BEEE Unit–1 Notes

D.C. Circuits

Printable Notes for RGPV Engineering Students

UNIT OVERVIEW

This unit is one of the most important units in Basic Electrical & Electronics Engineering.

Topics included:

- Voltage & Current Sources
- Source Conversion
- Ohm's Law
- Kirchhoff's Laws
- Superposition Theorem
- Thevenin's Theorem
- Series & Parallel Circuits
- Power & Energy
- Mesh Analysis
- Nodal Analysis
- Star Delta Transformation

These topics are important for:

✅ Semester Exams ✅ Viva Questions ✅ Numerical Problems ✅ Competitive Exams

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1. ELECTRIC CURRENT

Definition

Electric current is the flow of electric charge through a conductor.

Formula

$I = Q / t$

Where:

- I = Current
- Q = Charge
- t = Time

Unit

Ampere (A)

Types of Current

1. Direct Current (DC)

Current flows in only one direction.

Examples:

- Battery
- Cell

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2. Alternating Current (AC)

Current changes direction periodically.

Example:

- Household supply

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2. ELECTRIC VOLTAGE

Definition

Voltage is the electrical pressure that causes current to flow.

Formula

V = W / Q

Where:

- V = Voltage
- W = Work done
- Q = Charge

Unit

Volt (V)

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3. VOLTAGE AND CURRENT SOURCES

Sources supply electrical energy to circuits.

Types of Sources

1. Independent Source

Provides fixed voltage or current.

Types

- Independent Voltage Source
- Independent Current Source

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2. Dependent Source

Value depends on another circuit variable.

Types

- Voltage Controlled Voltage Source
- Current Controlled Voltage Source
- Voltage Controlled Current Source

- Current Controlled Current Source

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4. SOURCE CONVERSION

Definition

Conversion of voltage source into current source and vice versa.

Voltage Source to Current Source

I = V / R

Current Source to Voltage Source

V = IR

Importance

- Simplifies circuit analysis
- Useful in network theorems

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5. OHM’S LAW

Statement

Current flowing through conductor is directly proportional to voltage applied across it provided temperature remains constant.

Formula

V = IR

Where:

- V = Voltage
- I = Current
- R = Resistance

Applications

- Electrical calculations
- Circuit analysis
- Power calculation

Numerical Example

Question

Find current when:

- Voltage = 10V
- Resistance = 5Ω

Solution

Using Ohm’s Law:

I = V / R

I = 10 / 5

I = 2A

Final Answer

Current = 2A

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6. KIRCHHOFF’S CURRENT LAW (KCL)

Statement

Sum of currents entering a junction equals sum of currents leaving the junction.

Formula

$\Sigma I_{in} = \Sigma I_{out}$

Applications

- Nodal analysis
- Circuit solving

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7. KIRCHHOFF’S VOLTAGE LAW (KVL)

Statement

Sum of voltages around a closed loop is zero.

Formula

$\Sigma V = 0$

Applications

- Mesh analysis
- Loop calculations

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8. SUPERPOSITION THEOREM

Statement

In a linear circuit with multiple sources, current through any element equals algebraic sum of currents produced by each source acting alone.

Steps

1. Keep one source active
2. Replace other voltage sources by short circuit
3. Replace current sources by open circuit
4. Calculate current/voltage
5. Repeat for all sources
6. Add all responses

Applications

- Multi-source circuit analysis
- Electrical network solving

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9. THEVENIN'S THEOREM

Statement

Any linear bilateral network can be replaced by an equivalent voltage source and series resistance.

Equivalent Circuit

- Thevenin Voltage → Vth
- Thevenin Resistance → Rth

Steps

1. Remove load resistance

2. Find open circuit voltage
3. Find equivalent resistance
4. Draw Thevenin circuit

Applications

- Simplifies complex circuits
- Load analysis

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10. SERIES CIRCUIT

Definition

Circuit in which components are connected end-to-end.

Characteristics

- Same current flows
- Voltage divides

Total Resistance

R = R1 + R2 + R3

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11. PARALLEL CIRCUIT

Definition

Circuit in which components are connected across same voltage.

Characteristics

- Same voltage
- Current divides

Formula

$1/R = 1/R1 + 1/R2 + 1/R3$

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12. ELECTRICAL POWER

Definition

Rate of electrical energy consumption.

Formula

$P = VI$

Also:

$P = I^2R$

$P = V^2 / R$

Unit

Watt (W)

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13. ELECTRICAL ENERGY

Formula

$E = Pt$

Where:

- E = Energy
- P = Power
- t = Time

Unit

Joule (J)

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14. MESH ANALYSIS

Definition

Method based on KVL used for solving loop currents.

Steps

1. Identify meshes
2. Assume currents
3. Apply KVL
4. Solve equations

Applications

- Multi-loop circuits
- Current calculations

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15. NODAL ANALYSIS

Definition

Method based on KCL used to determine node voltages.

Steps

1. Identify nodes
2. Select reference node
3. Apply KCL
4. Solve equations

Applications

- Complex network analysis
- Voltage calculations

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16. STAR DELTA TRANSFORMATION

Used for conversion between star and delta networks.

Star to Delta Formula

RAB = (RARB + RBRC + RCRA) / RC

Delta to Star Formula

RA = (RAB × RCA) / (RAB + RBC + RCA)

Applications

- Circuit simplification
- Bridge network solving

MOST IMPORTANT 14 MARK QUESTIONS

1. Explain Ohm’s Law with applications.
2. State and explain KCL and KVL.
3. Explain Superposition Theorem.
4. Explain Thevenin’s Theorem.
5. Explain Mesh Analysis.
6. Explain Nodal Analysis.
7. Differentiate series and parallel circuits.
8. Explain source conversion.
9. Explain Star Delta Transformation.
10. Numerical problems on DC circuits.