BEEE Unit–2 Notes

1-Phase & 3-Phase AC Circuits

Printable / Downloadable Notes for RGPV Students

UNIT–2 TOPICS COVERED

1-Phase AC Circuits

- Generation of Sinusoidal AC Voltage
- Average Value
- RMS Value
- Form Factor
- Peak Factor
- Phasor Representation
- Power Factor
- Impedance & Admittance
- Active, Reactive & Apparent Power
- R-L Circuit
- R-C Circuit
- R-L-C Series Circuit
- R-L-C Parallel Circuit

3-Phase AC Circuits

- Necessity of 3-Phase System
- Advantages of 3-Phase Supply
- Phase Sequence
- Balanced & Unbalanced Supply
- Star Connection
- Delta Connection
- Line & Phase Relationship
- Power Measurement in 3-Phase Circuits

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1. GENERATION OF SINUSOIDAL AC VOLTAGE

Definition

Alternating voltage is generated when a coil rotates in a magnetic field.

Principle

Based on Faraday’s Law of Electromagnetic Induction.

When conductor cuts magnetic flux, emf is induced.

AC Voltage Equation

$e = E_m \sin\omega t$

Where:

- e = Instantaneous emf
- Em = Maximum emf
- ω = Angular frequency
- t = Time

Waveform Characteristics

- Positive half cycle
- Negative half cycle
- One complete cycle = 360°

Applications

- Domestic supply
- Industrial supply
- Alternators

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2. AVERAGE VALUE OF AC

Definition

Average of all instantaneous values over half cycle.

Formula

$V_{avg} = 2V_m / \pi$

Important Value

Average value of sine wave:

0.637 Vm

Applications

- AC measurements
- Rectifier circuits

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3. RMS VALUE

Definition

Equivalent DC value producing same heating effect.

Formula

$V_{rms} = V_m / \sqrt{2}$

Important Value

RMS value = 0.707 Vm

Applications

- AC power calculations
- Electrical ratings

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4. FORM FACTOR

Definition

Ratio of RMS value to average value.

Formula

Form Factor = Vrms / Vavg

Value for Sine Wave

1.11

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5. PEAK FACTOR

Definition

Ratio of maximum value to RMS value.

Formula

Peak Factor = Vm / Vrms

Value for Sine Wave

1.414

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6. PHASOR REPRESENTATION

Definition

Phasor is rotating vector representing sinusoidal quantity.

Importance

- Simplifies AC calculations
- Represents phase difference

Applications

- AC circuit analysis
- Power systems

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7. POWER FACTOR

Definition

Cosine of angle between voltage and current.

Formula

Power Factor = cosφ

Types

Lagging Power Factor

Occurs in inductive circuits.

Leading Power Factor

Occurs in capacitive circuits.

Advantages of High Power Factor

- Less losses
- Better efficiency
- Reduced current

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8. IMPEDANCE AND ADMITTANCE

Impedance

Definition

Total opposition offered by AC circuit.

Formula

$Z = R + jX$

Unit

Ohm (Ω)

Admittance

Definition

Reciprocal of impedance.

Formula

Y = 1/Z

Unit

Siemens

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9. ACTIVE, REACTIVE & APPARENT POWER

Active Power

Actual useful power consumed.

Formula

P = VI cosφ

Unit = Watt

Reactive Power

Power stored and returned.

Formula

$Q = VI \sin\varphi$

Unit = VAR

Apparent Power

Total supplied power.

Formula

$S = VI$

Unit = VA

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10. R-L SERIES CIRCUIT

Components

- Resistance
- Inductance

Characteristics

- Current lags voltage
- Lagging power factor

Impedance

$Z = \sqrt{(R^2 + XL^2)}$

Phase Angle

$\text{Tan}\varphi = XL / R$

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11. R-C SERIES CIRCUIT

Characteristics

- Current leads voltage
- Leading power factor

Impedance

$Z = \sqrt{(R^2 + XC^2)}$

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12. R-L-C SERIES CIRCUIT

Components

- Resistance
- Inductance
- Capacitance

Impedance

$Z = \sqrt{(R^2 + (XL - XC)^2)}$

Resonance Condition

$XL = XC$

Applications

- Radio tuning
- Filters

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13. THREE PHASE SYSTEM

Definition

System containing three AC voltages 120° apart.

Necessity

- Efficient transmission
- Constant power

Advantages

- Less conductor material
- Better efficiency
- Smooth motor operation

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14. PHASE SEQUENCE

Definition

Order in which phase voltages attain maximum value.

Importance

- Motor rotation direction
- Proper system operation

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15. BALANCED & UNBALANCED SYSTEM

Balanced System

Equal voltages and equal phase difference.

Unbalanced System

Unequal voltages or unequal loads.

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16. STAR CONNECTION

Characteristics

- Neutral available
- Lower insulation

Relationship

VL = $\sqrt{}$3 Vph

IL = Iph

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17. DELTA CONNECTION

Characteristics

- No neutral wire
- Suitable for heavy loads

Relationship

VL = Vph

$I_L = \sqrt{3}\, I_{ph}$

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18. POWER IN THREE PHASE CIRCUIT

Formula

$P = \sqrt{3}\, V_L I_L \cos\varphi$

Applications

- Industrial motors
- Power transmission

MOST IMPORTANT 14 MARK QUESTIONS

1. Explain generation of sinusoidal AC voltage.
2. Define RMS value, average value, form factor and peak factor.
3. Explain power factor and its importance.
4. Explain impedance and admittance.
5. Explain active, reactive and apparent power.
6. Explain R-L, R-C and R-L-C series circuits.
7. Explain three phase AC system.
8. Differentiate balanced and unbalanced system.
9. Explain star and delta connection.
10. Derive relationship between line and phase quantities.

IMPORTANT NUMERICALS

1. RMS value calculation
2. Form factor calculation
3. Peak factor calculation
4. Impedance calculation
5. Power factor calculation
6. RLC circuit numerical
7. Three phase power calculation

QUICK REVISION FORMULAS

Vrms = Vm / √2

Power Factor = cosφ

P = √3 VL IL cosφ

EXAM TIPS

✅ Practice phasor diagrams

✅ Learn formulas properly

✅ Practice RLC numericals

✅ Remember star-delta relationships

✅ Solve previous year questions

END OF UNIT–2 NOTES