

Basic Electronics Solutions

DI01000101 – Winter 2024

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Explain ohm's law with its limitation and application.

Solution

Table 1: Ohm's Law Summary

Aspect	Description
Statement	Current through conductor is directly proportional to voltage
Formula	$V = I \times R$
Units	V (Volts), I (Amperes), R (Ohms)

Limitations:

- **Temperature dependency:** Resistance changes with temperature
- **Non-linear materials:** Does not apply to semiconductors, diodes
- **AC circuits:** Modified form needed for reactive components

Applications:

- **Circuit analysis:** Calculate unknown voltage, current, or resistance
- **Power calculations:** $P = V^2/R, P = I^2R$

Mnemonic

“Voltage Is Really Important” ($V = I \times R$)

Question 1(b) [4 marks]

Explain faraday's law of electromagnetic induction with necessary figure.

Solution

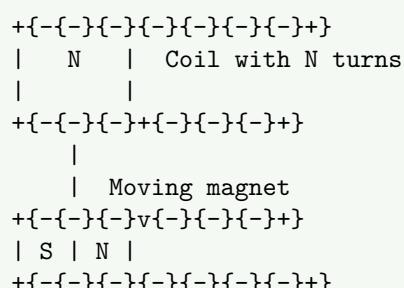
Faraday's Laws:

- **First Law:** EMF is induced when magnetic flux changes through conductor
- **Second Law:** Magnitude of EMF equals rate of flux change

Mathematical Expression:

$$e = -N \times (d\Phi/dt)$$

Diagram:



Applications:

- **Transformers:** Mutual induction principle

- **Generators:** Mechanical to electrical energy conversion
- **Inductors:** Self-induced EMF opposes current changes

Mnemonic

“Flux Change Generates EMF” ($d\Phi/dt = \text{EMF}$)

Question 1(c) [7 marks]

Explain kirchhoff's voltage law and kirchhoff's current law with necessary diagram.

Solution

Table 3: Kirchhoff's Laws Comparison

Law	Statement	Mathematical Form	Application
KVL	Sum of voltages in closed loop = 0	$\Sigma V = 0$	Series circuits
KCL	Sum of currents at node = 0	$\Sigma I = 0$	Parallel circuits

KVL Diagram:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph LR
    A["+" --- B[V1]] --- C[R1]
    C --- D[V2]
    D --- E[R2]
    E --- A

    style A fill:#f9f,stroke:#333,stroke-width:2px
    style C fill:#bbf,stroke:#333,stroke-width:2px
    style E fill:#bbf,stroke:#333,stroke-width:2px
{Highlighting}
{Shaded}
```

KCL Diagram:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting} []
graph TD
    A[I1] --- B((Node))
    C[I2] --- B
    B --- D[I3]
    B --- E[I4]

    style B fill:#f96,stroke:#333,stroke-width:4px
{Highlighting}
{Shaded}
```

Key Points:

- **KVL:** Algebraic sum considers voltage polarities
- **KCL:** Considers current directions (incoming vs outgoing)
- **Applications:** Circuit analysis, finding unknown values

Mnemonic

“Voltage Loops, Current Nodes” (KVL for loops, KCL for nodes)

Question 1(c OR) [7 marks]

Differentiate statically induced emf and dynamically induced emf

Solution

Table 5: Static vs Dynamic EMF

Parameter	Statically Induced EMF	Dynamically Induced EMF
Cause	Changing magnetic field	Relative motion between conductor and field
Field	Time-varying, conductor stationary	Steady field, conductor moving
Examples	Transformer, inductor	Generator, motor
Formula	$e = -N(d\Phi/dt)$	$e = BLv$
Applications	AC circuits, power supplies	Power generation, motors

Static EMF Types:

- **Self-induced:** Same coil creates and experiences flux change
- **Mutually induced:** One coil affects another coil

Dynamic EMF Factors:

- **Magnetic field strength (B):** Tesla
- **Conductor length (L):** Meters
- **Velocity (v):** m/s

Mnemonic

“Static Stays, Dynamic Dances” (Static = stationary, Dynamic = motion)

Question 2(a) [3 marks]

Explain various types of losses in transformer.

Solution

Table 7: Transformer Losses

Loss Type	Cause	Location	Characteristics
Iron Loss	Hysteresis + Eddy currents	Core	Constant, frequency dependent
Copper Loss	$I^2 R_{heating}$	Windings	Variable with load
Stray Loss	Leakage flux	Overall	Minimal

Iron Losses:

- **Hysteresis loss:** Magnetic domain reversal energy
- **Eddy current loss:** Circulating currents in core

Copper Losses:

- **Primary winding:** $I_1^2 R_1$
- **Secondary winding:** $I_2^2 R_2$

Mnemonic

“Iron Core, Copper Coil” (Location of main losses)