Factor (Q).

Resonance: A condition established by the application of a particular frequency (the resonant frequency) to a series or parallel R-L-C network. The transfer of power to the system is a maximum and for frequencies above and below, the power transfer drops off to significantly lower levels.

Quality Factor (Q) : Quality Factor is a measure of the efficiency of a resonant system. It is defined as the ratio of the reactive power of either the inductor or the capacitor to the average power of the resistor at resonance.

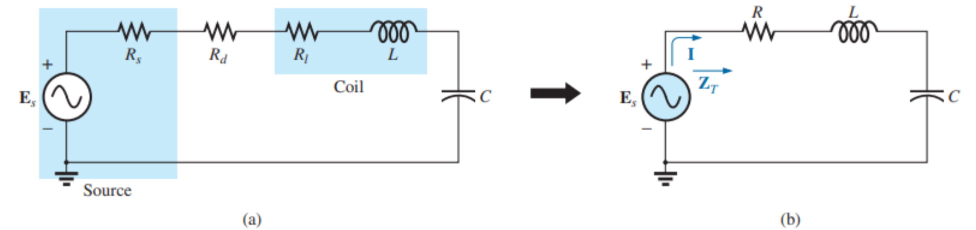
$$Q_s = \frac{\text{reactive power}}{\text{average power}}$$

b) What do you understand by resonant circuit?

Resonant circuit : A resonant circuit also known as a tuned circuit or an LC circuit, is an electronic circuit that consists of a capacitor and an inductor connected in series or in parallel. The circuit is designed to resonate at a specific frequency or range of frequencies, based on the values of the capacitor and inductor.

When an alternating current (AC) is applied to a resonant circuit, the circuit's natural frequency causes the capacitor and inductor to store and release energy in a cyclical manner. This results in a strong oscillation or resonance at the resonant frequency, with minimal energy loss.

c) Show that the resonant frequency of series resonant circuit is $f_s = \frac{1}{2\pi\sqrt{LC}}$, where the symbols have their usual meaning.



Series resonant circuit.

Here , The total Resistance $R = R_s + R_d + R_l$

The total impedance of this network at any frequency is determined by

$$X_T = R + jX_L - jX_c = R + j(X_L - X_c)$$

The resonant condition is :

$$X_L = X_c$$

Removing the reactive component from the total impedance equation. The total impedance at resonance is then,

$$Z_{T_s} = R$$

Substituting yields,

$$\omega L = \frac{1}{\omega C}$$

$$or, \omega^2 = \frac{1}{LC}$$

$$\text{or, } \omega_s = \frac{1}{\sqrt{LC}}$$

$$\text{or, } f_s = \frac{1}{2\pi\sqrt{LC}}$$

here, f =hertz(Hz)

L =henries(H)

C =farads(F)

d) Show that the quality factor of series resonant circuit is $Q_s = \frac{1}{R}\sqrt{\frac{L}{C}}$, where the symbols have their usual meaning.

$$\text{Quality Factor } Q_s = \frac{\text{reactive power}}{\text{average power}}$$

an inductive reactance in resonance gives us,

$$Q_s = \frac{I^2 X_L}{I^2 R}$$

and

$$Q_s = \frac{X_L}{R} = \frac{\omega_s L}{R}$$

If the resistance (R) is just the resistance of the coil (R_l), we can speak of the Q of the coil, where

$$Q_{coil} = Q_1 = \frac{X_L}{R_l}$$

and

$$\omega_s = 2\pi f_s$$

$$\text{then, } f_s = \frac{1}{2\pi\sqrt{LC}}$$

we have

$$Q_s = \frac{\omega_s L}{R} = \frac{2\pi f_s L}{R}$$

$$= \frac{2\pi}{R}\left(\frac{1}{2\pi\sqrt{LC}}\right)L = \frac{L}{R}\left(\frac{1}{\sqrt{LC}}\right)$$

$$Q_s = \frac{1}{R}\sqrt{\frac{L}{C}}$$

e) Draw and explain the total impedance (Z_T) versus frequency curve for the series resonant circuit. (answer: book, page:877).

f) What do you understand by selectivity? Show that the bandwidth of series resonant circuit is$BW = \frac{f_s}{Q_s}$, where the symbols have their usual meaning. (page:879)

g) See all highlighted math from reference book.

<u>Examples:</u> Chapter 20 (1-7).