RGIT FE-SAHYOG

Basic Electrical Engineering Module-wise Essential Questions Bank

📢Important Note Regarding Basic Electrical Engineering Question Bank

Dear First-Year Engineering Students,

We are pleased to provide you with a carefully prepared Basic Electrical Engineering Question Bank based on the analysis of past year question papers (PYQs) adhering to the NEP 2020 syllabus.

Please read this **caution** carefully:

1. **Reference Material Only:** This Question Bank is solely for reference and practice purposes. It is designed to highlight the most frequently tested concepts and question structures from the past.
2. **No Guarantee:** There is absolutely no guarantee that the questions in the upcoming examination will be drawn *exclusively* from this set.
3. **Comprehensive Preparation is Key:** High scores are achieved by mastering the entire syllabus (Modules I through VI), understanding the underlying concepts, and practising both derivations and numerical problems.
4. **Do check PYQs for questions that are not given here**

Our recommendation is to **use this Question Bank as a guide to:**

- **Identify High-Priority Topics** (Given in stars).
- **Master the Standard Derivations** (5-mark questions) and practice solving **Numericals** (3-mark and 5-mark questions).

Do not limit your study to these questions alone. Ensure you cover all the concepts listed in the Basic Electrical Engineering syllabus for complete and thorough preparation.

Read the question bank till the **Last Page** for maximum benefit.

Best of luck with your studies!

Made With 🩷 By,
Team FE SAHYOG

***Terms and Conditions applied**

List of IMP/Frequent Questions Module Wise

Module 1: DC Circuits (High Priority), Numerical Problems (Most Frequent)

1. **Nodal Analysis**
   Determine the current traversing a specified branch (e.g., a 4 Ohm resistor) within a given DC network through the application of nodal analysis.
2. **Superposition Theorem**
   Employ the superposition theorem to ascertain the voltage across or current through a designated element in a linear DC circuit comprising multiple independent sources.
3. **Norton's Theorem**
   Utilize Norton's theorem to calculate the current flow through a given load resistance connected across a complex DC network.
4. **Star–Delta / Delta–Star Conversion (Numerical)**
   Convert a given resistive network between Star (Y) and Delta (Δ) configurations and subsequently calculate the equivalent resistance between specified terminals.

Theoretical Questions

1. **Maximum Power Transfer Theorem**
   State and formally prove the Maximum Power Transfer Theorem. Derive the mathematical expression for the maximum power transferred and deduce the formula for (P_{max}).
2. **Star–Delta and Delta–Star Transformation**
   Provide the standard formulas governing the Star-to-Delta and Delta-to-Star transformations.

Module 2: AC Circuits (Critical Priority), Numerical Problems

1. **Series R–L–C Circuit**
   For a specified series RLC circuit energized by an AC voltage source, compute the following parameters:
   (a) Impedance (Z)
   (b) Circuit current (I)
   (c) Power factor (p.f.)
   (d) Total power consumption (P).
2. **3-Phase Star-Connected Load**
   A balanced three-phase star-connected load is supplied with a given line voltage (V_L) and impedance per phase (Z_{ph}). Calculate:

(a) Phase voltage
(b) Line current
(c) Total power consumed.

3. **AC Waveforms**
   Given an alternating current represented by ($i = I_m \sin(\omega t)$):
   (a) Determine the instantaneous value of current at time ($t = x$) ms.
   (b) Calculate the time elapsed required for the current to attain a specified value.
4. **Parallel AC Circuit**
   For a parallel AC circuit consisting of two branches, determine:
   (a) Total admittance (Y)
   (b) Total circuit current.

Theoretical Questions

1. **Resonance in Series RLC Circuit**
   Derive the mathematical expression for the resonant frequency (f_r) of a series RLC circuit. State the necessary condition for the occurrence of resonance.
2. **Series vs Parallel Resonance**
   Provide a comparative analysis of series resonance and parallel resonance. Illustrate and explain the impedance versus frequency characteristics pertinent to both phenomena.

Module 3: Transformers

Theoretical Questions

1. **EMF Equation of Transformer**
   Elucidate the operational principle of a single-phase transformer and derive its Electromotive Force (EMF) equation.
2. **Losses in a Transformer**
   Explain the various forms of energy losses that occur within a transformer, specifically:
   (a) Core (Iron) losses
   (b) Copper losses
   Furthermore, describe the relationship between these losses and the load applied to the transformer.

Numerical Problem

1. **Transformer Calculations**
   A transformer possesses N_1 primary turns and N_2 secondary turns. Given the primary voltage and the transformer's rating, calculate:

(a) Secondary voltage
(b) Full-load current on the secondary side.

Module 4: Electrical Machines

Theoretical Questions

1. **Three-Phase Induction Motor**
   Explain the fundamental working principle of a three-phase induction motor, incorporating the concept of the Rotating Magnetic Field (RMF).
2. **Brushless DC Motor (BLDC)**
   Describe the construction and operating mechanism of a Brushless DC Motor (BLDC). (Highly relevant to the NEP syllabus).
3. **Back EMF in DC Motor**
   Explain the phenomenon of Back Electromotive Force (Back EMF) in a DC motor and articulate its operational significance.
4. **Commutator and Brushes**
   State the specific functions of the commutator and brushes within the operation of a DC machine.

Module 5: Electronics – DiodesTheoretical Questions

1. **Zener Diode Characteristics**
   Sketch and provide a detailed explanation of the Voltage–Current (V–I) characteristics of a Zener diode.
2. **Zener Diode as Voltage Regulator**
   Explain the application of a Zener diode in its capacity as a voltage regulator, supported by a clear circuit diagram.
3. **Light Emitting Diode (LED)**
   Illustrate the construction of an LED, enumerate the materials typically utilized, and discuss its primary applications.

Module 6: Electronics – TransistorsTheoretical Questions

1. **BJT as a Switch**
   Explain the operational behavior of a Bipolar Junction Transistor (BJT) when functioning as a switch, detailing the cut-off and saturation regions.
2. **BJT as an Amplifier**
   Explain the functional principle of a BJT operating as an amplifier, employing the Common Emitter (CE) configuration.
3. **Comparison of BJT and FET**
   Differentiate between the BJT and the Field Effect Transistor (FET) based on criteria such as construction, operation, input/output impedance, and typical applications.

Solution

Module 1

Q1. Maximum Power Transfer Theorem

Statement

- The **Maximum Power Transfer Theorem** states that:
  Maximum power is transferred from a source to the load when the load resistance is equal to the internal resistance (or Thevenin resistance) of the source network.

Explanation

- Consider a linear bilateral DC network replaced by its **Thevenin equivalent** consisting of:
  - Thevenin voltage (V_{th})
  - Thevenin resistance (R_{th})
- A variable load resistance (R_L) is connected across the Thevenin equivalent terminals.

Circuit Parameters

- Current through load:

  $I = Vth/Rth + RL$

- Power delivered to the load:

  $$P_L = I^2 R_L = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 R_L$$ `[5]

Proof of Theorem

- Power transferred to the load is:

$$P_L = \frac{V_{th}^2 R_L}{(R_{th} + R_L)^2}$$

- To find the condition for maximum power, differentiate (P_L) with respect to (R_L):

$$\frac{dP_L}{dR_L} = 0$$

- Solving the above condition gives:

$$R_L = R_{th}$$

Hence proved that maximum power transfer occurs when load resistance equals source resistance.

Maximum Power Formula

- Substitute (R_L = R_{th}) in power equation:

$$P_{max} = \frac{V_{th}^2}{4R_{th}}$$

Important Observations

- Efficiency at maximum power transfer is **50%**.
- Half of the power is dissipated in the source resistance.
- The theorem is mainly used in:
  - Communication systems
  - Impedance matching

Limitations

- Not suitable for power systems due to low efficiency.
- Practical systems prefer higher efficiency rather than maximum power.

RGIT FE-SAHYOG

Q2. Star–Delta and Delta–Star Transformation

Introduction

- **Star (Y)** and **Delta (Δ)** transformations are used to simplify complex resistor networks that cannot be reduced using series–parallel combinations.

(A) Star to Delta (Y–Δ) Transformation

Star Network

- Resistances: (R_A, R_B, R_C)
- Connected to three terminals A, B, and C.

Delta Equivalent Resistances

- Resistance between terminals:

$$R_{AB} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C}$$

$$R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_{CA} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

Applications

- Used in bridge circuits
- Useful when star-connected resistors prevent direct simplification

(B) Delta to Star (Δ–Y) Transformation

Delta Network

- Resistances: (R_{AB}, R_{BC}, R_{CA})

Star Equivalent Resistances

$$R_A = \frac{R_{AB}R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

$$R_B = \frac{R_{AB}R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$$

$$R_C = \frac{R_{BC}R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

Advantages

- Simplifies complex resistive networks
- Reduces calculation effort
- Commonly used in DC circuit analysis

Conclusion

- Star–Delta transformations are powerful tools in DC circuit analysis.
- They help in converting non-series–parallel networks into simpler equivalent circuits.
- Essential for solving network problems efficiently.

Module 2

Q1. Series R–L–C Circuit

Introduction

- A **series RLC circuit** consists of a resistor (R), inductor (L), and capacitor (C) connected in series to an AC supply.
- The same current flows through all components, but the voltage across each component differs in phase.

Impedance of Series RLC Circuit

- Inductive reactance:

$$X_L = \omega L$$

- Capacitive reactance:

$$X_C = \frac{1}{\omega C}$$

- Net reactance:

$$X = X_L - X_C$$

- Total impedance:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Current in the Circuit

- Circuit current is given by:

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

Power Factor

- Power factor is defined as the cosine of the phase angle between voltage and current.
- Expression:

$$\cos\phi = \frac{R}{Z}$$

- Nature of power factor:
  - Lagging if ($X_L > X_C$)
  - Leading if ($X_C > X_L$)
  - Unity at resonance

Power Consumed

- Average power consumed:

$$P = VI\cos\phi = I^2R$$

- Only the resistor dissipates power.

Phasor Diagram Explanation

- Voltage across R is in phase with current.
- Voltage across L leads current by 90°.
- Voltage across C lags current by 90°.

Q2. Resonance in Series RLC Circuit

Definition of Resonance

- Resonance occurs when inductive reactance equals capacitive reactance:

$$X_L = X_C$$

Derivation of Resonant Frequency

- At resonance:

$$\omega L = \frac{1}{\omega C}$$

- Solving for angular frequency:

$$\omega_r = \frac{1}{\sqrt{LC}}$$

- Resonant frequency:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Conditions at Resonance

- Impedance is minimum and equals resistance (Z = R).
- Circuit current is maximum.
- Power factor is unity.
- Reactive power is zero.

Applications of Resonance

- Radio and TV tuning circuits
- Frequency selective circuits
- Communication systems

Q3. Series Resonance vs Parallel Resonance

Series Resonance

- Occurs in series RLC circuits.
- Impedance is minimum at resonance.

- Current is maximum.
- Acts as an **acceptor circuit**.

Parallel Resonance

- Occurs in parallel RLC circuits.
- Impedance is maximum at resonance.
- Line current is minimum.
- Acts as a **rejector circuit**.

Comparison Table

Parameter	Series Resonance	Parallel Resonance
Impedance at resonance	Minimum	Maximum
Current	Maximum	Minimum
Power factor	Unity	Unity
Application	Tuning	Filters

Impedance vs Frequency Curve

- Series resonance curve shows minimum Z at resonant frequency.
- Parallel resonance curve shows maximum Z at resonant frequency.

Q4. Three-Phase Star Connected Load

Introduction

- In a star (Y) connection, one end of each phase is connected to a common neutral point.

Line and Phase Quantities

- Relationship between line voltage and phase voltage:

$$V_L = \sqrt{3}V_{ph}$$

- Relationship between line current and phase current:

$$I_L = I_{ph}$$

Power in Three-Phase System

- Total power consumed:

$$P = \sqrt{3}V_L I_L \cos\phi$$

Advantages of Star Connection

- Lower insulation requirement
- Suitable for high-voltage transmission
- Neutral wire availability

Q5. AC Waveforms and Instantaneous Values

Sinusoidal AC Quantity

- General equation:

$$i = I_m \sin(\omega t)$$

Important Terms

- Maximum value (Im)
- RMS value: $I_{rms} = \frac{I_m}{\sqrt{2}}$
- Average value: $I_{avg} = \frac{2I_m}{\pi}$

Significance

- Instantaneous value helps in analyzing transient behavior.
- RMS value represents effective DC equivalent.

Q6. Parallel AC Circuit

Introduction

- In a parallel AC circuit, voltage across all branches is the same, but currents differ.

Admittance Concept

- Admittance is reciprocal of impedance:

$$Y = \frac{1}{Z} = G + jB$$

Total Admittance

- Total admittance is the sum of individual branch admittances:

$$Y_T = Y_1 + Y_2$$

Advantages

- Easy current calculation
- Widely used in AC power systems

RGIT
FE-SAHYOG

MODULE 3

Q1. Working Principle and EMF Equation of a Single-Phase Transformer

Introduction

- A **transformer** is a static electrical device that transfers electrical energy from one circuit to another without any direct electrical connection.
- It works on the principle of **mutual induction**.
- Transformers are widely used in power systems for stepping up or stepping down voltage levels during transmission and distribution.

Working Principle

- When an alternating voltage is applied to the **primary winding**, an alternating current flows.
- This current produces an alternating magnetic flux in the transformer core.
- The alternating flux links both primary and secondary windings.
- According to **Faraday's Law of Electromagnetic Induction**, an EMF is induced in both windings.
- Since the secondary circuit is closed, current flows and power is transferred.

Derivation of EMF Equation

- Let:
  - N_1 = Number of primary turns
  - N_2 = Number of secondary turns
  - ϕ_m = Maximum flux (Wb)
  - f = Frequency of supply (Hz)
- RMS value of induced EMF in primary winding:

$$E_1 = 4.44 f N_1 \phi_m$$

- RMS value of induced EMF in secondary winding:

$$E_2 = 4.44 f N_2 \phi_m$$

Voltage Transformation Ratio

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

Q2. Losses in a Transformer and Their Variation with Load

Introduction

- No transformer is 100% efficient due to various losses occurring during operation.
- These losses reduce the efficiency and cause heating of the transformer.
- Transformer losses are mainly classified into **Core (Iron) losses** and **Copper losses**.

1. Core (Iron) Losses

- Occur in the transformer core due to alternating magnetic flux.
- Independent of load.

(a) Hysteresis Loss

- Caused due to repeated magnetization and demagnetization of the core.
- Depends on frequency and maximum flux density.

(b) Eddy Current Loss

- Caused due to circulating currents induced in the core.
- Reduced by using laminated silicon steel cores.

2. Copper Losses

- Occur due to resistance of primary and secondary windings.
- Given by:

$$P_{cu} = I^2 R$$

- Copper losses **vary with square of load current**.

Variation of Losses with Load

- Core losses remain constant.
- Copper losses increase with increase in load.
- Total losses are minimum near rated load.

MODULE 4

Q1. Working Principle of a Three-Phase Induction Motor (RMF Concept)

Introduction

- A **three-phase induction motor** is the most widely used electrical motor in industrial applications.
- It is rugged, simple in construction, and requires low maintenance.
- Its operation is based on the principle of **electromagnetic induction**.

Rotating Magnetic Field (RMF)

- When a three-phase AC supply is applied to the stator windings:
  - Three currents flow with phase difference of 120°.
  - These currents produce three alternating magnetic fields.
- The combined effect produces a **rotating magnetic field** at synchronous speed.

Working Principle

- The rotating magnetic field cuts the rotor conductors.
- EMF is induced in the rotor conductors.
- Due to closed rotor circuit, rotor current flows.
- Interaction between rotor current and stator flux produces torque.
- Rotor starts rotating in the same direction as RMF.

Synchronous Speed

$$N_s = \frac{120f}{P}$$

- Where:
  - (f) = supply frequency
  - (P) = number of poles

Q2. Construction and Working of Brushless DC Motor (BLDC)

Introduction

- A **Brushless DC Motor (BLDC)** is an advanced type of motor that operates without brushes and mechanical commutators.
- It offers high efficiency, long life, and precise speed control.
- BLDC motors are increasingly popular under the **NEP curriculum**.

Construction

- **Stator**: Contains three-phase windings.
- **Rotor**: Made of permanent magnets.
- **Electronic Controller**: Replaces mechanical commutator.

Working Principle

- DC supply is given to electronic controller.
- Controller converts DC to AC and energizes stator windings sequentially.
- This creates a rotating magnetic field.
- Rotor follows the rotating field producing motion.

Advantages

- High efficiency
- No sparking
- Low maintenance
- Compact size

Applications

- Electric vehicles
- Drones
- Computer cooling fans
- Robotics

Q3. Back EMF in a DC Motor

Introduction

- In a DC motor, an EMF is induced in the armature when it rotates in a magnetic field.
- This induced EMF opposes the applied voltage and is known as **Back EMF**.

Expression for Back EMF

$$E_b = V - I_a R_a$$

Significance of Back EMF

- Limits armature current
- Provides self-regulation
- Improves efficiency

Q4. Function of Commutator and Brushes in a DC Machine

Introduction

- DC machines use commutator and brushes for current reversal and collection.

Commutator

- Converts AC induced in armature to DC output.
- Ensures unidirectional torque.

Brushes

- Provide electrical connection between rotating armature and external circuit.
- Made of carbon or graphite.

MODULE 5

Q1. V–I Characteristics of a Zener Diode

Introduction

- A **Zener diode** is a special type of PN junction diode designed to operate in the **reverse breakdown region**.
- Unlike ordinary diodes, it is heavily doped and can safely allow current in the reverse direction.
- Zener diodes are widely used for **voltage regulation and protection** in electronic circuits.

Construction of Zener Diode

- Heavily doped PN junction.
- Thin depletion layer.
- Sharp and well-defined breakdown voltage.

V–I Characteristics

Forward Bias Region

- Acts like a normal PN junction diode.
- Current increases rapidly after cut-in voltage (~0.7 V for silicon).

Reverse Bias Region

- Very small leakage current flows initially.
- At breakdown voltage (V_Z), current increases sharply.
- Voltage across the diode remains nearly constant.

Zener Breakdown Mechanism

- Occurs due to strong electric field.
- Electrons break free from covalent bonds.
- Results in large reverse current without damage.

Applications

- Voltage regulators
- Over-voltage protection
- Reference voltage source

Q2. Zener Diode as a Voltage Regulator

Introduction

- Voltage regulation is essential to protect electronic components from voltage fluctuations.
- A Zener diode is commonly used as a **shunt voltage regulator**.

Circuit Description

- Zener diode connected in reverse bias across the load.
- Series resistor limits current.
- Input voltage variations are absorbed by Zener diode.

Working Principle

- When input voltage increases:
  - Zener conducts more current.
  - Excess voltage is dropped across series resistor.
- When input voltage decreases:
  - Zener current reduces.
  - Load voltage remains constant.

Advantages

- Simple and economical
- Reliable voltage regulation
- Fast response

Limitations

- Low efficiency
- Suitable only for low power applications

Applications

- Power supplies
- Voltage stabilizers
- Electronic instruments

Q3. Light Emitting Diode (LED)

Introduction

- A **Light Emitting Diode (LED)** is a semiconductor device that emits light when forward biased.
- It operates on the principle of **electroluminescence**.

Construction

- PN junction made of compound semiconductors.
- Transparent epoxy casing.
- Reflector cup for enhanced brightness.

Materials Used

- Gallium Arsenide (GaAs)
- Gallium Phosphide (GaP)
- Gallium Arsenide Phosphide (GaAsP)

Working Principle

- Electrons recombine with holes.
- Energy released in the form of photons.
- Color depends on energy band gap.

Applications

- Indicator lamps
- Display panels
- Street lighting
- Optical communication

MODULE 6

Q1. BJT as a Switch

Introduction

- A **Bipolar Junction Transistor (BJT)** can operate as an electronic switch.
- It works in **cut-off and saturation regions**.
- Widely used in digital circuits and power control applications.

Cut-Off Region

- Base-emitter junction is not forward biased.
- Collector current is zero.
- Transistor behaves like an open switch.

Saturation Region

- Both junctions are forward biased.
- Maximum collector current flows.
- Transistor behaves like a closed switch.

Applications

- Relay driving
- Logic circuits
- Power switching

Q2. BJT as an Amplifier (Common Emitter Configuration)

Introduction

- Amplification is the process of increasing signal strength.
- The **Common Emitter (CE)** configuration is most widely used due to high gain.

Circuit Description

- Input applied between base and emitter.
- Output taken between collector and emitter.
- Emitter is common to both input and output.

Working Principle

- Small base current controls large collector current.
- Results in amplified output signal.
- Output voltage is 180° out of phase with input.

Characteristics

- High voltage gain
- Moderate current gain
- Medium input impedance

Applications

- Audio amplifiers
- Signal processing circuits

Q3. Difference between BJT and FET

Introduction

- BJTs and FETs are widely used semiconductor devices.
- They differ in construction, operation, and applications.

No.	BJT (Bipolar Junction Transistor)	FET (Field Effect Transistor)
1.	BJT is a **current-controlled device**.	FET is a **voltage-controlled device**.
2.	Conduction takes place due to **both electrons and holes** (bipolar).	Conduction takes place due to **only one type of charge carrier** (unipolar).
3.	Input current is **base current**.	Input is **gate voltage**, ideally zero current.
4.	Has **low input impedance**.	Has **very high input impedance**.
5.	Power consumption is **high** due to base current.	Power consumption is **very low**.

6.	Temperature stability is **poor** (risk of thermal runaway).	Temperature stability is **better**.
7.	Noise level is **high**.	Noise level is **low**.
8.	Switching speed is **comparatively slower**.	Switching speed is **faster**.
9.	Gain depends on **collector current**.	Gain depends on **gate voltage**.
10.	Requires **biasing current** continuously.	Requires **negligible biasing current**.
11.	Used mainly in **high-gain amplifiers**.	Used in **low-noise and high-impedance circuits**.
12.	Examples: NPN, PNP transistors.	Examples: JFET, MOSFET.

RGIT FE-SAHYOG

Sample Question Paper For practice

Instructions for Practice Examination:

- **Time Allocation:** Allocate a strict time limit of **2 Hours**.
- **Assessment Goal:** Attempt Question 1 (Mandatory) and any Three from the remaining set of questions.
- **Format Simulation:** This examination structure is designed to replicate the format of the June 2025 and Dec 2024 NEP question papers.

Paper / Subject Code: Basic Electrical & Electronics Engineering (NEP 2020)

Time: 2 Hours

Max Marks: 60

N.B.:

1. Question No. 1 is **Mandatory**.
2. Candidates are required to attempt any **THREE** questions from the remaining five questions.
3. The numerical values on the right-hand side indicate the full marks assigned to each question/sub-question.
4. Assume appropriate data where necessary.

Q.1 Answer any FIVE of the following (3 marks each): [15 M]

(a) State the formulas for Star to Delta transformation.

(b) An alternating current is specified by i = 14.14 sin(314t). Determine the maximum value, frequency, and RMS value.

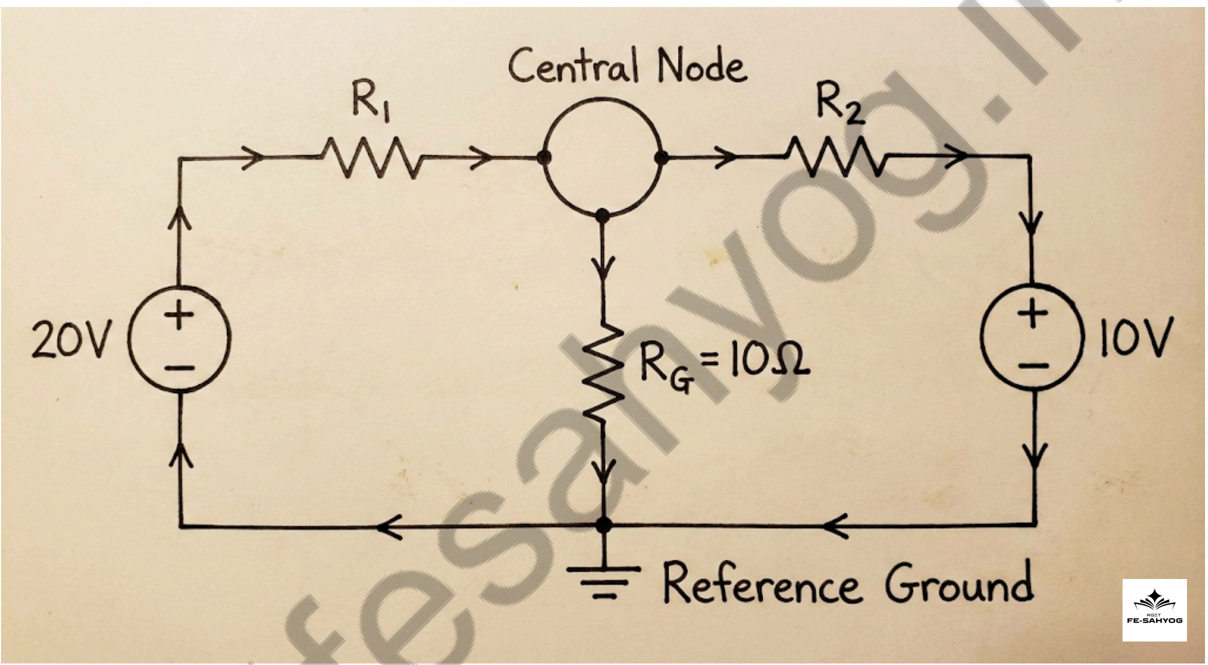
(c) Identify the losses present in a single-phase transformer. Discuss the factors upon which these losses are dependent.

(d) Explain the underlying concept of Back EMF in a DC Motor.

(e) Draw the constructional diagram of an LED and list two of its common applications.

Q.2 [15 M]

(a) Employing Nodal Analysis, calculate the current flowing through the 10 Ohm resistor in the circuit illustrated below. [8 M]



(b) Explain the operational principle of a **3-Phase Induction Motor**. Justify why it is classified as an asynchronous motor. **[7 M]**

Q.3 [15 M]

(a) A coil with a resistance of 10 Ohm and an inductance of 0.05H is connected in series with a capacitor of 100 μF across a 230V, 50Hz supply.

Calculate: (i) Impedance, (ii) Current, (iii) Power Factor, (iv) Total Power consumed. [8 M]

(b) Explain the application of a **Zener Diode as a voltage regulator** with the aid of a neat circuit diagram. **[7 M]**

Q.4 [15 M]

(a) State and formally prove the **Maximum Power Transfer Theorem**. Derive the mathematical expression for the maximum power output (P_{max}). **[6 M]**

(b) With the assistance of a clear circuit diagram, explain the operation of a **BJT as a Switch**. **[4 M]**

(c) Derive the expression for the **Resonant Frequency** in a series R-L-C circuit. Sketch the graphical representation of the variation of Impedance with respect to frequency. **[5 M]**

Q.5 [15 M]

(a) Derive the **EMF equation** of a single-phase transformer. **[5 M]**

(b) Explain the construction and working principle of a **Brushless DC (BLDC) Motor**. **[5 M]**

(c) Three identical coils, each having a resistance of 8 Ohm and an inductive reactance of 6 Ohm, are connected in a Star configuration across a 400V, 50Hz 3-phase supply. Calculate:

(i) Phase Voltage, (ii) Phase Current, (iii) Line Current, (iv) Total Power. [5 M]

Q.6 [15 M]

(a) Using the Superposition Theorem, determine the current flowing through the 5 Ohm resistor. [6 M]

(Diagram to be inserted: A circuit containing a 50V source on the left, a 5A current source on the right, with the 5 Ohm resistor positioned between them).

(b) Differentiate between **BJT and FET** (Specify any 4 key points). **[4 M]**

(c) A resistance of 20 Ohm and an inductance of 0.2H are connected in parallel across a 200V, 50Hz supply. Determine the total current and the circuit power factor. **[5 M]**

Top 20 Most Important & Frequent Questions

These are categorized by frequency (repeated topics) and importance (high marks).

Category A: Repeated / Guaranteed Questions (Appear in almost every paper)

These questions appeared in **both** Dec 2024 and May 2025 in slightly different forms.

1. Working Principle of 3-Phase Induction Motor

- *Dec 2024, Q2b:* "Explain the working principle of three phase induction motor."
- *May 2025, Q2b:* "Explain the working principle of three phase induction motor and mention its types." [2]

2. Single Phase Transformer: Principle & Equations

- *Dec 2024, Q5a:* "Explain the working principle and transformation ratio of a single-phase transformer." [3]
- *May 2025, Q5a:* "Explain the working principle of single phase transformer and derive the EMF equation." [4]

3. BLDC Motor

- *Dec 2024, Q5b:* "Write short note on... BLDC motor."
- *May 2025, Q5b:* "Explain the working principle of Brushless DC Motor."

4. Zener Diode Applications

- *Dec 2024, Q3b:* "Draw and explain the V-I characteristics of a Zener diode."
- *May 2025, Q3b:* "Explain the application of Zener diode as a voltage regulator."

5. LED (Light Emitting Diode)

- *Dec 2024, Q1e:* "Write applications of LED."
- *May 2025, Q1e:* "Draw and explain the construction diagram of LED and enlist the applications."

6. Nodal Analysis (Circuit Numerical)

- *Dec 2024, Q6a:* "Find current flowing through resistance by Node analysis."
- *May 2025, Q4a:* "Find the current through 4Ω resistance using Nodal analysis"

7. Resonance in AC Circuits

- *Dec 2024, Q6b:* "State the necessary condition for resonance in a series circuit. Compare series and parallel resonance."
- *May 2025, Q4c:* "What is the necessary condition for resonance in a series circuit? Derive an expression for resonance frequency."

8. BJT Applications (Amplifier vs Switch)

- *Dec 2024, Q4b:* "Explain the application of BJT as an amplifier."
- *May 2025, Q4b:* "With the help of a neat circuit diagram explain the operation of a BJT as a switch."

9. 3-Phase Circuit Numerical (Star Load)

- *Dec 2024, Q4a:* "Three similar coils... connected in star... Calculate (i) line current and (ii) active and reactive power" [17]
- *May 2025, Q5c:* "A balanced 3-ϕ, star connected load... Determine 1) Phase impedance 2) Phase voltage... 5) Power factor" [18]

10. Star-Delta Transformations

- *Dec 2024, Q1a:* "Write formulas for Delta to Star and Star to Delta transformation." [19]
- *May 2025, Q1a:* "Convert the star circuit into its equivalent delta circuit" [20]

Category B: High Value Topics (Distinct questions from each paper)

These cover the remaining crucial parts of the syllabus (Theorems & AC Fundamentals).

11. Superposition Theorem (Numerical)

- *Dec 2024, Q2a:* "Using Superposition theorem, find voltage across 4Ω resistor."

12. Norton's Theorem (Numerical)

- *May 2025, Q2a:* "Using Norton's theorem, calculate the current through 3Ω resistor across the terminals A and B in the given circuit."

13. Maximum Power Transfer Theorem

- *Dec 2024, Q4c:* "State and prove the Maximum power transfer theorem. Derive the formula of Maximum power delivered."

14. Single Phase AC Series Circuit (Numerical)

- *May 2025, Q3a:* "An inductive coil... connected is series with another inductive coil... Calculate the power dissipation in each coil and total power factor"

15. Single Phase AC Parallel Circuit (Numerical)

- *Dec 2024, Q5c:* "Two impedances... are connected in parallel... Find admittance, current and power factor of each branch."

16. Source Transformation (Numerical)

- *May 2025, Q6a:* "Using source transformation find the current flowing the 8Ω resistance"

17. DC Motor Concepts (Back EMF / Construction)

- *May 2025, Q1c:* "Explain the concept of back emf in a DC motor."
- *Dec 2024, Q1d:* "State the function of each constructional part of a DC motor."

18. Transformer Losses & Efficiency

- *May 2025, Q1d:* "What are the losses in a single-phase transformer?"

- *Dec 2024, Q1c:* "What is the efficiency of transformer?"

19. FET vs BJT

- *Dec 2024, Q6c:* "Write a short note on FET."
- *May 2025, Q6c:* "Differentiate between BJT and FET."

20. 3-Phase Relations (Theory)

- *May 2025, Q1b:* "Write down the relation between line current and phase current, line voltage and phase voltage, power in balanced three phase delta connected balanced load."