Unit - II
2.3 Mesh Analysis

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$80,000

Electric Vehicles

2019 → Cost – ≃ $30,000
2019 → Mileage – ≃ 400km

Tesla ✓
Hyundai
Mahindra
ola
Tata →

Lucid motor → >500 mi
→ 837 km → Bigger storage

8m
300km
EPA

- https://www.lucidmotors.com/

V
I

Syllabus

Tool chest
Source
ohm's
KVL, KCL
Mesh Analysis.

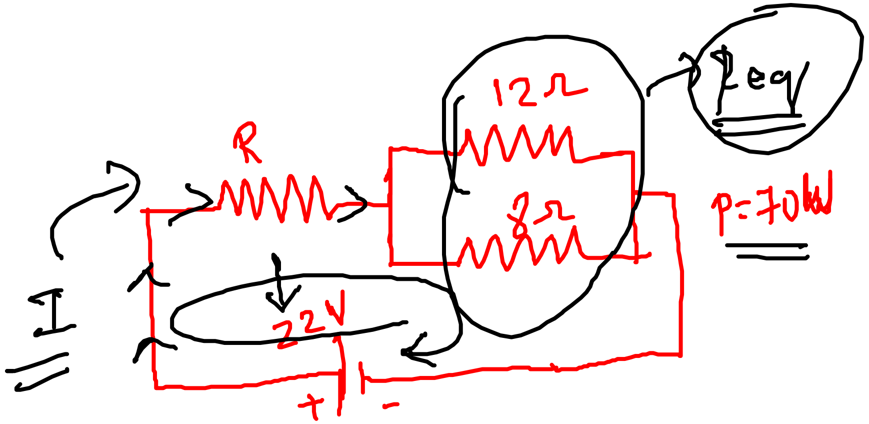
UNIT – II **14 Periods**

DC Circuit Analysis: Voltage source and current sources, ideal and practical, Kirchhoff's laws and applications to network solutions using mesh analysis, - Simplifications of networks using series- parallel, Star/Delta transformation, DC circuits-Current-voltage relations of electric network by mathematical equations to analyse the network (Superposition theorem, Thevenin's theorem, Maximum Power Transfer theorem), Transient analysis of R-L, R-C and R-L-C Circuits.

AC Steady-state Analysis: AC waveform definitions - Form factor - Peak factor - study of R-L - R-C -RLC series circuit - R-L-C parallel circuit - phasor representation in polar and rectangular form - concept of impedance - admittance - active - reactive - apparent and complex power - power factor, Resonance in R-L-C circuits - 3 phase balanced AC Circuits

Exercise – I

- A resistance R is connected in series with a parallel circuit comprising two resistor 12 Ω and 8 Ω respectively. The total power dissipated in the circuit is 70 W. When the applied voltage is 22 volts. Calculate the value of R.



$P = V \cdot I$

$I = P/V = \frac{70}{22} = 3.18A$

$R_{eq} = 12 \parallel 8$

$R_{eq} = 4.8\,\Omega$

$V_{eq} = I R_{eq}$

$= 3.18 \times 4.8$

$\boxed{V_{eq} = 15.26\,(V)}$

KVL

$+22 - V_R - V_{eq} = 0$

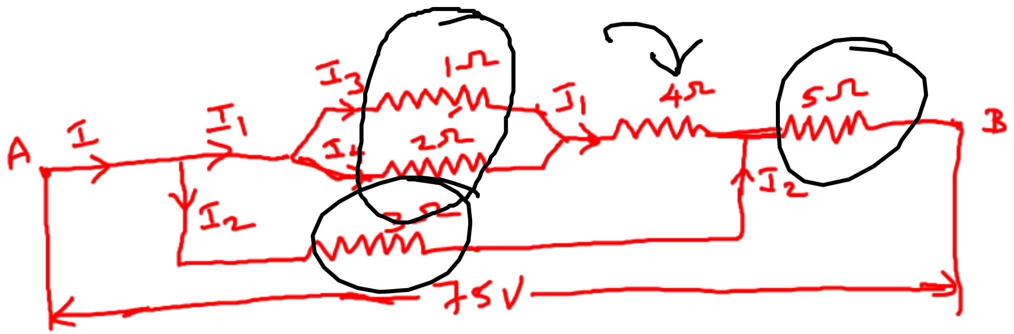
$\boxed{V_R = 6.73\,(V)}$

$R = \frac{V}{I}$

$\boxed{R = 2.12\,\Omega}$

Practice Problem

- Determine the effective resistance of the series-parallel combination shown in the figure. Also, find the current, voltage and power dissipated in each of the resistor in the given circuit.



$R_{eq} = 157/23\ \Omega$

$I = 10.98\,A$

$I_1 = 4.3\,A$

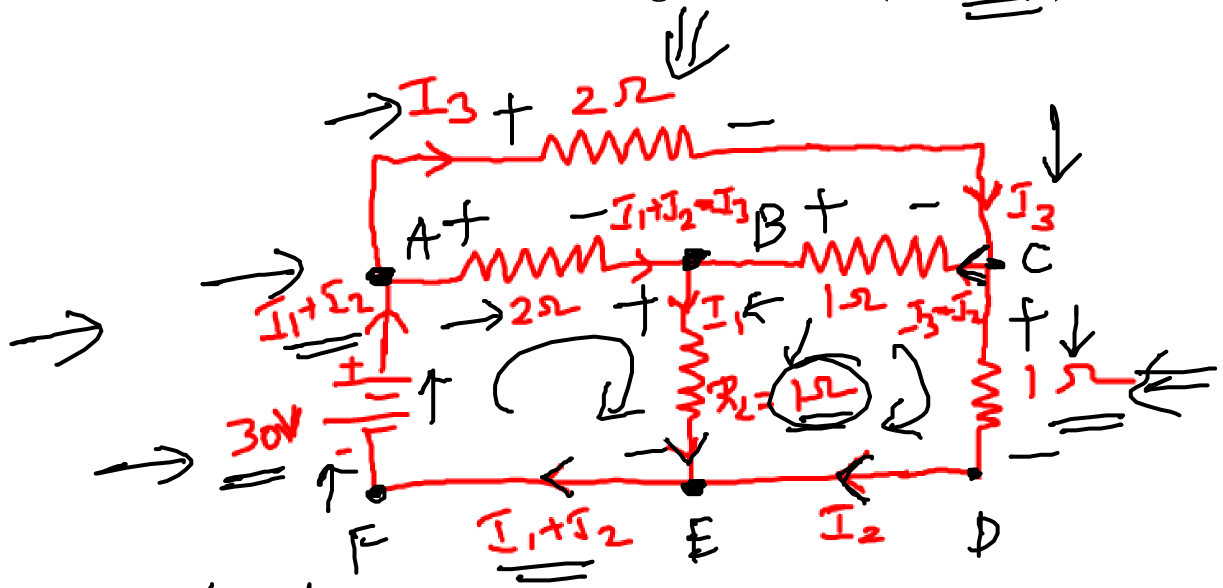
$I_2 = 6.78\,A$

$I_3 = 2.86\,A$

$I_4 = 1.43\,A$

Practice Problem

Find the load current in the given circuit (Use KVL).



Possible Loops:

ABEFA
BCDEB
ACBA

ABCDEF
FACDEF

Loop I KVL

$+30 - (I_1+I_2-I_3)2 - I_1\cdot 1 = 0$

Loop II (BCDEB)

$-(-(I_3-I_2)\cdot 1) - 1\cdot I_2 + (-I_1\cdot 1) = 0$

Loop III (ACBA)

$-2I_3 + (I_3-I_2)1 + (I_1+I_2-I_3)\times 2 = 0$

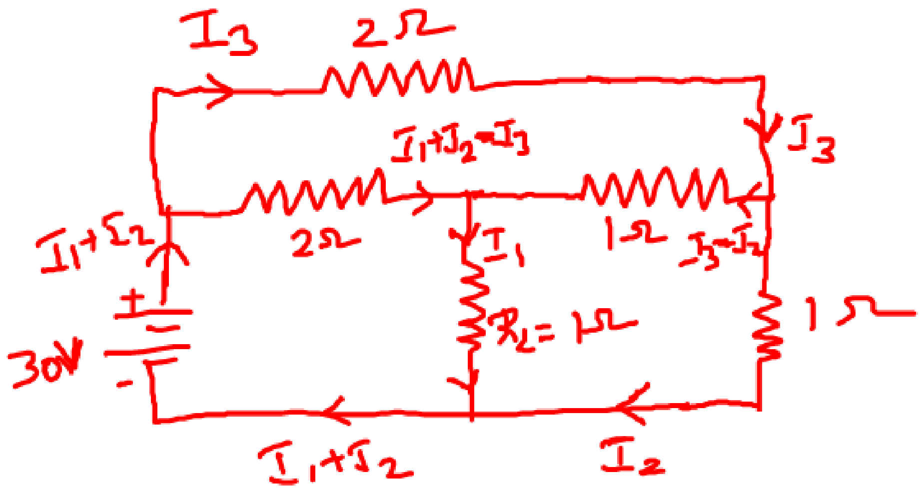
$I_1 = V_L = 10\,V$

$I_2 =$

$I_3 =$ → 10A

Practice Problem

Find the load current in the given circuit (Use KVL).



$V_L = 10\ V$

Mesh/Loop Analysis

- Loop analysis is developed by applying KVL around loops in the circuit
- Loop (mesh) analysis results in a system of linear equations which must be solved for unknown currents

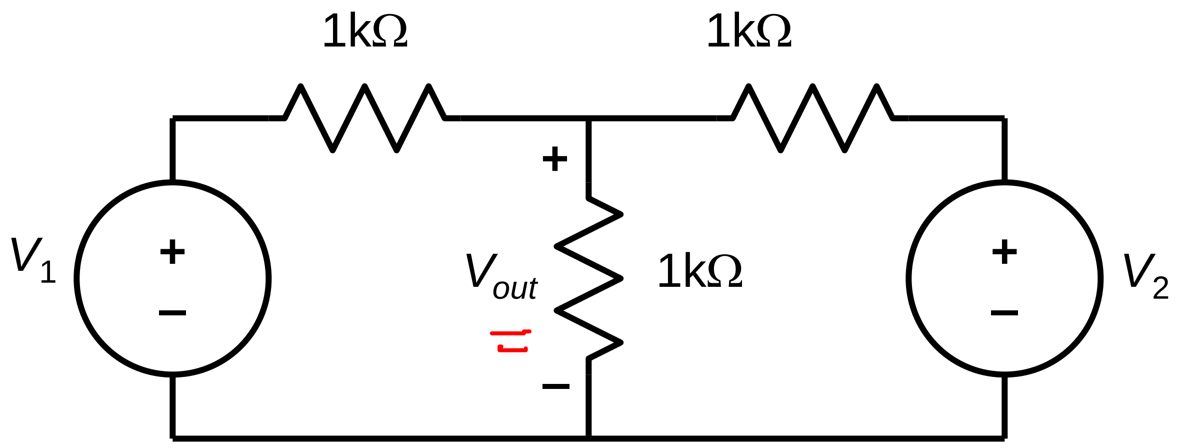
More of unknown

Loop →

Mesh →

Summing Circuit

- The output voltage *V* of this circuit is proportional to the sum of the two input voltages V_1 and V_2



Steps of Mesh Analysis

1. **Identify mesh (loops).**
2. Assign a current to each mesh.
3. Apply KVL around each loop to get an equation in terms of the loop currents.
4. Solve the resulting system of linear equations for the mesh/loop currents.

1. Identifying the Meshes

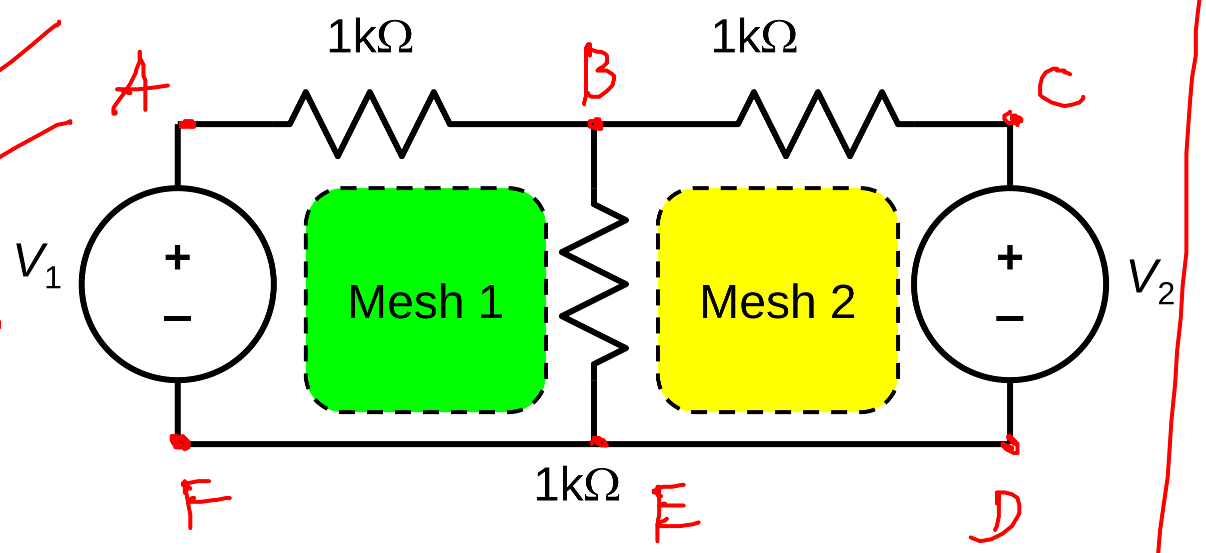
Loops:

(I) - ABEFA - ✓

(II) BCDEB - ✓

(III) - A BC DEFA - ×

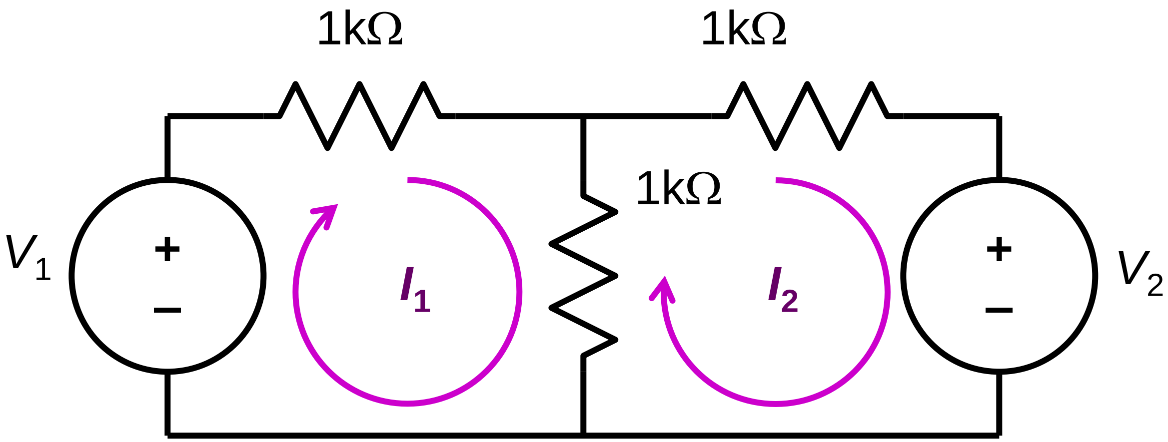
Mesh



Steps of Mesh Analysis

1. Identify mesh (loops).
2. **Assign a current to each mesh.**
3. Apply KVL around each loop to get an equation in terms of the loop currents.
4. Solve the resulting system of linear equations for the mesh/loop currents.

2. Assigning Mesh Currents

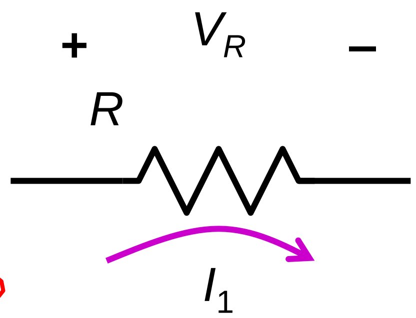


Convention → Assume clockwise currents

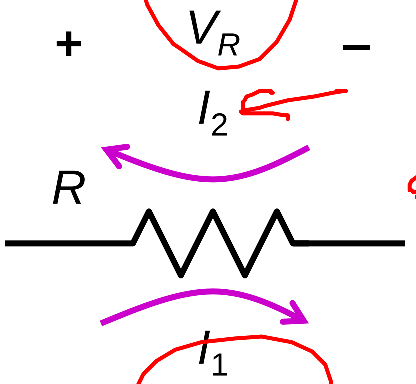
Steps of Mesh Analysis

1. Identify mesh (loops).
2. Assign a current to each mesh.
3. **Apply KVL around each loop to get an equation in terms of the loop currents.**
4. Solve the resulting system of linear equations for the mesh/loop currents.

Voltages from Mesh Currents



$$V_R = I_1 R$$



$$V_R = (I_1 - I_2)\ R$$

R

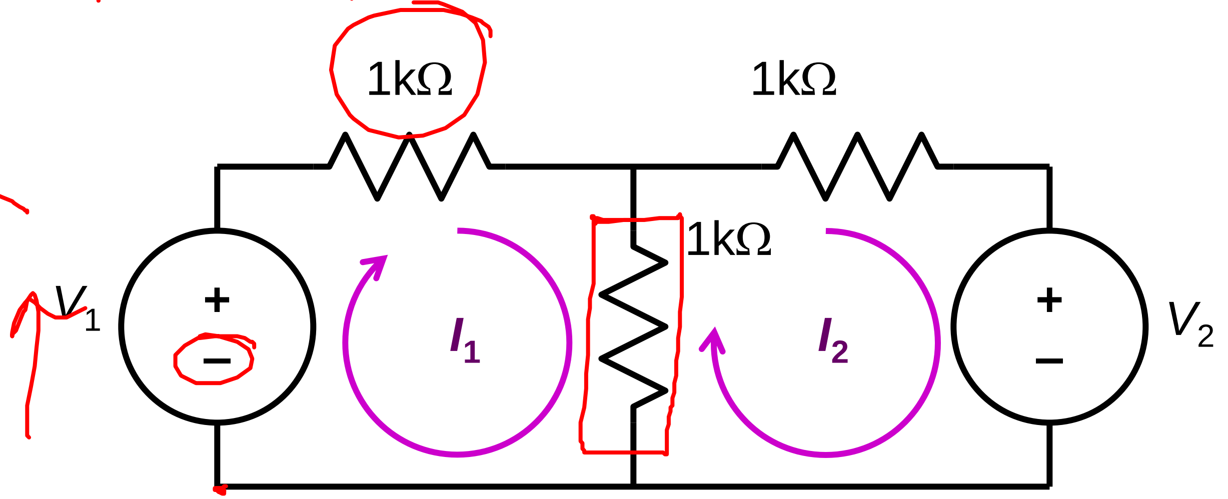
Mesh I → $I_1 - I_2$

Mesh II → $I_2 - I_1$

3. KVL Around Mesh 1

$+V_1 - I_1 \cdot 1k - (I_1 - I_2)\,1k = 0$

Resistance drop



$$+V_1 - I_1\,1k\Omega - (I_1 - I_2)\,1k\Omega = 0$$

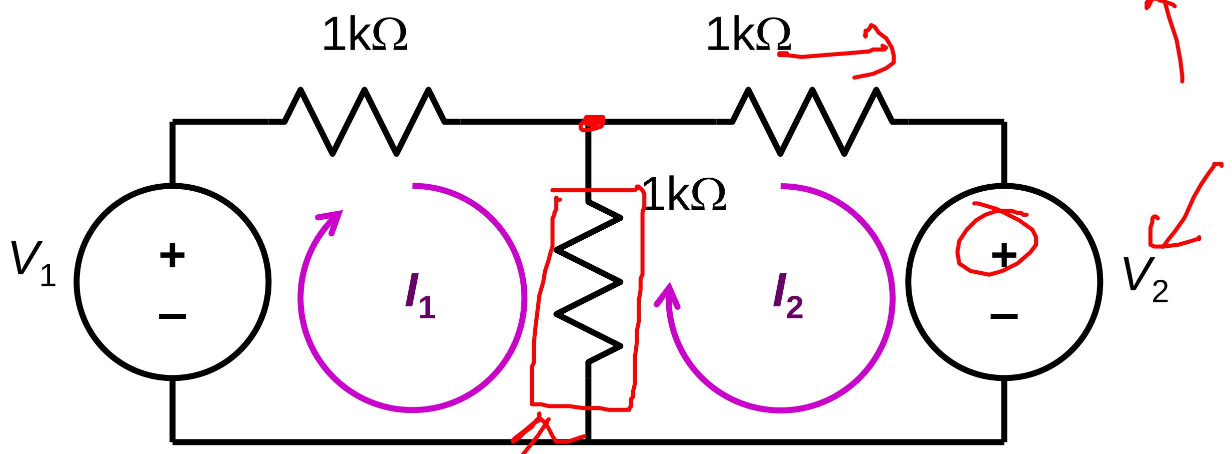
$$I_1\,1k\Omega + (I_1 - I_2)\,1k\Omega = V_1$$

$$I_1\,2k\Omega - I_2\,1k\Omega = V_1$$

3. KVL Around Mesh 2

$-1k\Omega \cdot I_2 - V_2 - \underline{(I_2 - I_1)}\,1k = 0$

Convention



$$-(I_2 - I_1)\ 1k\Omega - I_2\ 1k\Omega - V_2 = 0$$
$$(I_2 - I_1)\ 1k\Omega + I_2\ 1k\Omega = -V_2$$
$$-I_1\ 1k\Omega + I_2\ 2k\Omega = -V_2$$

Steps of Mesh Analysis

1. Identify mesh (loops).
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4. **Solve the resulting system of linear equations for the mesh/loop currents.**

Exercise

$V_1 = 7V$

$V_2 = 4V$

$I_1 = ?$

$I_2 = ?$

Summary

Toolchest

- → Ohm's law
- → Reduction
- → division
- → KVL, KCL
- → Method → steps → ✓