KSRCE/QM/7.5.1/33B/ECE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE – 637 215.
COURSE / LESSON PLAN SCHEDULE

NAME : SIVASANKAR RAJAMANI.
CLASS : I- ECE.
SUBJECT : ELECTRIC CIRCUITS

A). TEXT BOOKS:

1. Joseph A.Edminister, Mahmood Nahvi, "Electric Circuits, Schaum's Series, 4th edition Tata McGraw-Hill, New Delhi, 2002.
2. David A. Bell, "Electric Circuits"' PHI, 2006.
3. Prof.T.Nageswara Rao, "Electric Circuit Analysis", A.R.Publications, 2005.

B). REFERENCES:

1. K. Jack E.Kemmerly, William Hart Hayt, "Engineering Circuit Analysis-6th Edition", McGraw- Hill, New Delhi, 2002.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Networks", 2nd Edition, McGraw- Hill 2003.
3. William H.Kayt, Jr.Jack E. Kemmerly, Steven M.Durbin, "Engineering Network Analysis", 6th Edition, Tata McGraw-Hill Edition, 2006.
4. Sudhakar and Shyammohan S. Palli, "Circuits & Networks (Analysis and Synthesis)", Tata Mc Graw – Hill, 3rd Edition, 2007.

C). LEGEND:

L	-	Lecture	BB	-	Black Board
Tx	-	Text	OHP	-	Over Head Projector
Rx	-	Reference			
Ex	-	Extra	pp	-	Pages

S.No	Lecture hour	Topic(s) to be covered	Teaching aid required	Book No/Page No
UNIT-I DC NETWORK ANALYSIS				
1.	L1	Basic Components and Electric Networks Charge, Current, Voltage and Power, Voltage and Current Sources	BB	Tx3/I.1,Tx1/2,4 Tx2/4
2.	L2, L3	Ohms Law, Kirchhoff's Laws	BB	Tx1/21 Tx3/1.1,1.3 Tx2/36
3.	L4	Analysis of Series and Parallel Networks,	BB	Tx1/22 Tx3/1.6 Tx2/83,112
4.	L5	Voltage and Current Division	BB	Tx1/25 Tx2/92,122 Tx3/1.15
5.	L6, L7	Networks Reduction	BB	Tx1/38 Tx2/202 Tx3/9.37
6.	L8	Nodal and Mesh Analysis for Linear Resistive Networks	BB	Tx1/32 Tx2/174,178 Tx3/7.2, 7.17
7.	L9	An Introduction Network Topology	BB	Tx3/12.12 Tx2/923
UNIT-II NETWORK THEOREMS AND DUALITY				
8.	L10	Linearity and Non Linearity	BB	Tx3/I.2

9.	L11	Superposition Theorem,	BB	Tx1/39 Tx2/197 Tx3/9.1
10.	L12	Thevenin's Theorem	BB	Tx1/40 Tx2/201 Tx3/9.32
11.	L13	Norton's Theorem,	BB	Tx1/40 Tx2/206 Tx3/9.49
12.	L14, L15	Maximum Power Transfer Theorem,	BB	Tx1/42 Tx2/212 Tx3/9.63
13.	L16	Reciprocity Theorem	BB	Tx2/218 Tx3/9.90
14.	L17	Star - Delta Transformation	BB	Tx1/239 Tx2/184 Tx3/1.69
15.	L18	Duals, Dual Networks	BB	Tx3/12.1
16. **UNIT-III**		**SINUSOIDAL STEADY STATE ANALYSIS**		
17.	L19, L20	Sinusoidal Steady State analysis	BB	Tx1/184 Tx3/2.1
18.	L21, L22	Characteristics of Sinusoids, AC Network Power Analysis	BB	Tx1/184 Tx2/456 Tx3/2.4
19.	L23	Instantaneous Power, Average Power, Apparent Power and Power Factor	BB	Tx1/211 Tx2/468 Tx3/2.7
20.	L24, L25	Phase Relationship for R, L, and C	BB	Tx3/3.1
21.	L26	Analysis of Simple Series AC Networks with Phasor Diagram	BB	Tx2/526, 533 Tx3/3.1
22.	L27	Analysis of Simple Parallel AC Networks with Phasor Diagram	BB	Tx2/544 Tx3/4.1
UNIT-IV		**TRANSISENTS AND RESONANCE IN RLC NETWORKS**		
23.	L28, L29, L30	Transient Response of RL, RC and RLC. Networks for DC Input and Sinusoidal Inputs	BB	Tx3/11.1 Tx3/11.20
24.	L31, L32	Series Resonance	BB	Tx1/272 Tx2/667 Tx3/5.1
25.	L33, L34	Parallel Resonance	BB	Tx1/274 Tx2/683 Tx3/5.24
26.	L35, L36	Frequency Response, Quality Factor Bandwidth, Half Power Frequencies	BB	Tx1/260, 273, 285, 265 Tx3/5.8, 5.11
UNIT V		**COUPLED NETWORKS AND THREE PHASE SYSTEMS**		
27.	L37, L38	Magnetically Coupled Networks, Self Inductance, Mutual Inductance	BB	Tx1/319 Tx2/357, 366 Tx3/8.1,8.2
28.	L39, L40	Co-efficient of Coupling	BB	Tx1/320 Tx3/8.3

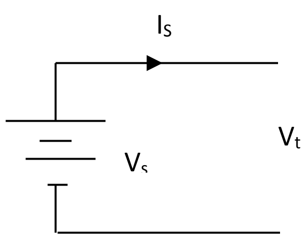
29.	L41, L42,	Single and Double Tuned Networks, Analysis and Applications	BB	Tx3/8.18, 8.21
30.	L43, L44	Analysis of 3 Phase 3 Wire and 4 Wire Systems with Star and Delta Connected Loads (balanced & Unbalanced)	BB	Tx1/240 Tx2/796 Tx3/6.1, 6.30, 6.8, 6.10
31.	L45	3 Phase power measurement by two watt meter method.	BB	Tx1/322 Tx3/6.45
				TOTAL: 45 HOURS

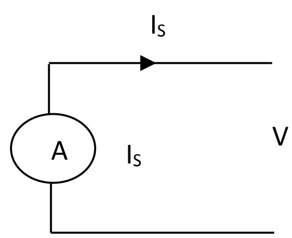
TWO MARKS
UNIT-I-CIRCUIT ANALYSIS TECHNIQUES

1. **What do you mean by circuit analysis? / State scope and importance of circuit analysis.**
   Analyzing a closed network making use of first principles is called circuit analysis which is a powerful tool to determine the circuit variable and / parameters. It plays a vital role in the entire range of equipments starting from home appliances to huge power circuits.
2. **What is charge?**
   Charge is the fundamental property of forms of matter that exhibit electrostatic attraction or repulsion in the presence of other matter.
3. **What is current?**
   Electric current is a flow of electric charge through a conductive medium
   The SI unit for measuring the rate of flow of electric charge is the ampere, which is charge flowing through some surface at the rate of one coulomb per second. Electric current is measured using an ammeter I=Q / T
4. **Define voltage**
   Voltage is defined is the electric potential difference between two points and it is measured in units of potential or joules per coulomb or (volts)
   A voltmeter can be used to measure the voltage (or potential difference) between two points in a system.
5. **What is power?**
   Electric power is the rate of doing work, measured in watts, and represented by the letter *P*. The electric power in watts produced by an electric current I consisting of a charge of *Q* coulombs every *t* seconds passing through an electric potential (voltage) difference of *V* is
   Power =work done per unit time = QV/T
   $$\text{Power} = VI \text{ (or) } I^2 R \text{ (or) } V^2/R$$
6. **What is resistor?**
   A resistor is a component of a circuit that resists the flow of electrical current. It has two terminals across which electricity must pass, and it is designed to drop the voltage of the current as it flows from one terminal to the other. Resistors are primarily used to create and maintain known safe currents within electrical components.
   Resistors may be fixed or variable, both controlling the flow of current differently.
7. **What is capacitor?**
   Capacitor is an electronic component that stores electric charge. The capacitor is made of 2 close conductors (usually plates) that are separated by a dielectric material. The plates accumulate electric charge when connected to power source. One plate accumulates positive charge and the other plate accumulates negative charge.
   The capacitance is the amount of electric charge that is stored in the capacitor at voltage of 1 Volt. The capacitance is measured in units of Farad (F).
8. **What is inductor?**
   An **inductor** (also choke, coil) is a passive two-terminal electrical component that stores energy in its magnetic field. Whenever current flows through a wire, it creates a magnetic field around the wire. By placing multiple turns of wire around a loop, it is measured in Henry

9. **What are the classifications of circuit elements?**
    a. lumped and distributed elements
    b. active and passive elements
    c. bilateral and unilateral elements
    d. linear and non linear elements
10. **What are active and passive elements?**
    a. The elements which can deliver energy are called as active elements eg: voltage & current
    b. The elements which consume energy in the form of absorption or by storage are called as passive elements eg: resistor capacitor inductor
11. **What are bilateral and unilateral elements?**
    c. In bilateral elements, the voltage –current relation is the same for current flowing in either direction eg: Resistor Capacitor & Inductors
    d. In an unilateral elements it has different relation between voltage and current for two possible direction of current eg: vacuum tubes, silicon diode
12. **What are lumped and distributed elements?**
    e. Physically separated elements such as resistor capacitor & inductor are called as lumped elements
    f. Distributed elements are one which is not separable for electrical purpose .a transmission line has distributed resistance capacitance and inductance along its length.

13. **What is meant by Linear and Bilateral Network?(Nov-Dec 2007)**
    Linear Network: A Network is said to be linear, if it satisfies the linear voltage – current relationship. It means that for linear elements, the relation between V and I is linear.
    Bi-Lateral Network: A Network is said to be bilateral, such that voltage and current relation in network is same for current flowing in either direction.
14. **Draw the ideal voltage source and current source. (Nov-Dec 2008)**
    g. Ideal Voltage Source: Ideal Current Source:





15. **Write the equivalent value formulas for series connected i. Resistances, ii.Capacitors. (Dec-2009).**

    Series connected resistances:
    $R = R_1 + R_2 + R_3 + ...R_N$

    Series connected Capacitances:
    $1/C = 1/C_1 + 1/C_2+1/C_3 + ...1/C_N$
16. **What is the equivalent resistance when 'N' resistors are in series and in parallel?(May-Jun 2007) (Nov-Dec 2011)**
    Resistors in series:
    $R = R_1 + R_2 + R_3 + R_4 +............R_N$
    Resistors in Parallel:
    $1/R = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4 + ...1/R_N$

17. **What is the effect when two current sources connected in parallel having current i.Same Direction? ii. Opposite Direction. (Dec-2009).**

    Current Sources in Same Direction:
    Currents will be added up

    Current Sources in Opposite Direction:
    Currents will be subtracted
18. **State Kirchhoff's Laws. (Nov/Dec – 2010). (Nov-Dec 2011) & (Apr-May 2011)**
    h. Kirchhoff's current law: Kirchhoff's current law states that in a node, sum of entering current is equal sum of leaving current.Σ I at junction point = 0

i. Kirchhoff's voltage law: Kirchhoff's Voltage Law (KVL) states that the algebraic sum of the voltages around any closed path is zero. Around a closed path $\Sigma V = 0$.

19. Define Ohm's law

j. **Ohm's law** states that the current through a conductor between two points is directly proportional to the potential difference across the two points, temperature remaining constant. Introducing the constant of proportionality, the resistance

k. $I=V / R$

20. Compare Series and Parallel Circuits.

Series Circuits.	**Parallel Circuits.**
Current is same through all the elements	Current is divided, inversely proportional to resistance.
Voltage is distributed	Voltage is same across each element
There is only one path for the flow of current	There are more than one path for the flow of current
Total resistance is the sum of the individual resistances	Reciprocal of total resistance equals the sum of the reciprocal of the individual resistances.

21. Define current division rule.

The current in any branch is equal to the ratio of the opposite parallel branch resistance to the total resistance value, multiplied by the total current in the circuit.

22. Define voltage division rule.

Voltage across a resistor in a series circuit is equal to the voltage across series elements multiplied by the value of that resistor divided by the total resistance of the series elements.

23. What is a node, a junction and branch?

A node is point in a network in which two are more elements have a common connection.
A junction is that point in a network where three more circuit elements are joined
Branch is the part of a network which lies between two junctions points

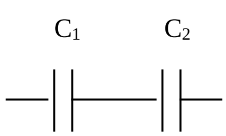
24. What is the difference between loop and mesh?

A loop is any closed path of a network
A mesh is the elementary form of a loop and cannot further divide into other loops.

25. What are the different types of dependent or controlled source?

a. Voltage controlled voltage source (VCVS)
b. Current controlled voltage source (CCVS)
c. Voltage controlled current source (VCCS)
d. Current controlled voltage source (CCVS)

26. Two Capacitors C_1 & C_2 are connected in Series. If C_1=10 µF and equivalent capacitance is 1.67µF.Find C_2. (Jun-July 2009).

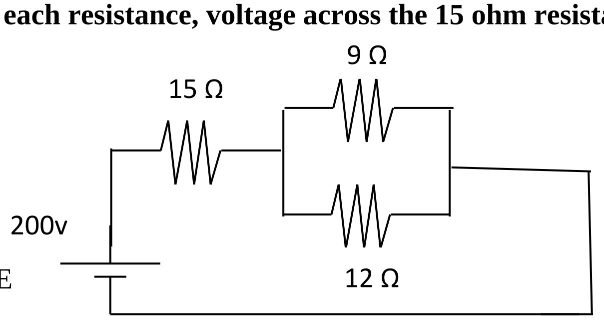


0µF C_2= ? 1/C = 1.67µF

$1/C = 1/C_1 + 1/C_2$ $\quad$ $1/C_2 = 1/1.67 - 1/10$, $1/C_2 = 0.4988$

$1/1.67 = 1/10 + 1/C_2$ $\quad$ $C_2 = 1/0.4988 = 2$, $\mathbf{C_2 = 2\mu F}$

27. Two resistances 9 ohm and 12 ohm are connected in parallel. A resistor of 15 ohm is connected in series with the combination. A voltage of 200V is applied across the entire circuit. Find the current in each resistance, voltage across the 15 ohm resistance?* .(June-July 2010)



Equivalent resistance:

$R_{eq} = \frac{15 + (9 * 12)}{(9 + 12)} = 20.14\ \Omega$

Total Current:

$I = V / R = 200 / 20.14 = 9.93A = 10A$

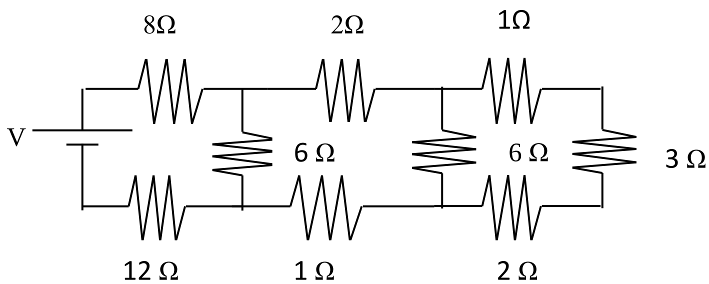
Current in 9Ω resistor: $I_1 = I * (12)/ (9 + 12) = 10 * (12)/ (9 + 12) = 5.71A$

Current in 12Ω resistor: $I_2 = I * (9)/ (9 + 12) = 10 * (9)/ (9 + 12) = 4.28A$

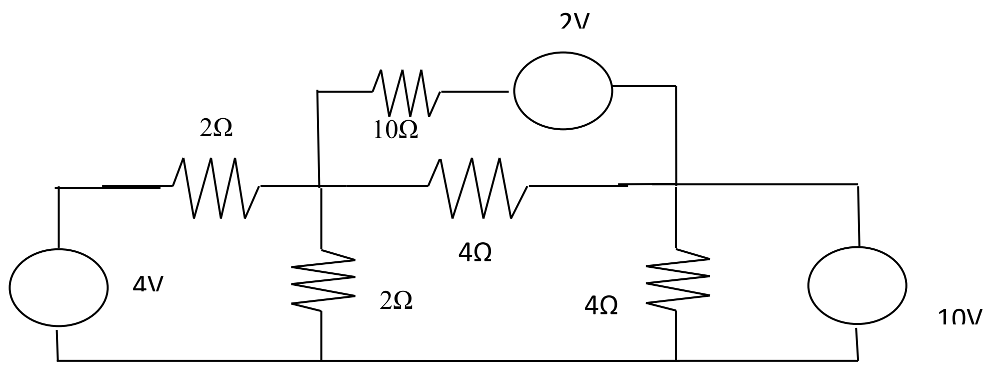
Voltage across 15Ω resistor: $V_{15\Omega} = I.R_{15\Omega} = 10 X 15 = 150V$

<u>12 Mark questions and 16 mark questions:</u>

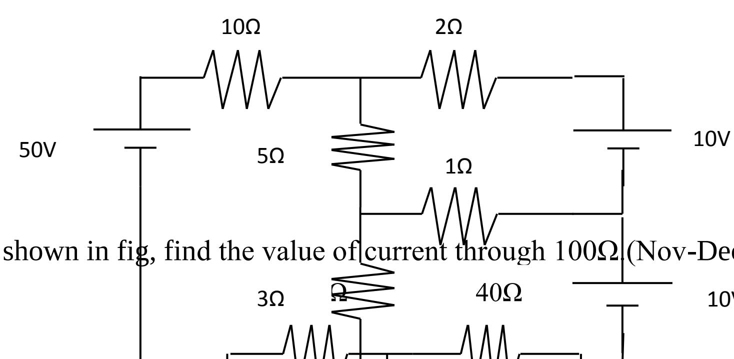
1. What is the supply voltage V in order to get 1 ampere in 3Ω resistor?(Nov-Dec 2003)



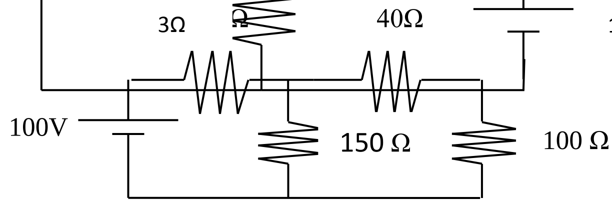
2. Determine the current I_1, in the circuit shown below, by writing mesh equations. (Apr-May 2004).*



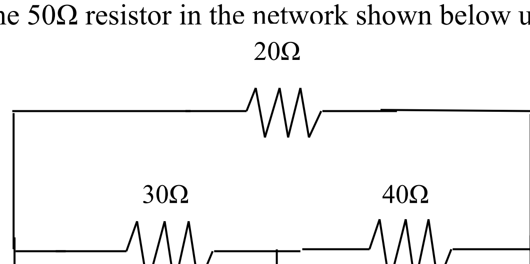
3. Determine the mesh current I_1, I_2, and I_3 for the circuit shown in fig.(Nov-Dec 2004)



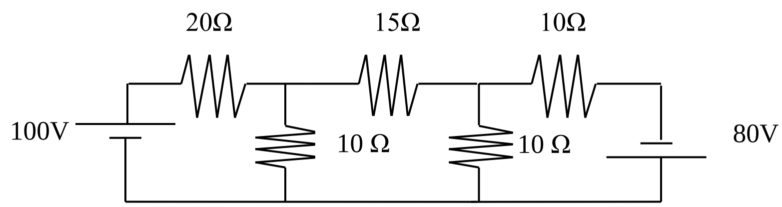
4. In the circuit shown in fig, find the value of current through 100Ω.(Nov-Dec 2004)



5. Calculate the current in the 50Ω resistor in the network shown below using mesh analysis.*

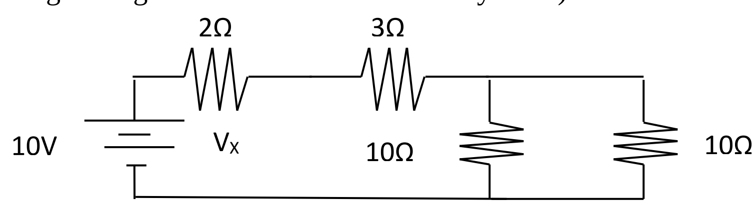


6. Calculate the voltage across the 15Ω resistor in the network shown below using Nodal Analysis.(May-Jun 2005).



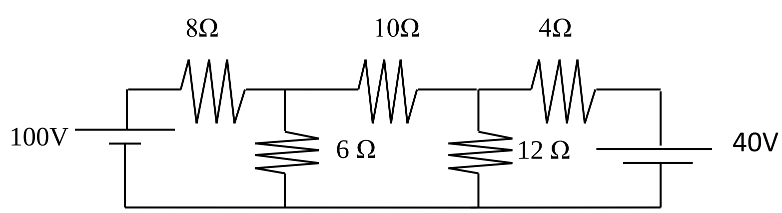
7. A voltage divider circuit of two resistors is designed with a total resistance of the two resistors equal to 50Ω.If the output voltage is 10% of the input voltage, Obtain the values of the two resistors in the circuit.(Jun-July 2009)

8. Determine V_x using Voltage Division Method. (Jun-July 2009).*



9. Find the inter connection of R_1=10Ω, R_2=2Ω, R_3=15 Ω such a way that the equivalent resistance is 8 Ω. (Nov-Dec 2008).

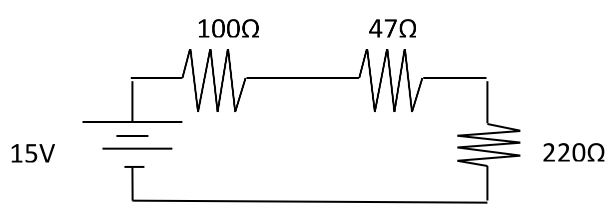
10. a. Solve the circuit shown below using Mesh Current method of analysis and determine the current in 12 Ω resistor and voltage drop across 6 Ω resistor. (June-July 2010)



c. For the circuit shown in question 18. a. Without sacrificing the two voltage sources, reduce the π network into a T network. (June - July 2010)

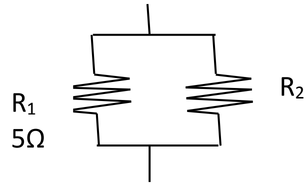
12. Explain in detail about star-delta conversion. (Apr-May 2011).

13. i. Verify Kirchhoff's Voltage Law for the given network (8) (Nov-Dec 2011)



ii. Verify Kirchhoff's current law for the given network (8) (Nov-Dec 2011)

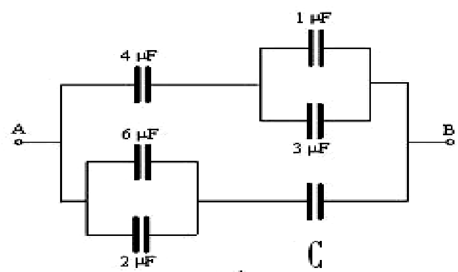
14. Find the value of resistance R_1 and R_2 when they are in parallel with the following conditions. The current in R_1 is twice the current flowing through R_2 and the equivalent resistance of the parallel combination is 10/3Ω. (Nov-Dec 2003)



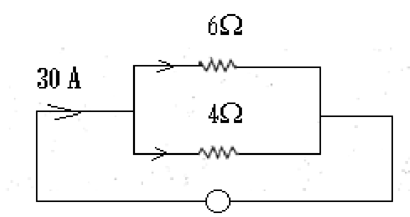
i. Value of R_1 = 5 Ω
ii. Value of R_2 =10Ω.

15. In the circuit, shown in fig, find the value of C Which gives an equivalent capacitance of 0.5μF

ii. between A and B. (May-Jun 2006)*



16. Two resistors of 4Ω & 6Ω connected in parallel if the total current is 30 A. Find the current through each resistor.



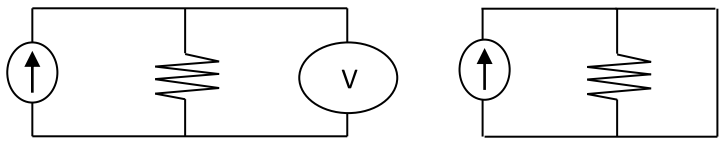
UNIT-II
NETWORK THEOREM AND DUALITY

1. **What are linear and non linear elements?**
   An element is said to be linear if it satisfies the linear current voltage relationship is called as linear The element which does not satisfy the linear voltage –current relationship is called as non linear elements.

2. **What is superposition theorem?**
   The **superposition theorem** for electrical circuits states that for a linear system the response (Voltage or Current) in any branch of a bilateral linear circuit having more than one independent source equals the algebraic sum of the responses caused by each independent source acting alone, while all other independent sources are replaced by their internal impedances.
   To ascertain the contribution of each individual source, all of the other sources first must be "turned off" (set to zero) by:
   Replacing all other independent voltage sources with a short circuit (thereby eliminating difference of potential. i.e. V=0, internal impedance of ideal voltage source is ZERO (short circuit)).
   Replacing all other independent current sources with an open circuit (thereby eliminating current. i.e. I=0, internal impedance of ideal current source is infinite (open circuit).

3. **When is the Superposition theorem applied? (Nov-Dec 2008)**
Superposition theorem is applied for finding the current through or voltage across a particular element in a linear circuit containing more than two sources. But this theorem cannot be applied for finding the power.

4. **By Superposition theorem, find the current through the 5Ω resistor shown in fig. (Apr-May 2004).***



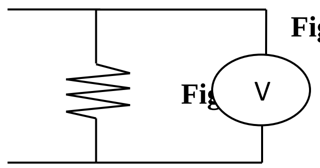


Fig.1

$I_5(01) = 0A$

$I_5(02) = 10/5 = 2A$

$I_L = I_5(01) + I_5(02)$

$\mathbf{I_L = 0A + 2A = 2A.}$

5. **State and explain Thevenin's theorem. (May-Jun 2007), (June/July 2010) (Nov/Dec-2011) (Apr-May 2011)**
A Complex network shown in fig.1consisting of linear, bilateral active or passive elements with two accessible terminals can be reduced to a simple circuit as shown in fig.2, with a single voltage source V_0 Called open circuit voltage and R_{th} (Looking back resistance or thevenin's resistance).

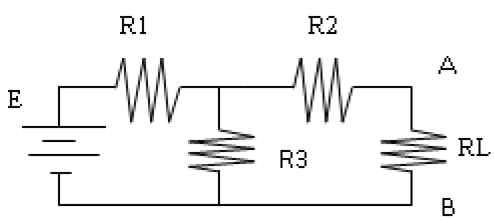


Fig. 1

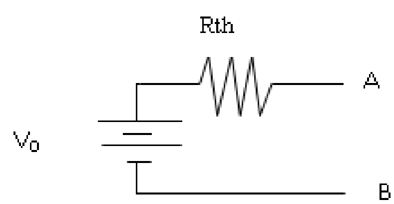


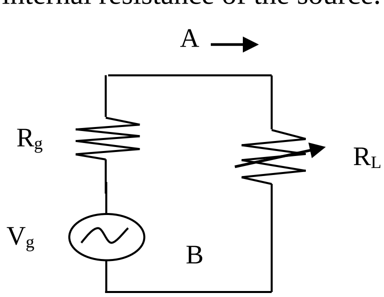
Fig. 2

6. **State Norton's theorem. (May-Jun 2006), (Nov/Dec 2010)**
Any Combination of linear bilateral circuit elements and active sources, connected to a given load can be replaced by a simple two terminal network consisting of a single current source and single impedance in parallel with it, across the two terminals of the load.

7. **List Various steps to apply the Norton's theorem.(Dec-2009).**
Step 1: Find the short circuit current I_{SC}. Step 2: Find the Norton's resistance R_n.
Step 3: Find the current through R_L by applying the formula $I_L = \frac{Isc\ X\ Rn}{Rth+RL}$

8. **What are the limitations of Thevenin's theorem? (May-Jun 2006)**
i.Not applicable to unilateral networks. ii.Not applicable to circuits having non-linear elements. iii.There should not be magnetic coupling between the load and circuits. iv.In the load side, there should not be controlled sources.

9. **State Maximum Power Transfer theorem. (Nov-Dec 2003)***
Theorem states that, "Maximum power will be delivered from a voltage source to a load, when the load resistance is equal to the internal resistance of the source. Consider the following figure,



When $R_L = R_g$, 1 Maximum Power is transfered.

a. Total resistance = $R_L + R_g = R_L + R_L$ **from 1=** 2
b. R_L = Load resistance, R_g = Source resistance.
c. **Current $I = V_g / 2 R_L$. Power delivered to $R_L = I^2{}_L . R_L$**

$R_L = (V^2{}_g/4R_L{}^2 . R_L) = V^2 g/4R_L$

10. Give the condition for maximum power transfer in DC and in AC circuits. (June/July 2010)

DC circuits: When $R_L = R_{TH}$

AC circuits: Maximum power will be delivered from a voltage source to load when the load impedance is the complex conjugate of the source impedance.

Z_g = Internal impedance of the source = $R_g + jX_g$ Z_L = Load impedance = $R_L + jX_L$

According to theorem, Z_L = Complex conjugate of Z_g **Hence, $Z_L = R_g - jX_g$**

11. State Tellegen's theorem.

In any network the summation of instantaneous power or the summation of complex power of sinusoidal source is zero. The network may be linear, non-linear, passive or active and time invariant or varying.

$$\sum_{b=1}^{b} v_b i_b = 0$$

12. Represent the star resistance in terms of delta values. (Apr-May 2011).

$$R_{AB} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C} \qquad R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_{CA} = \frac{RA\ R_B + R_B R_C + R_C R_A}{R_B}$$

13. Give the equations to convert a star circuit to a delta circuit. (June/July 2010),(Nov/ Dec 2010)

$R_1 = R_A.R_B / (R_A+R_B+R_C)$ $R_2 = R_B.R_C / (R_A+R_B+R_C)$ $R_3 = R_A.R_C / (R_A+R_B+R_C)$

14. What is duality? (Nov/Dec – 2010).

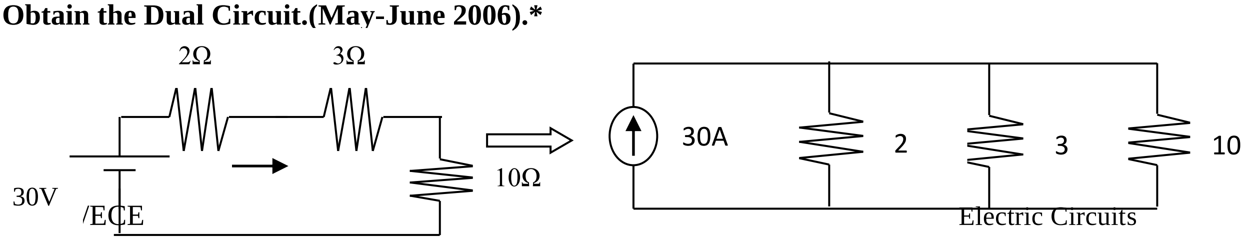
Two electrical networks which are governed by the same type of equations are called Duality.

15. Prepare a list of dual quantities encountered in electrical engineering.(Nov-Dec 2008).

The following are the dual quantities encountered in electrical engineering,

Original Network	Dual Network
Current	Voltage
Voltage	Current
Source Current	Source Voltage
Source Voltage	Source Current
Mesh Current	Nodal Voltage
Nodal Voltage	Mesh Current
Open Circuit	Short Circuit
Short Circuit	Open Circuit
Resistance	Conductance
Inductance	Capacitance
Capacitance	Inductance
Series Branch	Parallel Branch
Parallel Branch	Series Branch
Impedance	Admittance
Reactance	Susceptance
KCL	KVL

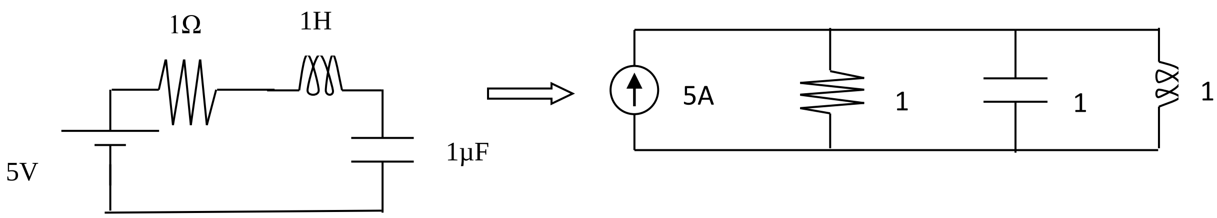
16. Obtain the Dual Circuit.(May-June 2006).*



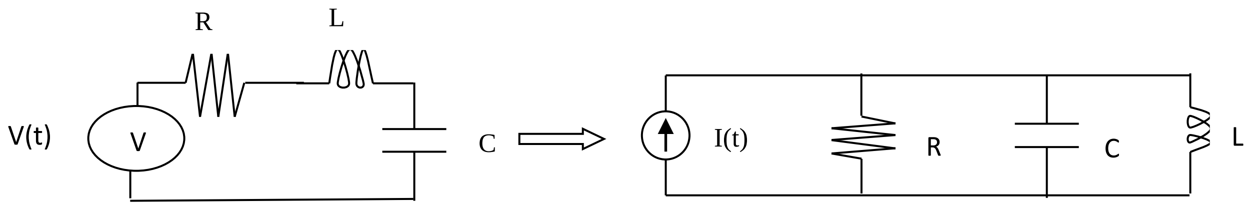
17. When do you say the two circuits are dual to each other? (Nov-Dec 2003)

Two networks are called dual networks, if the mesh equations of one have the same form as the nodal equations of the other.The property of duality is mutual property.

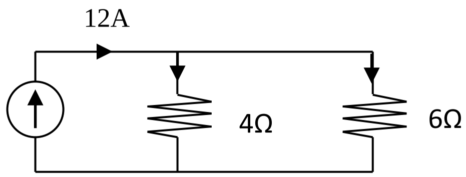
18. Draw a dual network for the following fig. (Apr-May 2004)*



19. Find the dual of the following circuit.(Nov-Dec 2004).



20. Two resistors 4Ω and 6Ω are connected in parallel. If the total current is 12A, find the current through each resistor.(May-June 2005)



$I_{4\Omega} = I \text{ X } \frac{6}{6+4}$ $\qquad I_{6\Omega} = I \text{ X } \frac{4}{10}$

$I_{4\Omega} = 12 \text{ X } \frac{6}{10} = 7.2A$ $\qquad I_{6\Omega} = 12 \text{ X } \frac{4}{10} = 4.8A.$

21. Find the star equivalent of the delta network.(May-Jun 2005) *

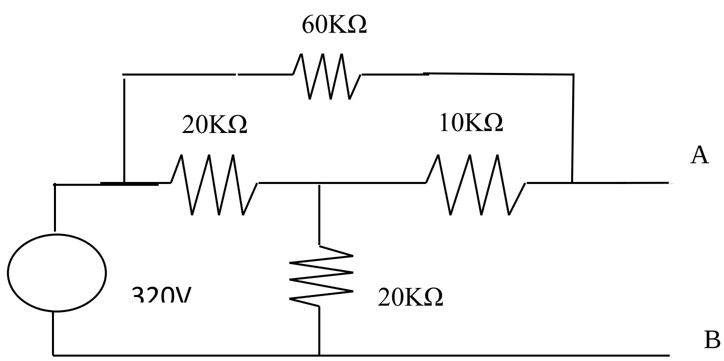
$$R_A = \frac{RAB.RCA}{RAB+RBC+RCA} \qquad R_A = \frac{12 \text{ X } 12}{12+12+12} = 4\ \Omega$$

$$R_B = \frac{RAB.RBC}{RAB+RBC+RCA} = \frac{12 \text{ X } 12}{12+12+12} = 4\ \Omega$$

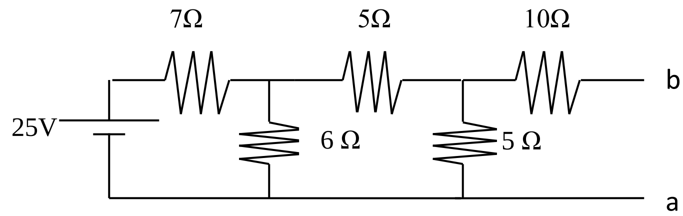
$$R_C = \frac{RCA.RBC}{RAB+RBC+RCA} = \frac{12 \text{ X } 12}{12+12+12} = 4\ \Omega$$

<u>12 Mark questions and 16 mark questions:</u>

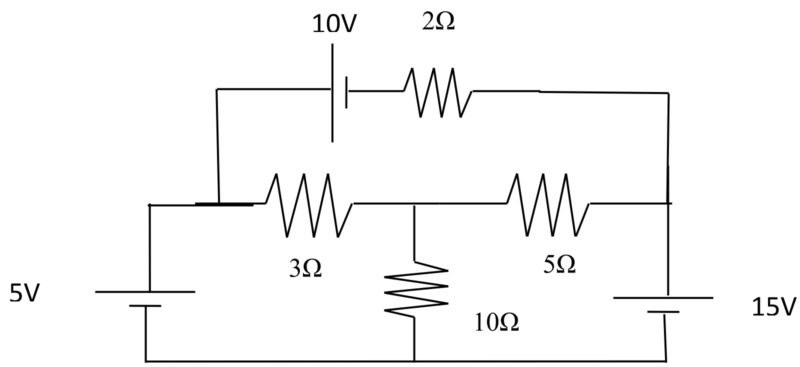
1. State and explain Thevenin's theorem. (May-Jun 2005).
2. Find the Thevenin's equivalent at terminals AB in the circuit of the following figure.(Apr-May 2004)*



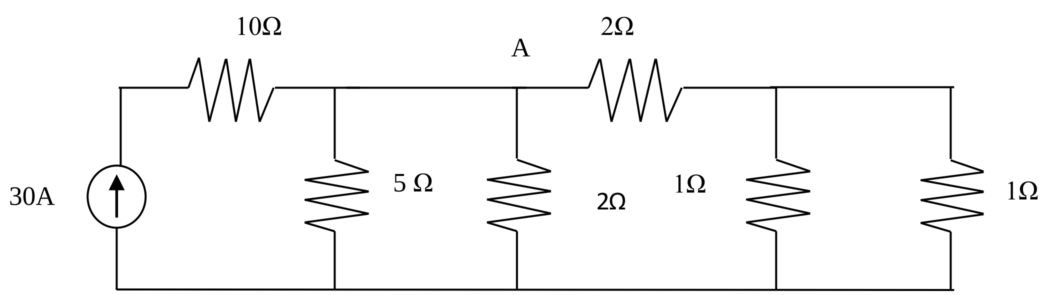
3. Find the thevenin's voltage and thevenin's resistance for the circuit shown below.(Nov-Dec 2004)



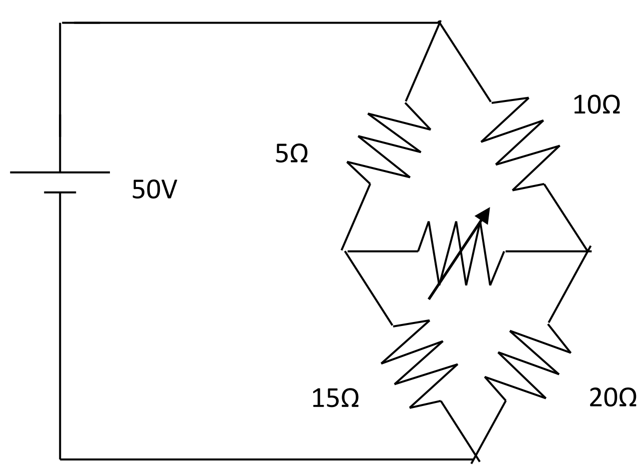
4. State and explain the Principle of Superposition. (May-Jun 2005).
5. Using Superposition theorem find the current in 10Ω resistor.(Nov-Dec 2004).



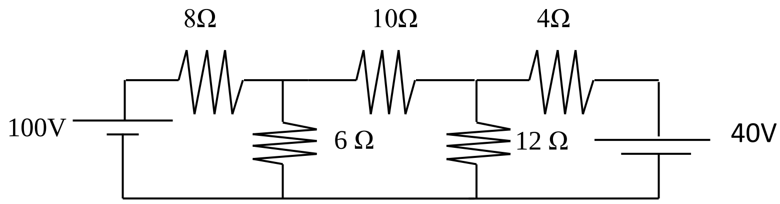
6. Find the current through AB in the network shown below using Norton's theorem.(May-Jun 2005).



7. Find the Maximum Power across the load impedance for the circuit shown below.(May-Jun 2007).*



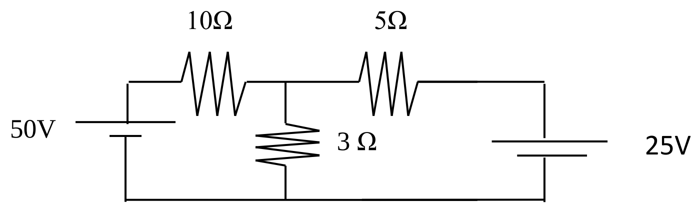
8. For the circuit shown in question 18 a. Find the Thevenin's equivalent across 10Ω resistor. Also find the current through the 10Ω resistor. (June - July 2010)



9. Prove Maximum power transfer theorem in a DC Circuit. (June - July 2010), (Nov/Dec 2010)

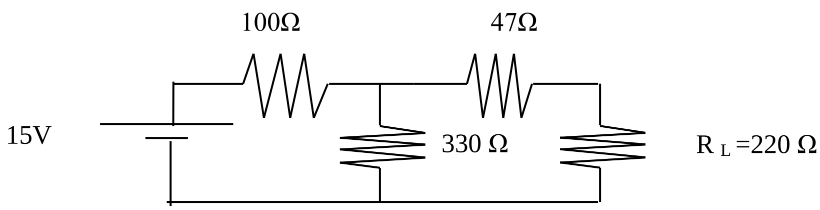
10. a. Compare and differentiate series and parallel circuit.

a. b. Find the current in each resistor using super position principle for the following circuit.

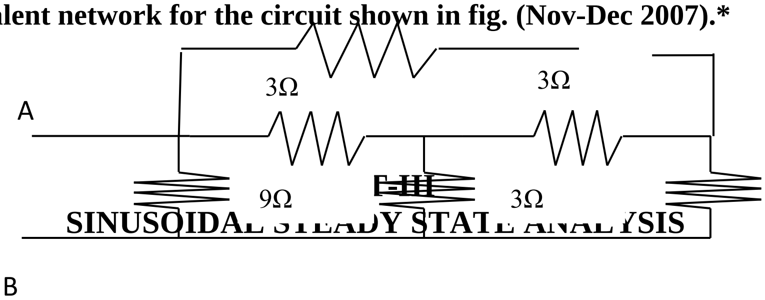


11. State Norton's theorem and list the steps for nortonizing a circuit. Compare the Norton equivalent circuit to the thevenin equivalent circuit. (Apr-May 2011).

12. Determine the current flowing through the load using Thevenin's theorem (16) (Nov-Dec 2011)



13. Find the equivalent network for the circuit shown in fig. (Nov-Dec 2007).*



UNIT-III
SINUSOIDAL STEADY STATE ANALYSIS

1. **Define averag**
   The average value of an alternating quantity is defined as that value which is obtained by averaging all the instantaneous value over a period of half cycle.
2. **Define instantaneous value**
   The value of an alternating quantity at particular instant is known as instantaneous value for example e_1, e_2 as instantaneous value of an alternating EMF at instantaneous $t_1$and t_2 respectively
3. **Define time period of an alternating quantity?**
   The time taken by an alternating quantity to complete its one complete cycle as its time period is denoted by T after every T seconds the cycle of alternating quantity repeats.
4. **Define frequency of an alternating quantity**.
   The number of cycles completed by an alternating quantity per second is knows as its frequency. It is denoted by F and is measured in cycles/second which is knows as Hertz, denoted as Hz.

   $$F=1/T \text{ Hz}$$
5. **Define cycle of an alternating quantity.**

Each repetition of a set of positive and negative instantaneous value of the alternating quantity is called as cycle.

6. **Define impedance and admittance**.
   The ratio of phasor voltage V to phasor current I is called as impedance (Z) .the reciprocal of impedance is called as admittance (Y)
7. **Define peak value of an alternating quantity.**
   The maximum value attained by an alternating quantity during positive or negative half cycle is called peak value. It is denoted by Em or Im.WhereEm is the peak value of voltage .Im is the peak voltage of current.
8. **Define RMS value.**
   The Root Mean Square (RMS) value or effective value is defined as the steady steady current (D.C) which ,when flowing through a give circuit for a given time , produces the same amount of heat as produced by alternating current ,which when flowing through the same circuit for the same time.

$$I = \frac{\sqrt{(i_1^2 + i_2^2 + i_3^2 + \cdots + i_n^2)}}{n} \qquad V = \frac{\sqrt{(v_1^2 + v_2^2 + v_3^2 + \cdots + v_n^2)}}{n}$$

9. **Define peak factor**
   The peak factor of any wave form is defined as the ratio of the peak value of the wave to the RMS value of the wave. Peak factor=maximum value/ rmsvalue. Peak factor=V_m/V_{rms}
10. **Define form factor**
    Form factor is defined as ration of rms value to the average value of the wave
    Form factor =rms value / average value. For sin wave, form factor =1.11
11. **Define average value of alternating current.**
    The average value of alternating current is defined as the D.C. current which transfers across any circuit the same charge as is transferred by that alternating current during the same time.
12. **What is instantaneous power?**
    Instantaneous power is defined as the product of voltage and current at ever instant of time. It is represented as follows

$$P = V(t) * I(t)$$

13. **Define real power.**
    The real power or true power is the power dissipated from the resistance in the form of heat. The unit of real power is watts (W).
    In RL circuit, the real power is $P = VI \cos \varphi$
14. **What is reactive power?**
    The power supplied to a reactance (inductance or capacitance) can be termed as reactive power. The unit of reactive power is volt-ampere-reactive (VAR)

$$Q=|V||I|\sin\varphi$$

15. **Define apparent power.**
    Apparent power S is defined as the product of rms voltage and rms current. The unit of apparent power is volt-amps (VA)

$$S = VI$$

16. **Define Power factor.**
    Power factor is defined as the ratio of true power to apparent power.

$$Power\ factor = \frac{Real\ power}{Apparent\ power} = \frac{P}{S} = \cos\varphi$$

17. **What is a phasor?**
    In sinusoidal steady state analysis, phasors are used to represent current and voltages. Phasors are representation of a quantity in the form of a magnitude and argument.

Polar form $X = X_m \angle \theta$

In this polar representation, X_m is the magnitude and θ is the argument or the angle of the quantity. The other forms of phasor representation are rectangular and exponential form

Rectangular form $X = X_m(\cos\theta + j\sin\theta)$

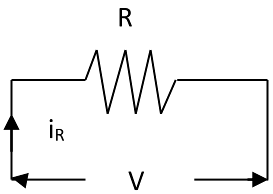
Exponential form $X = X_m e^{j\theta}$

18. Give the phasor representation of e=E_m sin ωt.

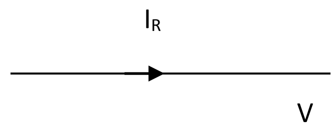
Maximum value = E_m. The RMS value is $E_m/\sqrt{2} = 0.707E_m$.
The angle of the voltage is 0.
Hence the phasor representation is $E = 0.707E_m\angle 0$

19. Draw the phasor diagram for pure inductor, pure capacitor and resistance.(Nov-Dec 2007).

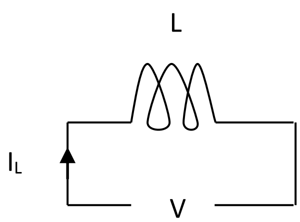
Pure resistance:



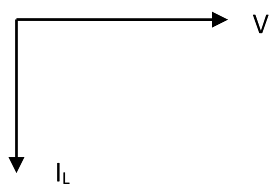
Phasor Diagram:



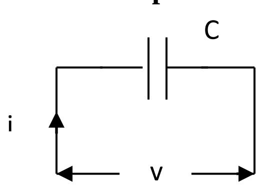
Pure inductance:



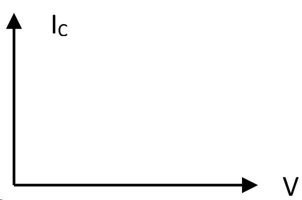
Phasor Diagram:



Pure Capacitance:



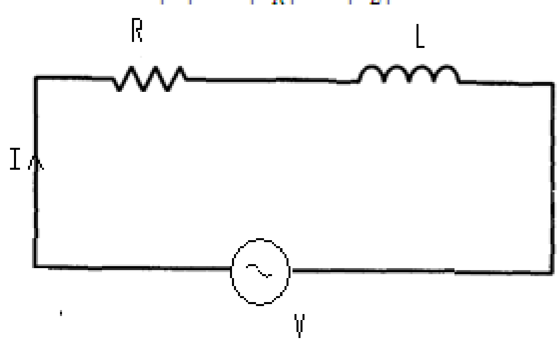
Phasor Diagram:



20. Calculate the impedance of a series RL circuit.

The voltage across R is V_R. The voltage across L is V_L.

$$|V|^2 = |V_R|^2 + |V_L|^2$$



By using Ohm's law, voltages can be written as a product of current and resistance.

$$|V|^2 = |IR|^2 + |IX_L|^2 \qquad |V| = |I|\sqrt{R^2 + X_L^2}$$

$$|Z| = \sqrt{R^2 + X_L^2}$$

21. Find the impedance of a series RL circuit with a resistance of 200 Ω, frequency of 50 Hz and an inductor of 0.45 μH.

Given: R = 200 Ω L = 0.45 H f = 50 Hz
$X_L = 2\pi fL = (2*3.14*50*0.45)$
$X_L = 141.3\ \Omega$

$|Z| = \sqrt{R^2 + X_L^2} = \sqrt{200^2 + |141.3|^2} = 244.87\Omega$

22. Find the phase angle of the impedance (4+j3).

$$\Phi = tan^{-1}\left(\frac{X_L}{R}\right)$$

$$\Phi = tan^{-1}\left(\frac{3}{4}\right) \qquad \Phi = 36.9^0$$

23. Calculate the power factor of a series RL circuit with impedance of $11.17\angle 57.5^0$.

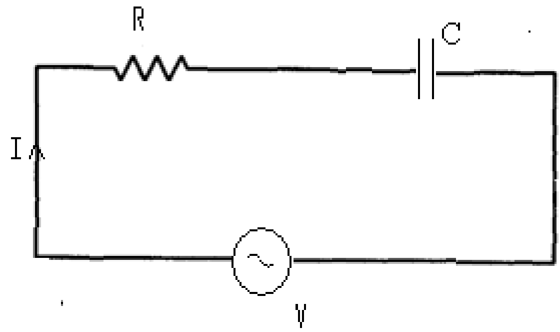
Power factor = cos Φ

= cos (57.5)

Power factor = 0.537 (lag)

The term lag is added because in series RL circuit the phase lags.

24. Calculate the impedance of a series RC circuit.



The voltage across R is V_R. The voltage across C is V_C.

$$|V|^2 = |V_R|^2 + |-V_C|^2$$

By using Ohm's law, voltages can be written as a product of current and resistance.

$$|V|^2 = |IR|^2 + |-IX_C|^2 \qquad |V| = |I|\sqrt{R^2 + |-X_C^2|}$$

$$|Z| = \sqrt{R^2 + |-X_C^2|}$$

$$|Z| = \sqrt{R^2 + |X_C^2|}$$

25. Give the condition of current and voltage for RL and RC circuits through phasor diagrams. (Nov/Dec 2010)

In RL circuit, the phasor diagram is given in figure 1. The voltage V leads the current I by an angle of φ.

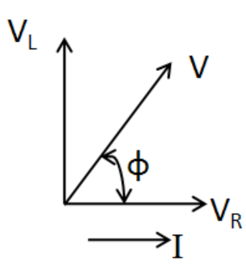


Fig. 1

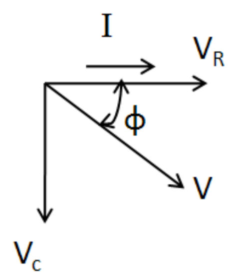


Fig. 2

In RC circuit, the phasor diagram is given in figure 2. The voltage V lags the current I by an angle of φ.

26. Define average power.

Average power delivered by the source is also equal to the power dissipated by the resistor in the form of heat.

Average power = $|I|^2R$

$= |I|*|I|*R$

$= \frac{|V|}{|Z|}*|I|*R = |V| * |I| * \frac{R}{|Z|}$

Average power = |V|*|I|*cos φ

27. What is the average power and apparent power of a series RC circuit with 100 V 300 Hz voltage source, 47 Ω resistance and 10 µF capacitance?

V = 100 V

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2 * 3.14 * 300 * 10 * 10^{-6}} = 53.1\,\Omega$$

$$|Z| = \sqrt{R^2 + |X_C^2|} = \sqrt{47^2 + 53.1^2} = 70.9\,\Omega$$

$$I = \frac{V}{Z} = \frac{100}{70.9} = 1.41\,A$$

$$\Phi = tan^{-1}\left(\frac{-X_c}{R}\right) = tan^{-1}\left(\frac{-53.1}{47}\right) = -48.5^0$$

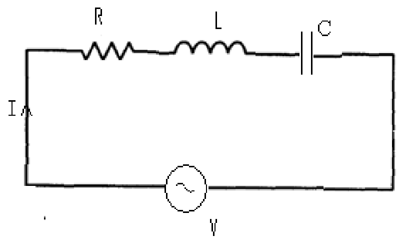
$$Averge\ power = |V||I|\cos\Phi = 100 * 1.41 * \cos(-48.5) = 93.45$$

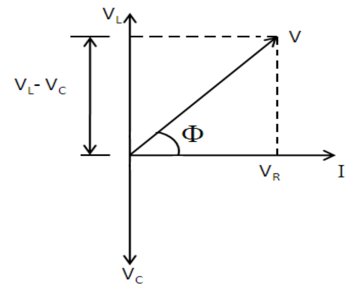
$$Apparent\ power = |V||I| = 100 * 1.41 = 141\ W$$

28. Give the phasor diagram and impedance of a series RLC circuit.

The voltage across R is V_R. The voltage across C is V_C. The voltage across L is V_L.

$$|Z| = \sqrt{R^2 + (X_L - X_C)^2}$$





29. Define admittance.

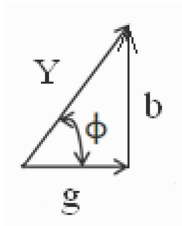
Admittance is defined as the reciprocal of resistance. It is represented as Y.

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

The unit of admittance is siemen or mho.

30. Explain admittance triangle.

Admittance Y has two rectangular components. Its active component is conductance (g) and reactive component is susceptance (b).



31. Define conductance and susceptance through admittance.

Conductance = |g| = |Y| cos φ

Susceptance = |b| = |Y| cos φ

Conductance is always positive irrespective of circuit parameters. Susceptance is positive for capacitive reactance and negative for inductive reactance.

<u>12 Mark questions and 16 mark questions:</u>

1. Determine the average and rms value of a Sine wave.(Nov-Dec 2005).

2. Analyze the series RL circuit with 20 Ω resistance, 20 mH inductance and 60 V 100 Hz power supply. Determine the current, the voltage across R and L and the phase angle of current with respect to the supply voltage.
3. An inductor in series with a 2.7 kΩ resistor is connected to a 100 mV, 250 kHz supply. The resistor voltage is measured as 40.5 mV. Calculate the inductance.
4. A 33 V signal is applied to a 10 kΩ resistor in series with a 4000 pF capacitor. Calculate the capacitor voltage when the signal frequency is 30 kHz.
5. A series circuit consists of a 10 mH inductor, 0.1 µF capacitor and 1 kΩ resistor. If the resistor voltage is measured as 1 V with a frequency of 10 kHz, calculate the supply voltage and its phase angle with respect to the current.
6. Calculate the admittance, susceptance, conductance and current of a parallel RL circuit with 1.2 kΩ, 100 mH and 50 V 500 Hz power supply.
7. Draw phasor and admittance diagrams and determine total circuit impedance. The parallel RLC circuit consists of 5 kΩ resistor, 30 mH inductor, 10 µF capacitor and 35 V 500 Hz power supply.
8. A series RL circuit has R = 20 Ω, L= 0.05 H and is connected to 250 volts 50Hz. Calculate a). Impedance b). Current c). Power factor (Nov/Dec 2010)

UNIT-IV
TRANSISENTS AND RESONANCE

1. **The Current Passing through RLC Series Circuit is given by $i = I_m Sin\omega t$. What is the Voltage across L and C? (May-June 2006).**

   Voltage across L: $V_L = L.di/dt = L. \frac{d(ImSin\omega t)}{dt} = L\omega Cos\omega t.$

   Voltage across C: $V_C = I/C \int i\, dt = 1/C \int I_m Sin\omega t dt = - \frac{-ImCos\omega t)}{\omega c}$.
2. **Assume a Sinusoidal Voltage, $V = V_m$ Sinωt is applied to a passive network. What is the average value of Power if (a). Network contains only inductive element. (b). Network contains only resistive element (May-Jun 2006).**

   Network containing only inductive element: Average value of power is Zero.

   Network containing only resistive element: Average value of Power is $1/2V_m I_m$.
3. **Obtain the natural frequency and time constant of an RLC Series Circuit with R = 1KΩ, L=100Mh, C=0.1 µF(May-Jun 2006).**

   Natural Frequency: $\omega_n = \frac{1}{\sqrt{LC}} = 1 / \sqrt{100 * 10^{-3} * 0.1*10^{-6}} = 10,000$ Rad/Sec.

   Time Constant: **τ =** 2L/R = 2*0.1/1000 = 0.2msec.
4. **An inductive coil having a resistance of 20Ω and an inductance of 0.02H is connected in Series with 0.01µF Capacitor. Calculate a. Q of the coil. b. Resonant frequency of the circuit.(May-Jun 2006)**

   Q of a Coil. $= 1/R\sqrt{L/C} = 1/20\sqrt{0.02/0.01 \times 10^{-6}} = 70.71$

   Resonant frequency $f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.02*0.01*10-6}} = 11.254$ KhZ.
5. **Two Coupled coils with $L_1 = 0.02$H, $L_2 = 0.01$H and K = 0.5 are connected in series aiding arrangement. Obtain the equivalent inductance in such case.(May-Jun 2006)**

   Mutual Inductance, $M = K\sqrt{L_1 L_2} = 0.5\sqrt{0.02 * 0.01} = 7.071$Mh.

   Equivalent inductance, $L=L_1+L_2+2M=0.02+0.01+2*7.07*10^{-3}=44.14$Mh.
6. **What do you mean by resonance? (Nov-Dec 2003).**

   An A.C.Circuit comprising of R, L and C is said to be in resonance when the applied voltage (Source voltage) and the Source Current are in phase. Thus at resonance power factor of the circuit is unity and the circuit act as purely resistive.
7. **When do you get transient response? Why? (Nov-Dec 2003).**

   We get transient response, when the circuit contains storage elements L and C. Because, when this circuit is excited by a source which abruptly changes its value, the energy state of the circuit is disturbed. After a certain time the circuit settles down to a new steady state value. The values of voltages and currents during the transient period are called transient response.

8. For the RLC Parallel circuit with R = 15Ω, L = 10mH, C = 150µF.Determine the resonant frequency.(April – May 2004)

F= $\frac{1}{2\pi\sqrt{\frac{1}{LC}-R^2/L^2}} = \frac{1}{2\pi\sqrt{\frac{1}{10X10^{-3}X150X10^{-6}}-15^2/(10X10^{-3})^2}}$

9. Define Quality Factor (Q) of a coil.(Nov-Dec 2004).

The ratio f_r to (f_2-f_1) is called the quality of a coil represented by Q.

$Q = f_r/f_2-f_1 = \frac{\frac{f_r}{R}}{2\pi L} = \frac{\omega_r L}{R} = \frac{\frac{1}{R}}{\omega_r CR}$.

10. A series circuit has R = 10Ω, L = 1Mh, C = 0.01µF.Calcultae the resonance frequency in rad/sec.(Nov-Dec 2004).

F= $\frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{1X10^{-3}X0.01X10^{-6}}}$ =50.35 kHz

11. Define rms Value of a Sinusoidal current.(May-June 2005)

RMS Value of a current is defined as, ratio of square root of area under the squared wave to its period.

I_{RMS} = √Area under the squared wave/Period.

RMS Value of sinusoidal current is given by $I_{RMS} = I_M / \sqrt{2}$.

12. Find the reactance of a 0.2H inductor at 50Hz frequency. At what frequency is the reactance 500 Ω. (Nov-Dec 2005).

Reactance ⇨ $X_L = \omega L = 2\pi fL = 2X \pi X 50 X 0.2$

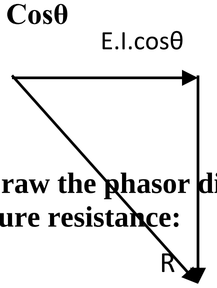
At what frequency is the reactance 500 Ω

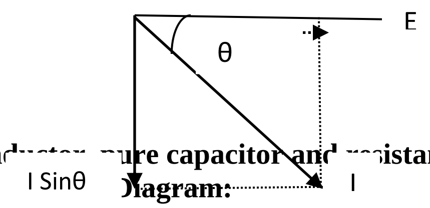
500 = 2X π X f X 0.2., f = 500/2X π X 0.2 = 398.08Hz.

13. Draw the Phasor diagram of a Power triangle.(Nov-Dec 2008)

Power Triangle: **Phasor Diagram:**

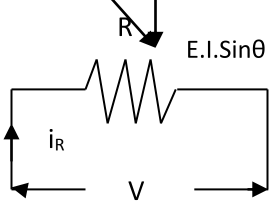
I Cosθ

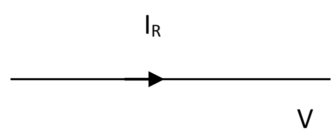




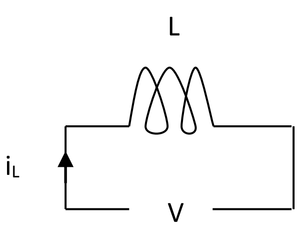
14. Draw the phasor diagram for pure inductor, pure capacitor and resistance.(Nov-Dec 2007).

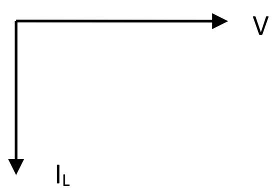
Pure resistance: **Phasor Diagram:**



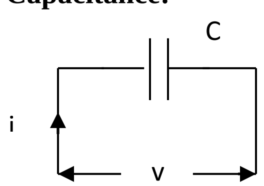


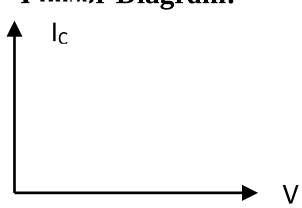
Pure inductance: **Phasor Diagram:**





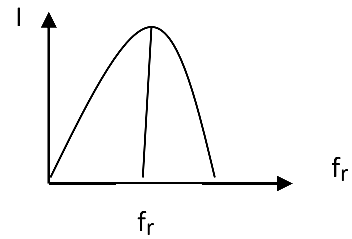
Pure Capacitance: **Phasor Diagram:**





15. When the current is maximum in the series resonance circuit? Why? (Nov-Dec 2007)

At resonance frequency, f_r Current (I) is Maximum, because at this condition **Z = R** has only minimum value.



16. Define Bandwidth and Sensitivity of series RLC Circuit.

Bandwidth: Bandwidth is defined as band of frequencies between f_2 and f_1. The Bandwidth = $f_2 - f_1$ = R/2ΠL.

Sensitivity: Sensitivity is defined as sharpness of the curve and it depends on the ratio R/L.A small value of R/L indicates a high degree of sensitivity.

17. Give any two comparisons how the circuit responses during series and parallel resonance. (June-July 2010)

Series resonance	Parallel resonance
1. In the characteristics curve drawn between frequency and current, current increases as the frequency increases.	1. In the characteristics curve drawn between frequency and current, current decreases as the frequency increases.
2.Q = ωL / R Or Q = 1 / ωCR	2. Q = R / ωL Or Q = ωC

18. Give the formula for Quality factor. (Nov/Dec 2010). (Apr-May 2011) or what is Q-factor? (Nov-Dec 2011)

The quality factor is defined as the ratio of maximum energy stored to the energy dissipated per cycle.

$$\text{Quality factor (Q)} = 2\pi * \frac{\text{Maximum energy stored per cycle}}{\text{Energy dissipated per cycle}}$$

19. Write an expression for transient current of RL circuit with DC excitation. (Nov/Dec 2010).

$$i(t) = i_F\left(1 - e^{-\frac{R}{L}t}\right),$$

20. Write the equation for natural oscillation and neper frequency. (Apr-May 2011).

Natural frequency:

The natural frequency of oscillation of RLC Series circuit is given by $w_n = 1 / \sqrt{LC}$.

Neper frequency:

An RLC Series circuit can be represented by

$$\frac{d^2 i(t)}{dt^2} + (R / L)\frac{d\,i(t)}{dt} + (1 / LC)\, i(t) = 0$$

More applicable form is:

$$\frac{d^2 i(t)}{dt^2} + 2\alpha \frac{d\,i(t)}{dt} + \omega_0^2\, i(t) = 0 \qquad (a)$$

From the equation (a) **α is called neper frequency**

21. Define Damping frequency. (Apr-May 2011).

Damping frequency is defined as the ratio of neper frequency to angular resonance frequency. It is denoted as ξ. **ξ** = α / ω_0. Where α is neper frequency and ω_0 is angular resonance frequency.

22. What is resonance frequency? (Apr-May 2011).

The frequency at which the resonance condition occurs is called resonance frequency. The resonance condition is $\omega L = 1/\omega c$. It is denoted as $f_r = \frac{1}{2\pi\sqrt{LC}}$

23. What is time constant of RC Circuit? (Nov-Dec 2011).

The time constant of RC Circuit is denoted as λ. The time constant is defined as the time during which the current falls to 36.8% of initial current. i.e. $i = I * e^{-1} = I\ (0.368) = 36.8\%\ (I)$

<u>12 Mark questions and 16 mark questions:</u>

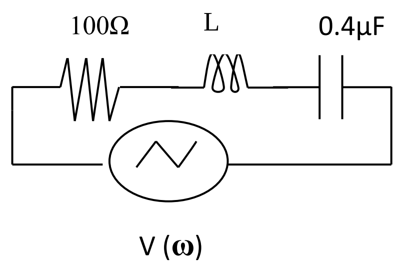
1. Explain the response of series RLC Circuits with respect to sinusoidal inputs with neat diagrams. (DEC 2009).

2. Derive the resonant frequency of a series R-L-C Circuit. Also prove the relation Bandwidth=R/L.(Nov-Dec 2003)

3. Derive and draw the response of a series R-L-C Circuit for the step input. (Nov-Dec 2003).

4. Show that for an RLC Series resonance circuit $Q_0 = (\omega_0 L/R = f_0/B.W)$.(Apr-May 2004)

5. For the circuit shown in fig., a) Determine L if resonant frequency of the circuit is 356 Hz. Also obtain the half power frequencies and bandwidth.(Apr-May 2004)



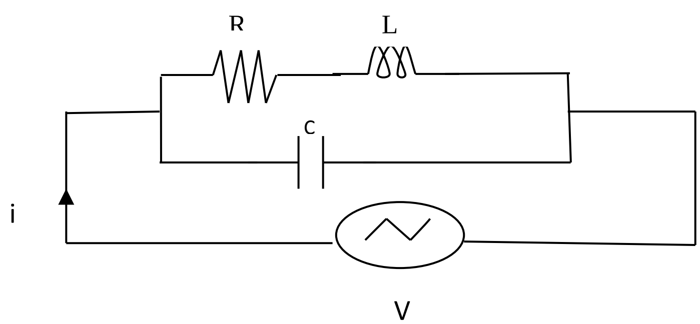
6. Explain i. Under damped ii. Over damped iii. Criticaly damped conditions of R-L-C Series circuit. Also draw approximate responses in each case. (Nov-Dec 2004).

7. Obtain an expression for the resonant frequency for the circuit shown in fig below.(May-Jun 2005)

8. Obtain the step response of a RC Circuit. (Nov-Dec 2005).

9. An alternating voltage of 100 V, 50Hz, is applied across a series combination of R = 50Ω and C=500μF. Find the current, Power and the Power factor. Draw the Phasor diagram. (May-Jun 2006).

10. Derive the resonant frequency of Parallel RLC Circuit. (May-Jun 2007).



11. Find the quality factor, bandwidth and half power frequencies of a series RLC Circuit with R=16Ω, L=5Mh and C=2μF (May-Jun 2007).

12. A Series RLC Circuit has R = 50Ω, L=0.01H and C=0.04 μF-system Voltage is 100V.Find i. Resonant frequency ii. Circuit impedance at resonance condition. iii. Maximum voltage across capacitor and the frequency at which this occurs. (Nov-Dec 2008).

13. A Step voltage V (t) = 120sin (t) is applied at t = 0, to a series, RLC Circuit with L = 12H, R = 12Ω and C = 22.2μF. The initial current in the circuit is Zero but there is an initial voltage of 60V on the capacitor in a direction which opposes the applied source. Find the expression for the current in the circuit. Also draw the current response. (June - July 2010)

14. A Series RLC Circuit consists of a 20Ω resistance, 0.24H inductance and 33.3μF capacitance with an applied voltage of 40V. Determine the resonant frequency. Find the Q factor of the circuit. (June - July 2010)

15. Derive the transient current response of RL Series Circuit. (16). (Nov-Dec 2011)

16. Derive the resonant frequency and Q-Factor of RLC Series circuit. (16) (Nov-Dec 2011)
17. Derive the expression for the transient current in RLC series circuit under various damping conditions. (Nov/Dec 2010).
18. Explain what occurs when a step voltage source is switched on to a series RLC Circuit. Explain the various damping conditions that occur and sketch current versus time waveforms for each condition. (Apr-May 2011).

UNIT V
COUPLED NETWORKS AND THREE PHASE SYSTEMS

1. **Define self-inductance.**
   The self inductance of a coil is defined as flux linkage in that coil per ampere current in the same coil.

$$L = \frac{N\Phi}{i}$$

2. **Define mutual inductance.**
   The mutual inductance of two coils is defined as the weber turns in one coil per ampere current in other coil. It is also defined as the ability of one coil to produce e.m.f. in other coil by induction when the current in the first changes.

$$M = N_1 \frac{\Phi_{12}}{\Phi_1}$$

3. **Give the properties of magnetically coupled coils.**
   Two conductors from different circuits in close proximity to each other are magnetically coupled to a degree that depends upon the physical arrangement and the rates of change of the currents. This coupling is increased when one coil is wound over another.
4. **Define coefficient of coupling.**
   Coefficient of coupling is the fraction of the total flux produced by coil 1 linking coil 2.

$$K = \frac{\Phi_{12}}{\Phi_1}$$

5. **Mention the characteristics of coefficient of coupling.**
   - Coefficient of coupling (K) depends on spacing, orientation of coils and permeability of the medium.
   - It is a non-negative number.
   - It is independent of the reference directions of the current.
   - Maximum value of K is 1.
6. **Define coupled circuits.**
   Coupled circuits are two or more electric circuits which are arranged such that energy can be transferred electrically or magnetically from one to another.
7. **State dot rule for coupled circuits.**
   - If both currents enter dotted ends of coupling coils or if both currents leave dotted ends, then the signs on the M-terms will be same as the signs on the L-terms.
   - If one current enters a dotted end and the other an undotted end, the signs on the M-terms will be opposite to the signs on the L-terms.
8. **Give the formula to find the equivalent inductance when they are connected in series aiding and series opposing (bucking) configuration.**
   Series aiding equivalent inductance $L_a = L_1+L_2+2M$
   Series opposing equivalent inductance $L_b=L_1+L_2-2M$
9. **Give the formula to find the equivalent inductance when they are connected in parallel aiding and parallel opposing (bucking) configuration.**
   Parallel aiding equivalent inductance $L_a = \frac{L_1L_2-M^2}{L_1+L_2-2M}$

   Parallel opposing equivalent inductance $L_b = \frac{L_1L_2-M^2}{L_1+L_2+2M}$

10. Two coupled coils with L_1 = 0.01 H, L_2 = 0.05 H and K = 0.5 are connected in series aiding and series opposition. What are the equivalent inductances?

$$M = K\sqrt{L_1 L_2} = 0.5*\sqrt{0.01*0.05} = 0.011H$$

For series aiding, $L_a = L_1+L_2+2M$ = 0.01+0.05+2*(0.011) = 0.082 H

For series opposing, $L_a = L_1+L_2 - 2M$ = 0.01+0.05 - 2*() = 0.038 H

11. What is the maximum possible mutual inductance of two inductively coupled coils with self inductances L_1= 37 mH and L_2 = 49 mH?

For maximum possible mutual inductance, the coefficient of coupling should be 1.

$$M_{max} = \sqrt{L_1 L_2}$$

12. Two inductively coupled coils have self inductance L_1 = 42 mH and L_2 = 130 mH. If the Co-efficient of coupling is 0.7.Find the value of mutual inductance between the coils.L_1 = 42 mH, L2 = 130 mH K=0.7. (June-July 2010)

FORMULA: K = M / ($\sqrt{}L_1$ * L_2)   0.7 = M / ($\sqrt{}$ (42 X 10^{-3}) * (130 X 10^{-3})   M = 0.0511

13. What is meant by double tuned coupled circuit? (Nov/Dec 2010).

Two or more electric circuits are said to be coupled if energy can transfer electrically or magnetically from one to another. If electric charge, or current, or rate of change of current in one circuit produces electromotive force or affects the voltage between nodes in another circuit, the two circuits are coupled

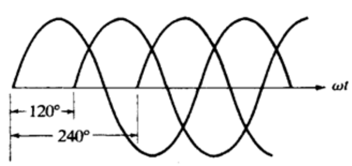
14. What are the applications of coupled tuned circuits?

Coupled tuned circuits are used in the application of radio signals of range (500-1600 kHz).
They are used in radio receivers to produce uniform response to modulated signals over specified bandwidth.

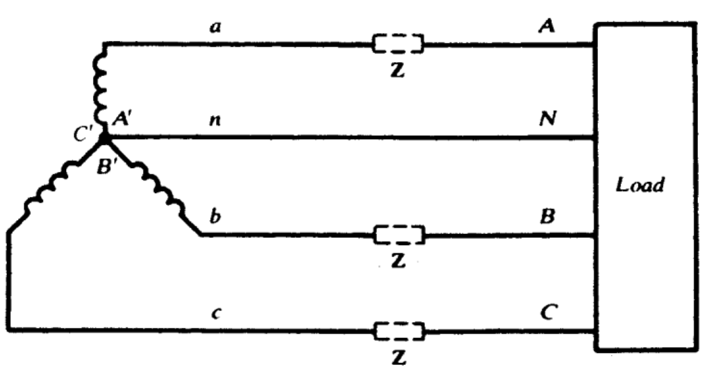
15. Explain the generation of three phase voltage system.

The 3-phase voltage can be produced in a stationary armature with rotating field or in a rotating armature with a stationary field. 3-phase voltages are generated in three separate but identical sets of windings or coils which are displaced by 120 electrical degrees in the armature.

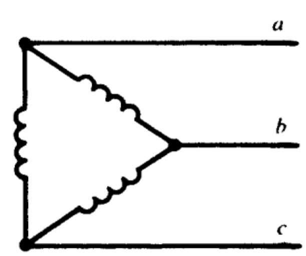
$$e_{RR'} = E_m \sin \omega t$$
$$e_{YY'} = E_m \sin(\omega t - 120^0)$$
$$e_{BB'} = E_m \sin(\omega t - 240^0)$$



16. Give the 3-phase star and delta connection.



Star connection



Delta connection

17. Give the condition for balanced star connected load.

The current through the voltage sources (I_φ) and through the line conductors (I_L) are same.

$$I_L = I_\phi$$

The line currents form a balanced connection.

$$I_R + I_Y + I_B = 0$$

18. Give the condition for balanced delta connected load.

The current through the voltage sources (Iφ) and through the line conductors (I_L) are related as follows.

$$|I_L| = \sqrt{3}\,|I_\phi|$$

<u>12 Mark questions and 16 mark questions:</u>

1. Compare the Single tuned and double tuned circuits with proper expressions. (Dec 2009) (Apr-May 2011).
2. Two identical coils of inductance 94.2 mH each are wound on a ring-shaped iron core. Calculate the mutual inductance.
3. Two 500 μH coils have a mutual inductance of 200 μH. Determine the total inductance of the two coils when they are connected (a) series-aiding and (b) series-opposing.
4. Calculate the inductance that must be connected in parallel with a 100 μH inductor to give a total inductance of 70 μH. Assume no mutual inductance between the two coils.
5. Explain the line and phase voltages in a 3-phase star connection system.
6. Explain the line and phase voltages in a 3-phase delta connection system.