Question 1(a) [3 marks]

Define: 1) Branch 2) Junction 3) Mesh

Answer:

- **Branch**: A branch is a single circuit element or a combination of elements connected between two nodes of a network.
- **Junction**: A junction (or node) is a point in a circuit where two or more circuit elements are connected together.
- **Mesh**: A mesh is a closed path in a network where no other closed path exists inside it.

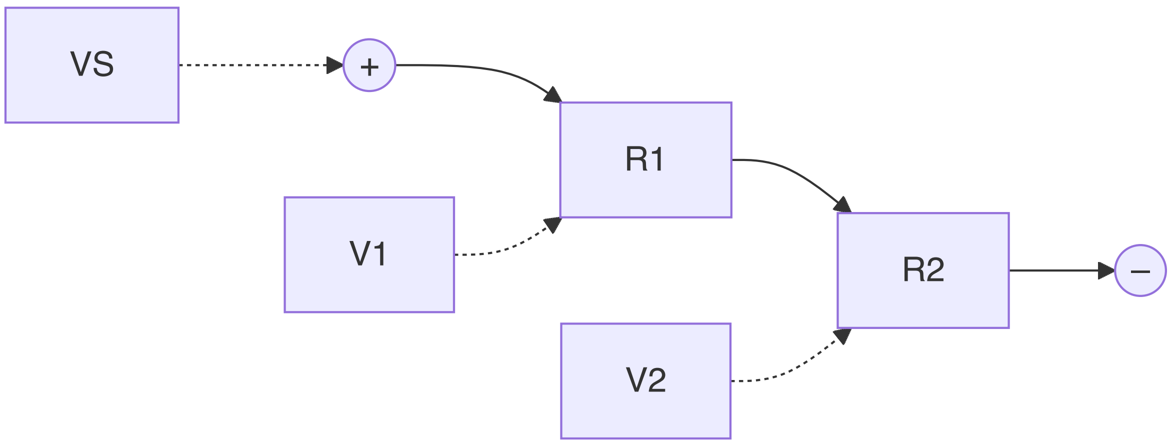
Mnemonic: "BJM: Branches Join at junctions to Make meshes"

Question 1(b) [4 marks]

Write voltage division and current division rule with necessary circuit diagram

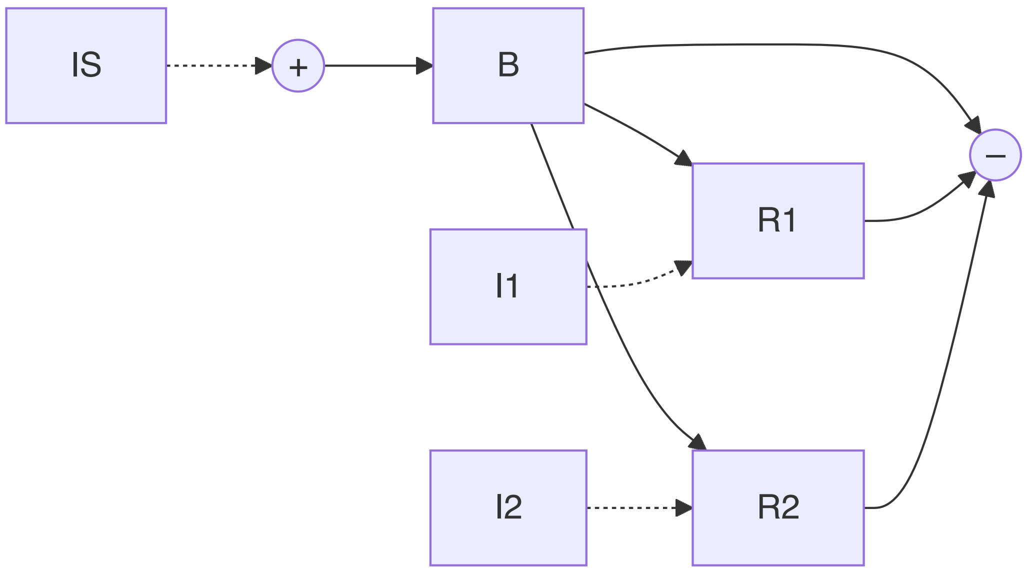
Answer:

Voltage Division Rule: In a series circuit, voltage across any component is proportional to its resistance.



- **Formula**: V_1 = VS × (R_1/(R_1+R_2))
- **Application**: Used to find individual voltage drops across series components

Current Division Rule: In a parallel circuit, current through any branch is inversely proportional to its resistance.



- **Formula**: $I_1 = IS \times (R_2/(R_1+R_2))$
- **Key concept**: Current takes path of least resistance

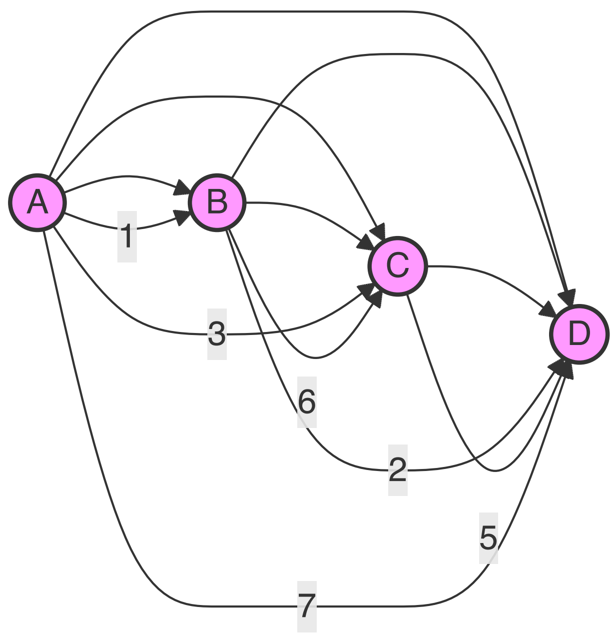
Mnemonic: "VoSe CuPa: Voltage divides in Series, Current divides in Parallel"

Question 1(c) [7 marks]

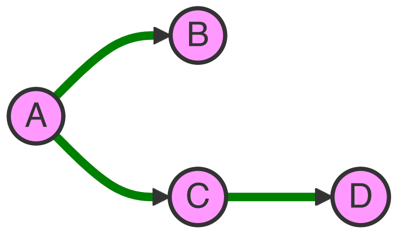
Draw Graph and Tree for a network shown in fig(1). Show link currents on a graph. Also write Tie-set schedule for a tree of network shown in fig. (1)

Answer:

Graph of the Network:



Tree of the Network (shown with bold edges):



Link Currents (shown on remaining branches that are not part of the tree):

- Link 1: Branch 2 (BD)
- Link 2: Branch 6 (BC)
- Link 3: Branch 7 (AD)
- Link 4: Branch 5 (CD)

Tie-set Schedule:

Link/Tree Branch	Branch 1 (AB)	Branch 3 (AC)	Branch 4 (CD)	Branch 2 (BD)	Branch 6 (BC)	Branch 7 (AD)	Branch 5 (CD)
Link 1 (BD)	1	0	0	1	0	0	0
Link 2 (BC)	1	1	0	0	1	0	0
Link 3 (AD)	0	0	1	0	0	1	0
Link 4 (CD)	0	0	1	0	0	0	1

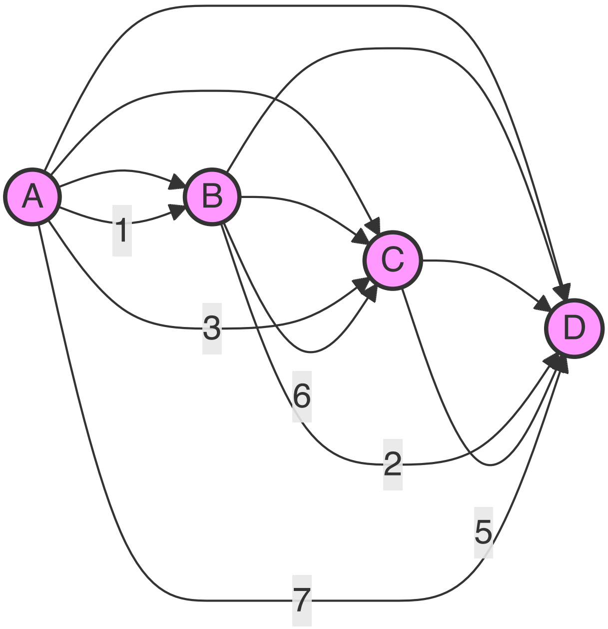
Mnemonic: "TGLT: Trees Generate Link-current Tie-sets"

Question 1(c) OR [7 marks]

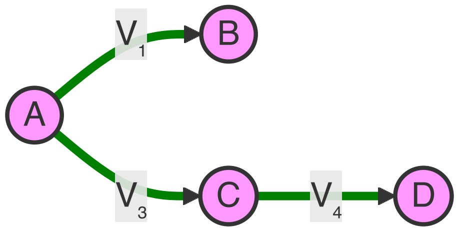
Draw Graph and Tree for a network shown in fig(1). Show branch voltages on tree. Also write cut-set schedule for a tree of network shown on fig.(1)

Answer:

Graph of the Network:



Tree of the Network (shown with bold edges and branch voltages):



Cut-set Schedule:

Cut-set/Branch	Branch 1 (AB)	Branch 3 (AC)	Branch 4 (CD)	Branch 2 (BD)	Branch 6 (BC)	Branch 7 (AD)	Branch 5 (CD)
Cut-set 1 (AB)	1	0	0	-1	-1	0	0
Cut-set 2 (AC)	0	1	0	0	1	-1	0
Cut-set 3 (CD)	0	0	1	1	0	1	1

Mnemonic: "CGVS: Cut-sets Generate Voltage Sources"

Question 2(a) [3 marks]

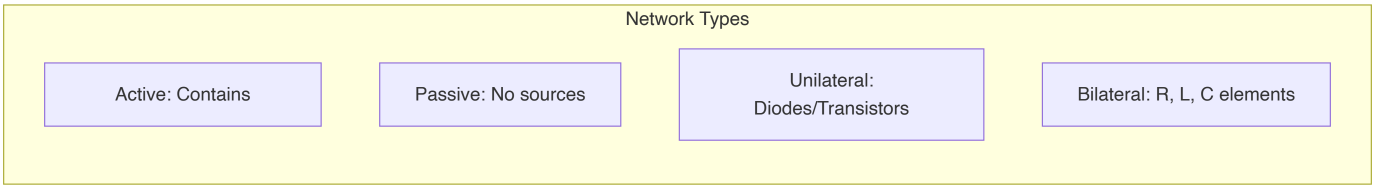
Define: 1) Active and passive network 2)Unilateral and Bilateral network.

Answer:

- **Active Network**: A network containing one or more sources of EMF (voltage/current sources) that supply energy to the circuit.
- **Passive Network**: A network containing only passive elements like resistors, capacitors, and inductors with no energy sources.
- **Unilateral Network**: A network in which the properties and performance change when input and output terminals are interchanged.

- **Bilateral Network**: A network in which the properties and performance remain unchanged when input and output terminals are interchanged.

Diagram:



Mnemonic: "APUB: Active Provides energy, Unilateral Blocks reversal"

Question 2(b) [4 marks]

Write equation for Z parameter and derive Z11, Z12, Z21, Z22 from that equation.

Answer:

Z-parameters define the relationship between port voltages and currents in a two-port network:

Equations:

- $V_1 = Z_{11}I_1 + Z_{12}I_2$
- $V_2 = Z_{21}I_1 + Z_{22}I_2$

Derivation:

- **$Z_{11} = V_1/I_1$** (with $I_2 = 0$): Input impedance with output port open-circuited
- **$Z_{12} = V_1/I_2$** (with $I_1 = 0$): Reverse transfer impedance with input port open-circuited
- **$Z_{21} = V_2/I_1$** (with $I_2 = 0$): Forward transfer impedance with output port open-circuited
- **$Z_{22} = V_2/I_2$** (with $I_1 = 0$): Output impedance with input port open-circuited

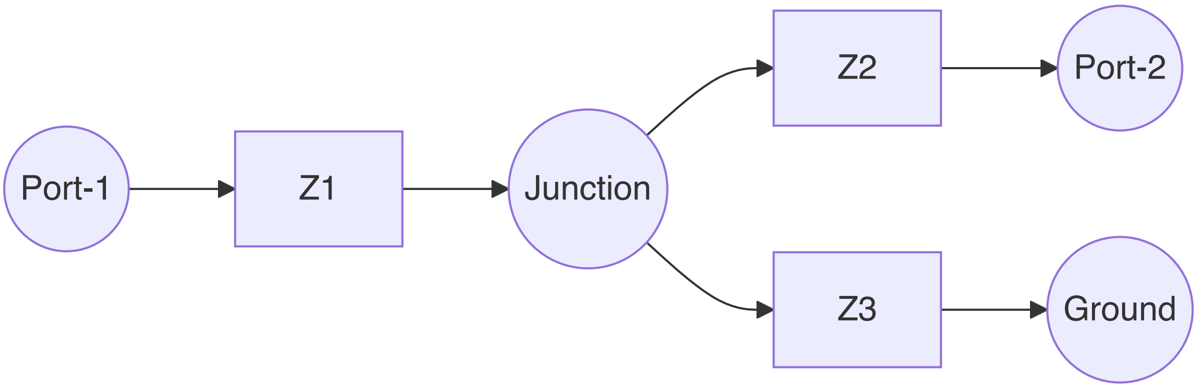
Mnemonic: "Z Impedance: Open circuit gives correct Parameters"

Question 2(c) [7 marks]

Derive equation of characteristic impedance(ZOT) for a standard T network.

Answer:

For a standard T-network:



Derivation Steps:

1. For a symmetric T-network, $Z_1 = Z_2$
2. Under matched condition, input impedance equals characteristic impedance
3. $Z_{0t} = Z_1 + (Z_1 \times Z_3)/(Z_1 + Z_3)$
4. For balanced T-network where $Z_1 = Z_2 = Z/2$ and $Z_3 = Z$:
5. $Z_{0t} = Z/2 + (Z/2 \times Z)/(Z/2 + Z)$
6. $Z_{0t} = Z/2 + (Z^2/2)/(Z + Z/2)$
7. $Z_{0t} = Z/2 + (Z^2/2)/(3Z/2)$
8. $Z_{0t} = Z/2 + Z^2/3Z$
9. $Z_{0t} = Z/2 + Z/3$
10. $Z_{0t} = (3Z + 2Z)/6$
11. $Z_{0t} = \sqrt{(Z_1(Z_1 + 2Z_3))}$

Final Equation: $Z_{0t} = \sqrt{(Z_1(Z_1 + 2Z_3))}$

Mnemonic: "TO Impedance: Two arms Over middle branch"

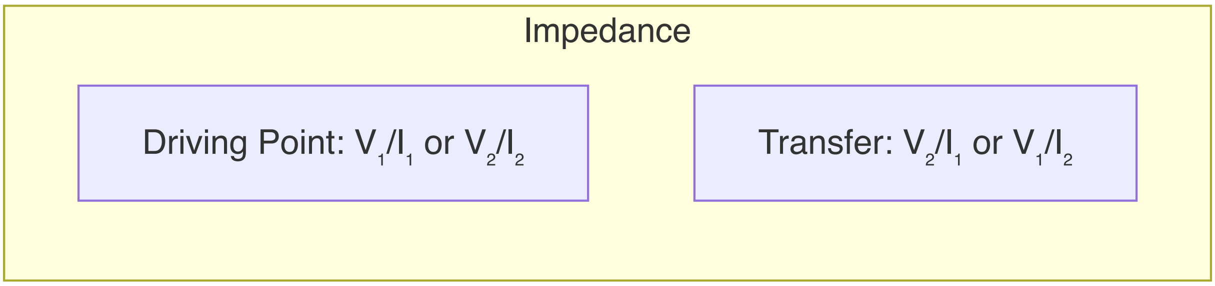
Question 2(a) OR [3 marks]

Define: 1)Driving point impedance 2) Transfer impedance

Answer:

- **Driving Point Impedance**: The ratio of voltage to current at the same port/pair of terminals when all other independent sources are set to zero.
- **Transfer Impedance**: The ratio of voltage at one port to the current at another port when all other independent sources are set to zero.

Diagram:



Mnemonic: "DTSS: Driving at Terminal Same, Transfer at Separate"

Question 2(b) OR [4 marks]

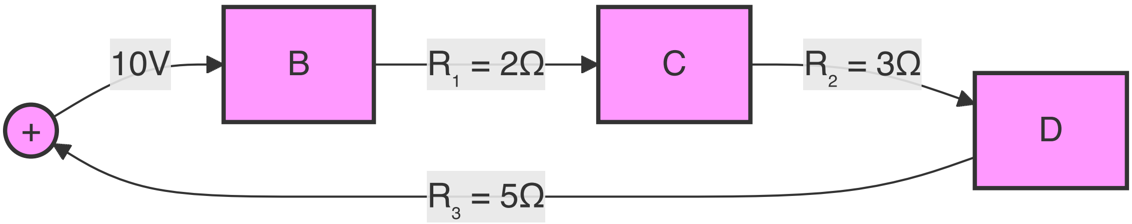
Explain Kirchhoff's voltage law with example.

Answer:

Kirchhoff's Voltage Law (KVL): The algebraic sum of all voltages around any closed loop in a circuit is zero.

Mathematically: $\sum V = 0$ (around a closed loop)

Circuit Example:



If I = 1A, then:

- $V_1 = 1A \times 2\Omega = 2V$
- $V_2 = 1A \times 3\Omega = 3V$
- $V_3 = 1A \times 5\Omega = 5V$

Applying KVL: 10V - 2V - 3V - 5V = 0 ✓

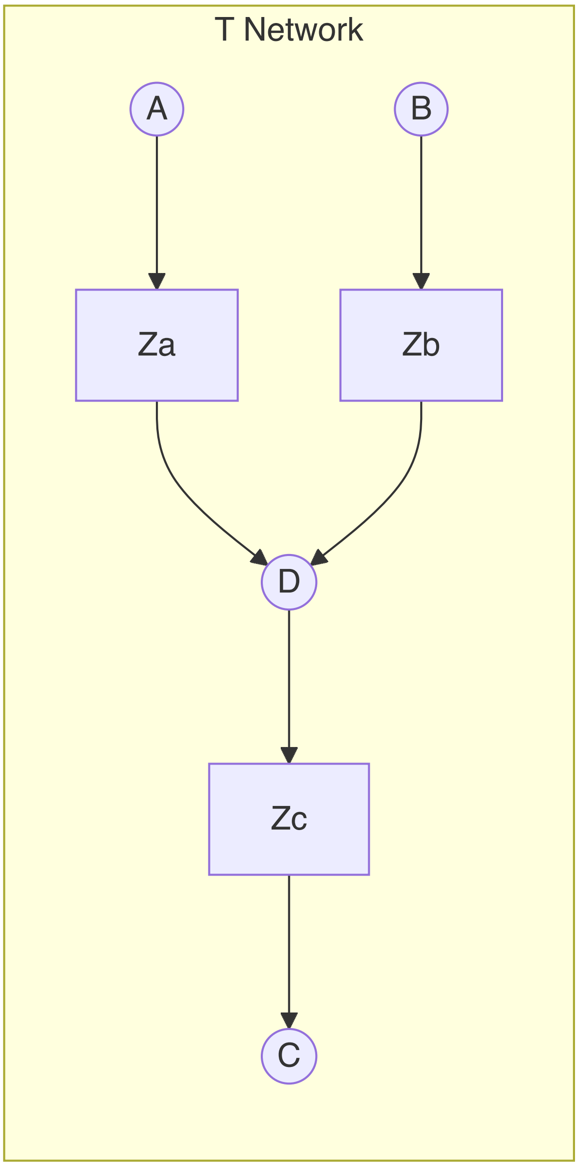
Mnemonic: "VACZ: Voltages Around Closed loop are Zero"

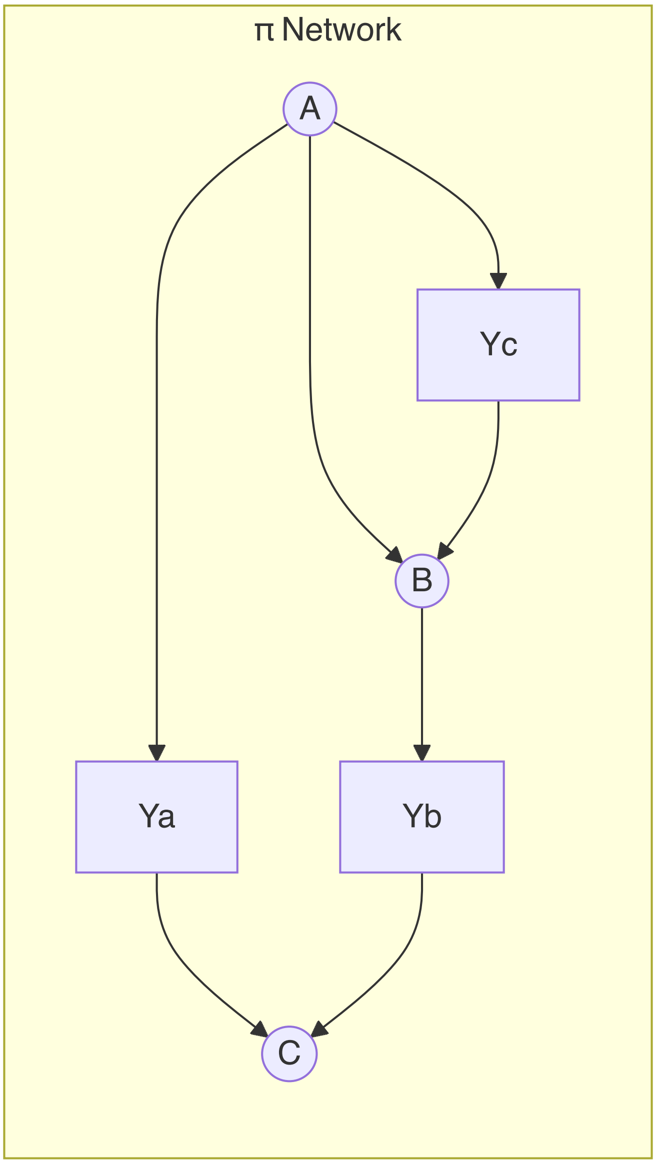
Question 2(c) OR [7 marks]

Derive equation to convert π network into T network.

Answer:

π Network to T Network Conversion:





Conversion Equations:

1. Za = (Ya × Yc) / YΔ
2. Zb = (Yb × Yc) / YΔ
3. Zc = (Ya × Yb) / YΔ

Where YΔ = Ya + Yb + Yc

Derivation:

1. Start with Y-parameters of π-network
2. Express Y-parameters in terms of branch admittances
3. Convert to Z-parameters using matrix inversion
4. Express T-network impedances in terms of Z-parameters
5. Simplify to get the conversion formulas above

Mnemonic: "PIE to TEA: Product over sum for opposite branch"

Question 3(a) [3 marks]

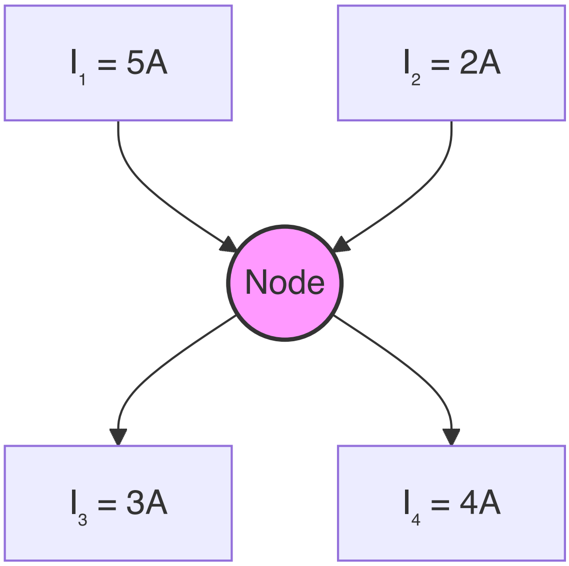
Explain Kirchhoff's current law with example.

Answer:

Kirchhoff's Current Law (KCL): The algebraic sum of all currents entering and leaving a node must equal zero.

Mathematically: $\sum I = 0$ (at any node)

Circuit Example:



Applying KCL at node B:

- Currents entering: $I_1 + I_2 = 5A + 2A = 7A$
- Currents leaving: $I_3 + I_4 = 3A + 4A = 7A$
- Therefore: $I_1 + I_2 - I_3 - I_4 = 5 + 2 - 3 - 4 = 0$ ✓

Mnemonic: "CuNoZ: Currents at Node are Zero"

Question 3(b) [4 marks]

Explain mesh analysis with required equations.

Answer:

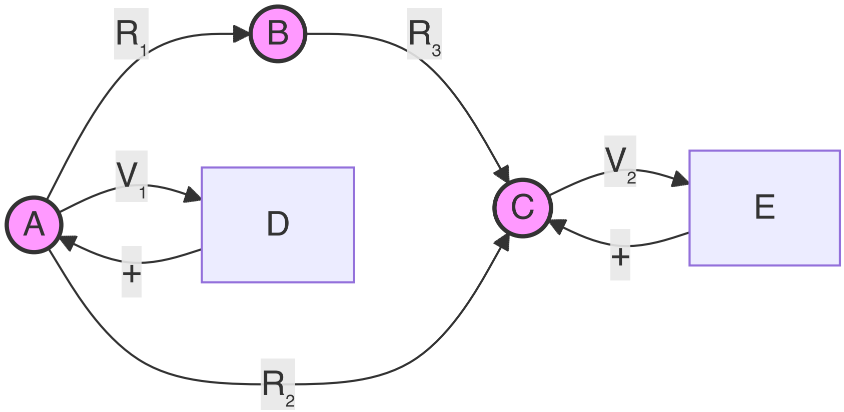
Mesh Analysis: A circuit analysis technique that uses mesh currents as variables to solve a circuit with multiple loops.

Steps:

1. Identify all meshes (closed loops) in the circuit
2. Assign a mesh current to each mesh
3. Apply KVL to each mesh

4. Solve the resulting system of equations

Example Circuit:



Equations:

- Mesh 1: $V_1 = I_1R_1 + I_1R_2 - I_2R_2$
- Mesh 2: $V_2 = I_2R_2 + I_2R_3 - I_1R_2$

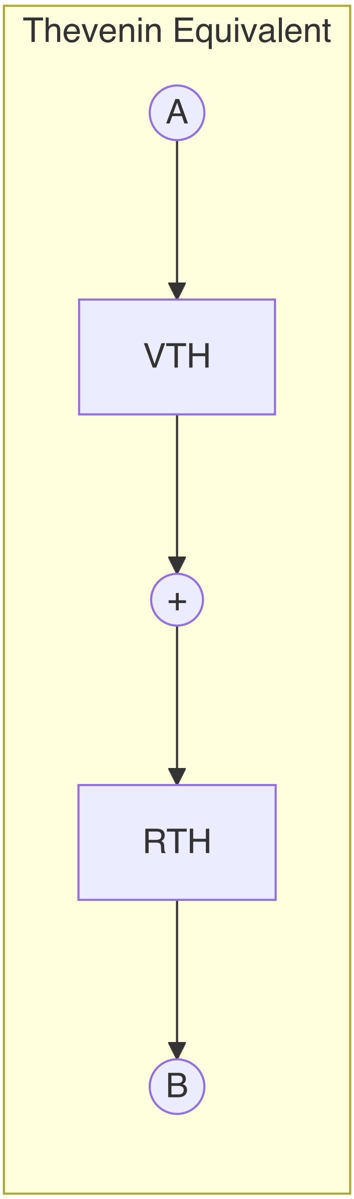
Mnemonic: "MILK: Mesh Is Loop with KVL"

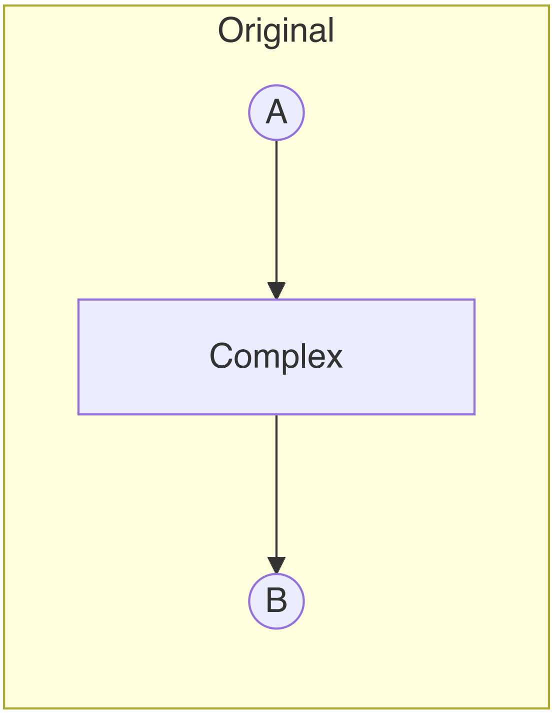
Question 3(c) [7 marks]

State and explain Thevenin's theorem.

Answer:

Thevenin's Theorem: Any linear network with voltage and current sources can be replaced by an equivalent circuit consisting of a voltage source (VTH) in series with a resistance (RTH).





Steps to Find Thevenin Equivalent:

1. Remove the load from the terminals of interest
2. Calculate the open-circuit voltage (VOC) across these terminals (= VTH)
3. Calculate the resistance looking back into the circuit with all sources replaced by their internal resistances (= RTH)
4. The Thevenin equivalent consists of VTH in series with RTH

Example Application:

- Original complex circuit with load RL
- Remove RL and find VOC = VTH
- Deactivate sources and find RTH
- Reconnect RL to simplified Thevenin equivalent

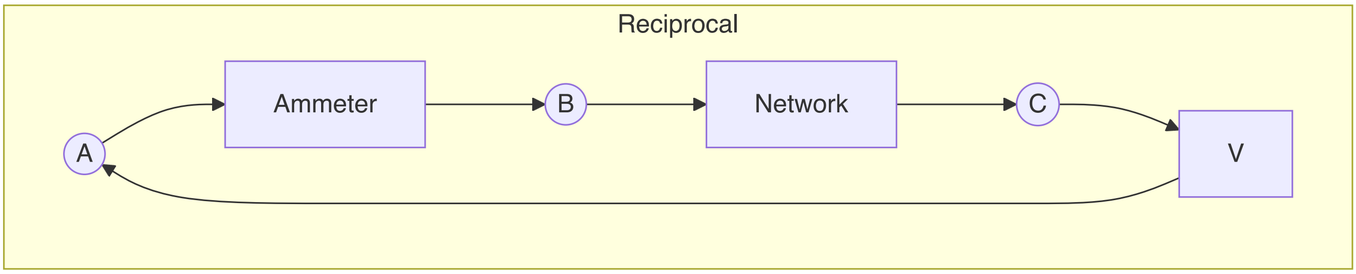
Mnemonic: "TORV: Thevenin's Open-circuit Resistance and Voltage"

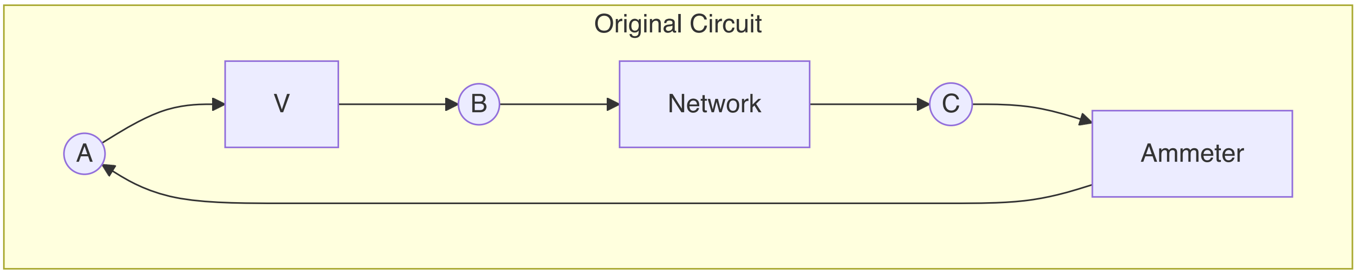
Question 3(a) OR [3 marks]

State and explain reciprocity theorem.

Answer:

Reciprocity Theorem: In a linear, bilateral network, if a voltage source in one branch produces a current in another branch, then the same voltage source, if placed in the second branch, will produce the same current in the first branch.





Mathematically: If a voltage V_1 in branch 1 produces current I_2 in branch 2, then voltage V_1 in branch 2 will produce current I_2 in branch 1.

Limitations: Applies only to networks with:

- Linear elements
- Bilateral elements (no diodes, transistors)
- Single independent source

Mnemonic: "RESWAP: REciprocity SWAPs Position with identical results"

Question 3(b) OR [4 marks]

Explain nodal analysis with required equations.

Answer:

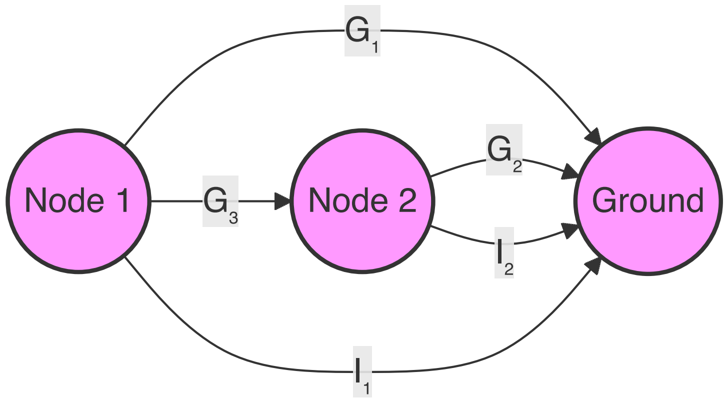
Nodal Analysis: A circuit analysis technique that uses node voltages as variables to solve a circuit.

Steps:

1. Choose a reference node (ground)
2. Assign voltage variables to remaining nodes

3. Apply KCL at each non-reference node
4. Solve the resulting system of equations

Example Circuit:



Equations:

- Node 1: $I_1 = V_1G_1 + (V_1\text{-}V_2)G_3$
- Node 2: $I_2 = V_2G_2 + (V_2\text{-}V_1)G_3$

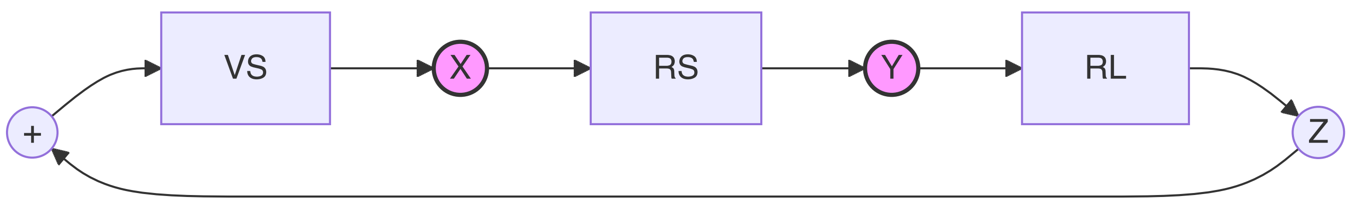
Mnemonic: "NKCV: Nodal uses KCL with Voltage variables"

Question 3(c) OR [7 marks]

State and prove maximum power transfer theorem.

Answer:

Maximum Power Transfer Theorem: A load connected to a source will extract maximum power when its resistance equals the internal resistance of the source.



Proof:

1. Current in the circuit: I = VS/(RS + RL)
2. Power delivered to load: $P = I^2RL = (VS^2RL)/(RS + RL)^2$
3. For maximum power, dP/dRL = 0
4. Solving: $(VS^2(RS + RL)^2 - VS^2RL\cdot 2(RS + RL))/(RS + RL)^4 = 0$
5. Simplifying: $(RS + RL)^2 = 2RL(RS + RL)$
6. Further simplifying: RS + RL = 2RL
7. Therefore: RS = RL

Maximum Power: $P_{max} = V_S^2/(4R_S)$

Mnemonic: "MaRLRS: Maximum power when load Resistance equals Source Resistance"

Question 4(a) [3 marks]

Why series resonance circuit act as voltage amplifier and parallel resonance circuit act as current amplifier?

Answer:

Series Resonance as Voltage Amplifier:

- At resonance, series circuit impedance is minimum (just R)
- Voltage across L or C can be much larger than source voltage
- Voltage magnification factor = $Q = X_L/R = 1/R\sqrt{(L/C)}$
- Voltage across L or C = Q × Source voltage

Parallel Resonance as Current Amplifier:

- At resonance, parallel circuit impedance is maximum
- Current in L or C can be much larger than source current
- Current magnification factor = $Q = R/X_L = R\sqrt{(C/L)}$
- Current through L or C = Q × Source current

Table:

Circuit Type	Impedance at Resonance	Amplification
Series	Minimum (R only)	Voltage (V_L or $V_C = Q \times V_S$)
Parallel	Maximum (R^2/r)	Current (I_L or $I_C = Q \times I_S$)

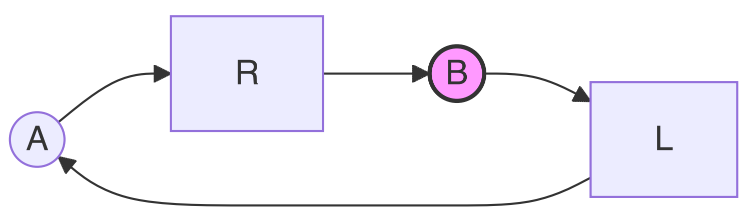
Mnemonic: "SeVoPa: Series Voltage, Parallel current amplification"

Question 4(b) [4 marks]

Derive equation of Q of coil.

Answer:

Q-factor of a Coil:



Derivation:

1. Q-factor is defined as: Q = Energy stored / Energy dissipated per cycle
2. Energy stored in inductor = $(1/2)LI^2$
3. Power dissipated in resistor = I^2R
4. Energy dissipated per cycle = Power × Time period = $I^2R \times (1/f)$
5. Therefore: $Q = ((1/2)LI^2) / (I^2R \times (1/f))$
6. Simplifying: $Q = 2\pi \times (1/2)LI^2 \times f / (I^2R)$
7. $Q = 2\pi f \times L / R = \omega L / R$

Final Equation: $Q = \omega L / R = 2\pi fL / R = XL / R$

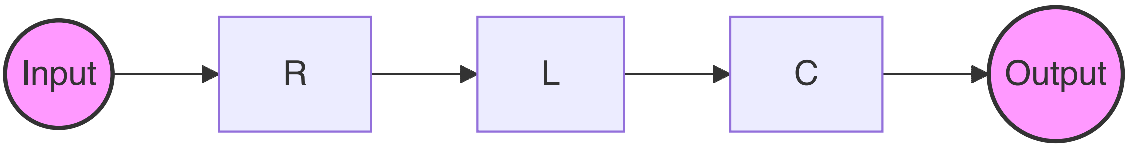
Mnemonic: "QualityEDR: Quality equals Energy stored Divided by energy lost per Radian"

Question 4(c) [7 marks]

Derive equation of series resonance frequency for series R-L-C circuit.

Answer:

Series R-L-C Circuit:



Derivation:

1. Impedance of series RLC circuit: Z = R + j(XL - XC)
2. Where: $XL = \omega L$ and $XC = 1/\omega C$
3. At resonance, XL = XC (inductive and capacitive reactances are equal)
4. Therefore: $\omega L = 1/\omega C$
5. Solving for ω: $\omega^2 = 1/LC$
6. Resonant frequency: $\omega_0 = 1/\sqrt{(LC)}$
7. In terms of frequency f: $f_0 = 1/(2\pi\sqrt{(LC)})$

Characteristics at Resonance:

- Impedance is minimum (purely resistive: Z = R)
- Current is maximum (I = V/R)
- Power factor is unity (circuit appears resistive)
- Voltages across L and C are equal and opposite

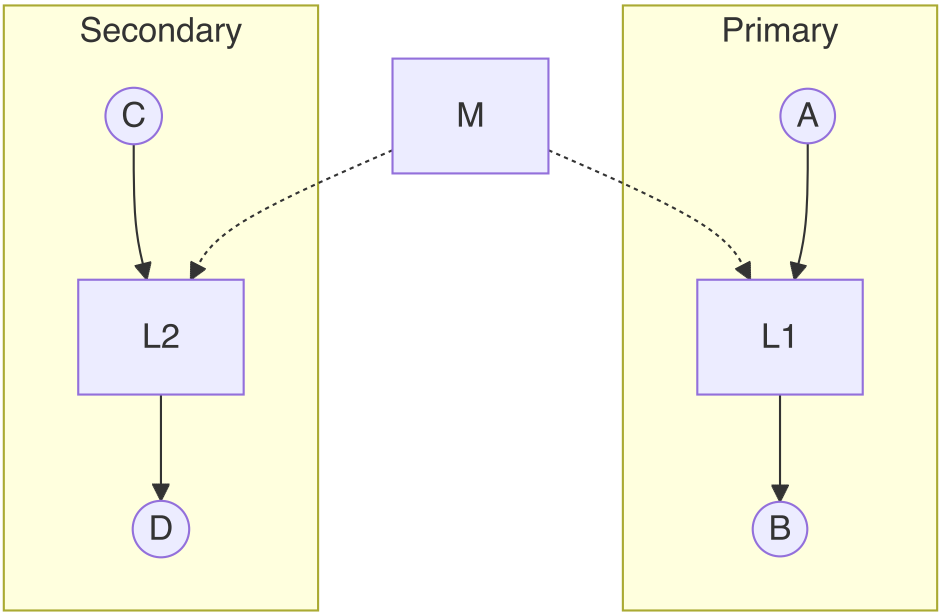
Mnemonic: "RES: Reactances Equal at Series resonance"

Question 4(a) OR [3 marks]

What is coupled circuits? Define self-inductance and mutual inductance.

Answer:

Coupled Circuits: Two or more circuits that are magnetically linked such that energy can be transferred between them through their mutual magnetic field.



Self-inductance (L): The property of a circuit whereby a change in current produces a self-induced EMF in the same circuit.
$L = \Phi/I$ (ratio of magnetic flux to the current producing it)

Mutual inductance (M): The property of a circuit whereby a change in current in one circuit induces an EMF in another circuit.
$M = \Phi_{21}/I_1$ (ratio of flux in circuit 2 due to current in circuit 1)

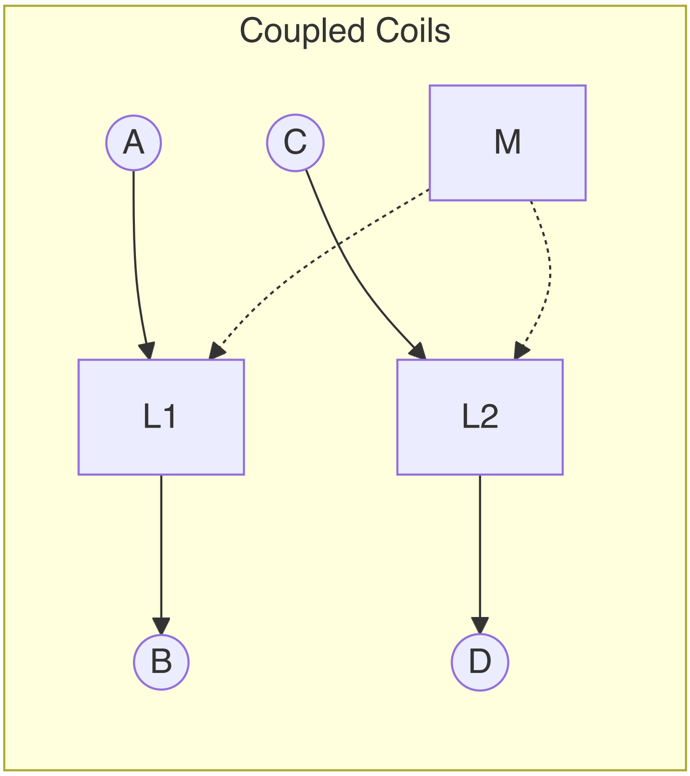
Mnemonic: "SiMu: Self in Mine, Mutual in Yours"

Question 4(b) OR [4 marks]

Derive equation for co-efficient of coupling (K).

Answer:

Coefficient of Coupling (k):



Derivation:

1. The mutual inductance (M) between two coils depends on:
    - Self-inductances of the coils (L_1 and L_2)
    - Physical arrangement (proximity and orientation)
2. Maximum possible mutual inductance: $M_{max} = \sqrt{(L_1 L_2)}$
3. Coefficient of coupling is defined as: $k = M/M_{max}$
4. Therefore: $k = M/\sqrt{(L_1 L_2)}$

Characteristics:

- k ranges from 0 (no coupling) to 1 (perfect coupling)
- k depends on geometry, orientation, and medium
- Typical transformers: k = 0.95 to 0.99
- Air-core coils: k = 0.01 to 0.5

Mnemonic: "KMutual: K Measures Mutual linkage proportion"

Question 4(c) OR [7 marks]

A series RLC circuit has R=30Ω, L=0.5H, and C=5μF. Calculate (i) series resonance frequency (2) Q Factor (3)BW

Answer:

Given:

- Resistance, R = 30Ω
- Inductance, L = 0.5H
- Capacitance, C = 5μF = 5×10^{-6}F

Calculations:

(i) Series Resonance Frequency:

- $f_0 = 1/(2\pi\sqrt{(LC)})$
- $f_0 = 1/(2\pi\sqrt{(0.5 \times 5\times10^{-6})})$
- $f_0 = 1/(2\pi\sqrt{(2.5\times10^{-6})})$
- $f_0 = 1/(2\pi \times 1.58\times10^{-3})$
- $f_0 = 1/(9.9\times10^{-3})$
- f_0 = 100.76 Hz
- $f_0 \approx$ 100 Hz

(ii) Q Factor:

- $Q = (1/R)\sqrt{(L/C)}$
- $Q = (1/30)\sqrt{(0.5/(5\times10^{-6}))}$
- $Q = (1/30)\sqrt{(100,000)}$
- Q = (1/30) × 316.23
- Q = 10.54

(iii) Bandwidth (BW):

- BW = f_0/Q
- BW = 100.76/10.54
- BW = 9.56 Hz

Table:

Parameter	Formula	Value
Resonant Frequency (f_0)	$1/(2\pi\sqrt{(LC)})$	100 Hz
Quality Factor (Q)	$(1/R)\sqrt{(L/C)}$	10.54
Bandwidth (BW)	f_0/Q	9.56 Hz

Mnemonic: "RQB: Resonance Quality determines Bandwidth"

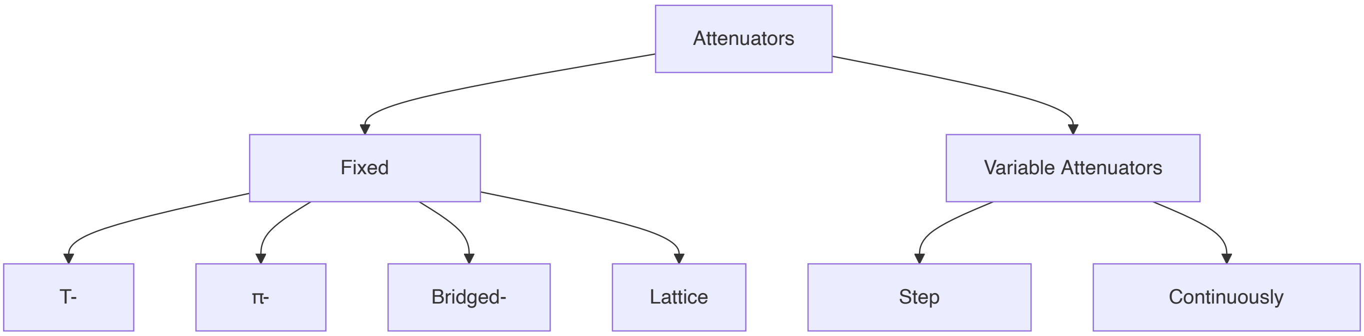
Question 5(a) [3 marks]

Classify various types of attenuators.

Answer:

Attenuators: Network of resistors designed to reduce (attenuate) signal level without distortion.

Types of Attenuators:



Based on configuration:

- **T-type**: Three resistor T-shaped configuration
- **π-type**: Three resistor π-shaped configuration
- **Bridged-T**: T-type with a resistor bridging across
- **Lattice**: Balanced configuration with four resistors

Based on symmetry:

- **Symmetrical**: Equal input and output impedance
- **Asymmetrical**: Different input and output impedance

Mnemonic: "ATP Fixed: Attenuator Types include Pad, Tee, Lattice"

Question 5(b) [4 marks]

Derive relation between attenuator and neper.

Answer:

Relationship between Attenuation and Neper:

- **Attenuation (α)**: Ratio of input voltage (or current) to output voltage (or current), expressed in different units.
- **Neper (Np)**: Natural logarithmic unit of ratios, used mainly in transmission line theory.

Derivation:

1. For a voltage ratio V_1/V_2:
   - Attenuation in Nepers = $\ln(V_1/V_2)$
   - Attenuation in Decibels = $20\log_{10}(V_1/V_2)$
2. For a power ratio P_1/P_2:
   - Attenuation in Nepers = $(1/2)\ln(P_1/P_2)$
   - Attenuation in Decibels = $10\log_{10}(P_1/P_2)$
3. Relationship between dB and Neper:

- 1 Neper = 8.686 dB
- 1 dB = 0.115 Neper

Table:

Unit	Voltage Ratio	Power Ratio
Neper (Np)	$\ln(V_1/V_2)$	$(1/2)\ln(P_1/P_2)$
Decibel (dB)	$20\log_{10}(V_1/V_2)$	$10\log_{10}(P_1/P_2)$

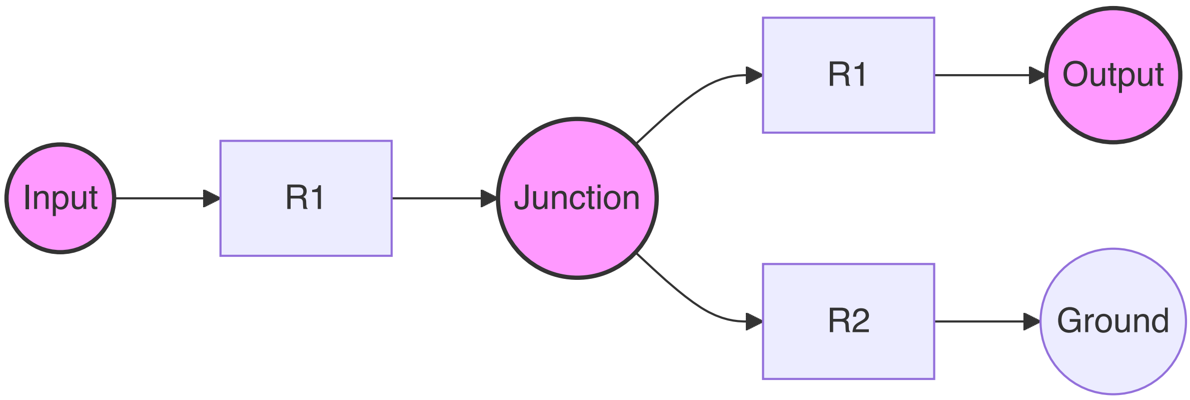
Mnemonic: "NED: Neper Equals Decibel divided by 8.686"

Question 5(c) [7 marks]

Derive equations of R1 and R2 for symmetrical T attenuator.

Answer:

Symmetrical T Attenuator:



Derivation:

1. For a symmetrical T-attenuator with characteristic impedance Z_0:
   - Input and output impedance must both equal Z_0
   - Attenuation ratio $N = V_1/V_2 = I_2/I_1$
2. From circuit analysis:
   - $Z_0 = R_1 + (R_2(R_1))/(R_2+R_1)$
   - $N = (R_1 + R_2 + R_1)/R_2 = (2R_1+R_2)/R_2$
3. Solving for R_1 and R_2:
   - $R_1 = Z_0(N-1)/(N+1)$
   - $R_2 = 2Z_0N/(N^2-1)$
4. For attenuation in dB (α):
   - $N = 10^{(\alpha/20)}$

- $R_1 = Z_0 \cdot \tanh(\alpha/2)$
- $R_2 = Z_0/\sinh(\alpha)$

Final Equations:

- $R_1 = Z_0(N-1)/(N+1)$
- $R_2 = 2Z_0N/(N^2-1)$

Mnemonic: "TSR: T-attenuator Symmetry Requires equal R1 values"

Question 5(a) OR [3 marks]

Draw circuit diagram of symmetrical Bridge T and symmetrical Lattice attenuator.

Answer:

Symmetrical Bridge-T Attenuator:

```
               R1
A o--------/\/\/\--------o B
           |      |
           |      |
           \      /
           /  R3  \
    R2     \      /
o---/\/\/\--+     +----o
|                      |
o----------------------o
C                      D
```

Symmetrical Lattice Attenuator:

```
          R1
A o----/\/\/\----o B
   \            /
    \          /
     \        /
  R2  \      / R2
       \    /
        \  /
         \/
         /\
        /  \
       /    \
      /      \
 R1  /        \
  C o--\/\/\/--o D
```

Characteristics:

1. **Bridge-T**: Combines features of T and π attenuators, suitable for high-frequency applications

2. **Lattice**: Balanced configuration with excellent phase and frequency response, commonly used in balanced lines

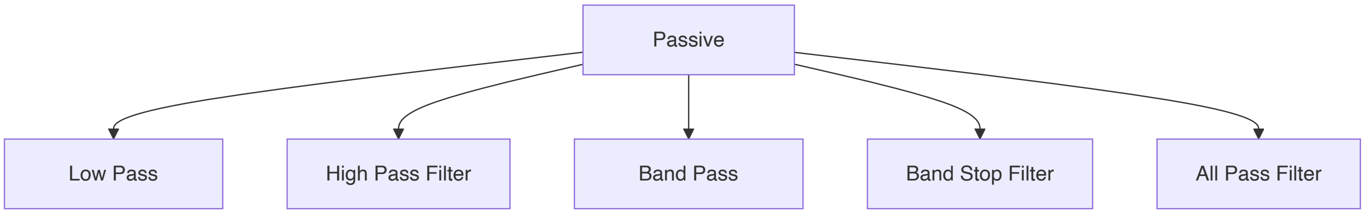
Mnemonic: "BL-BA: Bridge Ladder, Balanced Attenuators"

Question 5(b) OR [4 marks]

Write classification of filter based on frequency with their frequency responses showing pass band and stop band.

Answer:

Classification of Filters Based on Frequency:



Frequency Responses:

1. **Low Pass Filter**: Passes frequencies below cutoff, attenuates above

```
Gain |
   1 |****
     |    ****
     |        ****
   0 |------------****----
     |
     +----------------------
        0     fc         f →
```

2. **High Pass Filter**: Passes frequencies above cutoff, attenuates below

```
Gain |
   1 |            ****
     |        ****
     |    ****
   0 |****-----------------
     |
     +----------------------
        0     fc         f →
```

3. **Band Pass Filter**: Passes frequencies within a specific band

```
Gain |
   1 |        ****
     |    ****    ****
     |   *           *
   0 |***-------------***--
     |
     +----------------------
        0   f1   f2     f →
```

4. **Band Stop Filter**: Rejects frequencies within a specific band

```
Gain |
  1 |***            ***
     |   *            *
     |    ***     ***
  0 |        *****
     |
     +----------------------
        0   f1   f2     f →
```

Mnemonic: "LHBBA: Low High Band-pass Band-stop All-pass"

Question 5(c) OR [7 marks]

Draw the circuit for T-section and π-section constant-K low pass filter and Derive equation of cut-off frequency.

Answer:

T-section Constant-K Low Pass Filter:

```
        L/2            L/2
o------UUUUUU------UUUUUU-------o
|                               |
|                               |
|                               |
|              C                |
|              |                |
o--------------+----------------o
Input                        Output
```

π-section Constant-K Low Pass Filter:

```
        L
  o------UUUUUU---------o
  |                     |
  |                     |
  |                     |
  |                     |
 ---                   ---
 --- C/2               --- C/2
  |                     |
  |                     |
  o---------------------o
  Input              Output
```

Derivation of Cutoff Frequency:

1. For a constant-K filter:
   - $Z_1 \times Z_2 = R_0^2$ (characteristic impedance squared)
   - $Z_1 = j\omega L$ (series impedance)
   - $Z_2 = 1/j\omega C$ (shunt impedance)
2. Therefore:
   - $R_0^2 = Z_1 \times Z_2 = j\omega L \times 1/j\omega C = L/C$
   - $R_0 = \sqrt{(L/C)}$
3. Pass band condition:
   - $-1 < Z_1/4Z_2 < 0$
   - $-1 < j\omega L/(4 \times 1/j\omega C) < 0$
   - $-1 < -\omega^2 LC/4 < 0$
4. At cutoff frequency:
   - $\omega^2 LC/4 = 1$
   - $\omega c^2 = 4/LC$
   - $\omega c = 2/\sqrt{(LC)}$
   - $fc = \omega c/2\pi = 1/\pi\sqrt{(LC)}$

Final Equation:

- Cutoff frequency $fc = 1/\pi\sqrt{(LC)}$

Mnemonic: "KCLP: Konstant-k Cutoff in Low Pass depends on L and C product"