

Electrical Machines And Transformers Workbook

Electrical Machines And Transformers

Electrical Machines and Transformers: Understanding Their Role in Modern Electrical Systems

electrical machines and transformers are fundamental components in the world of

electrical engineering and power systems. These devices play a pivotal role in converting energy from one form to another and ensuring the efficient distribution of electrical power. Whether it's the electric motors that power household appliances or the transformers that enable electricity to travel vast distances, understanding these machines provides insight into the backbone of our modern electrical infrastructure.

The Essentials of Electrical Machines

Electrical machines are devices that convert electrical energy into mechanical energy or vice versa. Broadly, they are categorized into two main types: motors and generators. Both types rely on the interaction between magnetic fields and current-carrying conductors to perform their respective functions.

Types of Electrical Machines

Electric Motors: These machines convert electrical energy into mechanical energy.

1.

They are widely used in industrial applications, household appliances, electric vehicles, and robotics.

Generators: Generators work in the opposite manner, transforming mechanical

2.

energy into electrical energy. They are essential in power plants where turbines drive generators to produce electricity.

Special Purpose Machines: This category includes devices like transformers,

3.

which while technically not rotating machines, play a crucial role in power systems.

How Electric Motors Work

Electric motors operate on the principle of electromagnetism. When current flows through a coil placed in a magnetic field, it experiences a force that causes it to rotate. This rotational motion can then be harnessed to drive machinery or tools. Motors are classified based on their power source (AC or DC), construction (synchronous or asynchronous), and application.

Generators and Their Importance

Generators are vital for producing electricity on a large scale. The mechanical input, often from steam turbines, hydro turbines, or internal combustion engines, rotates the generator's rotor. This motion induces an electromotive force (EMF) in the stator windings, producing electrical power. Advances in generator design have led to higher efficiency

and reduced losses, making power generation more sustainable.

The Critical Role of Transformers in Power Systems

Transformers are electrical devices designed to change the voltage levels in AC power systems without altering the frequency. Unlike motors and generators, transformers do not have moving parts, but their impact on electrical networks is immense.

Understanding Transformer Operation

A transformer consists of two or more coils of wire wound around a magnetic core. When an alternating current passes through the primary coil, it creates a changing magnetic field. This changing field induces a voltage in the secondary coil. The ratio of turns between the primary and secondary coils determines whether the voltage is stepped up or stepped down.

Why Transformers Are Indispensable

In power transmission, electricity generated at power plants is stepped up to high voltages using transformers to minimize losses over long distances. Upon reaching the consumption areas, transformers step down the voltage to safer, usable levels for homes and industries. This ability to efficiently change voltage levels makes transformers an essential part of electrical grids worldwide.

Types of Transformers

Step-up Transformer: Increases voltage from primary to secondary coil.

1.

Step-down Transformer: Decreases voltage from primary to secondary coil.

2.

Isolation Transformer: Provides electrical isolation without changing voltage

3.

levels, enhancing safety.

Autotransformer: Shares part of the winding for both primary and secondary,

4.

offering a compact design for certain applications.

Efficiency and Performance Considerations

Both electrical machines and transformers must be designed and operated with efficiency

in mind. Energy losses in these devices translate to higher operational costs and

increased environmental impact.

Common Losses in Electrical Machines

Copper Losses: Caused by the resistance of the windings, leading to heat

generation.

Iron Losses: Occur in the magnetic core due to hysteresis and eddy currents.

Mechanical Losses: Include friction and windage in rotating parts.

Design improvements such as using high-grade magnetic materials and precision

manufacturing help reduce these losses.

Transformer Losses and Improvements

Transformers primarily experience:

Core Losses: Due to magnetization and demagnetization of the core.

Copper Losses: Heat generated in the winding resistance.

Using laminated silicon steel cores and advanced conductor materials enhances transformer efficiency. Modern transformers also incorporate cooling systems to maintain optimal operating temperatures.

Applications of Electrical Machines and Transformers

The versatility of electrical machines and transformers allows them to be used in numerous fields:

Industrial Applications

Electric motors drive conveyor belts, pumps, compressors, and machine tools, forming the backbone of manufacturing processes. Transformers enable the distribution of electrical power within plants at appropriate voltage levels.

Consumer Electronics and Appliances

Transformers are found in chargers and adapters, adjusting voltage for sensitive electronic devices. Motors power washing machines, fans, refrigerators, and HVAC systems.

Renewable Energy Systems

Wind turbines and hydroelectric generators rely on electrical machines to convert natural energy into electricity. Transformers then step up the voltage for grid transmission, supporting sustainable energy initiatives.

Tips for Maintaining Electrical Machines and Transformers

Proper maintenance ensures longevity and reliable performance:

Regular Inspection: Check for signs of wear, overheating, or unusual noises in

1.

motors and generators.

Lubrication: Keep bearings and moving parts well-lubricated to reduce friction.

2.

Cleaning: Remove dust and debris from transformers and machine components to

3.

prevent insulation failure.

Testing: Conduct insulation resistance and oil quality tests for transformers

4.

periodically.

Load Management: Avoid overloading electrical machines to prevent premature

5.

failure.

Future Trends in Electrical Machines and Transformers

As technology advances, electrical machines and transformers are evolving to meet new energy challenges:

Smart Transformers

Integrating sensors and IoT technology, smart transformers can monitor their own health,

predict failures, and optimize performance in real time.

High-Efficiency Motors

Developments in materials and design have led to motors with reduced losses, lower noise, and improved power factors, contributing to energy savings.

Renewable Integration

Electrical machines designed specifically for renewable energy applications are becoming more common, supporting the shift towards greener power generation.

Understanding the nuances of electrical machines and transformers reveals their indispensable role in powering our modern world. From the smallest appliances to the largest power grids, these devices ensure energy is transformed, transmitted, and utilized efficiently and safely.

Question

Answer

What are the main types of electrical machines used in industry?

The main types of electrical machines used in industry are transformers, DC machines (motors and generators), and AC machines (synchronous and induction motors). Each type

serves different purposes such as power conversion, motion control, and energy transformation.

How does a transformer

work and what is its

primary function?

A transformer works on the principle of electromagnetic induction to transfer electrical energy between two or more coils (windings) without changing the frequency. Its primary function is to step up or step down voltage levels in power transmission and distribution systems.

What are the

differences between

synchronous and

induction motors?

Synchronous motors operate at a constant speed synchronized with the supply frequency and require a DC supply for excitation. Induction motors operate slightly below synchronous speed and do not require separate excitation, making them simpler and more rugged for industrial applications.

What causes losses in

electrical machines and

how can they be

minimized?

Losses in electrical machines include copper losses (I^2R losses in windings), core losses (hysteresis and eddy currents in the core), mechanical losses (friction and windage), and stray load losses. Minimizing losses involves using high-quality materials, proper design, efficient cooling, and regular maintenance.

What is the significance

of the transformer

vector group

designation?

The transformer vector group designation indicates the winding configurations and phase displacement between primary and secondary windings. It is important for ensuring compatibility in parallel operation, managing load balancing, and maintaining system stability.

How is the efficiency of

an electrical machine

calculated?

The efficiency of an electrical machine is calculated as the ratio of output power to input power, usually expressed as a percentage: $\text{Efficiency (\%)} = (\text{Output Power} / \text{Input Power}) \times 100$. It indicates how effectively the machine converts input electrical energy into mechanical or electrical output.

What are the common cooling methods used in transformers?

Common cooling methods in transformers include natural air cooling (AN), oil natural air natural cooling (ONAN), oil natural air forced cooling (ONAF), and oil forced air forced cooling (OFAF). These methods help dissipate heat generated during operation to maintain optimal performance and prolong transformer life.

What role do electrical machines play in renewable energy systems?

Electrical machines such as generators and motors are critical in renewable energy systems. For example, wind

turbines use synchronous or induction generators to convert mechanical energy into electrical energy, while electric motors are used in various control and storage applications within renewable infrastructure.

How do transformers impact the efficiency of power transmission systems?

Transformers enable voltage levels to be increased for long-distance power transmission, which reduces current and consequently decreases I^2R losses in transmission lines. By stepping down voltage near consumption points, they ensure safe and efficient distribution, significantly improving overall system efficiency.

Electrical Machines and Transformers: Critical Components in Modern Electrical Engineering

electrical machines and transformers form the backbone of contemporary electrical

systems, enabling efficient energy conversion, transmission, and utilization across various industries. These devices are indispensable in power generation, industrial automation, transportation, and consumer electronics, underscoring their pervasive role in modern

society. Understanding their operational principles, types, and performance characteristics is essential for engineers, technicians, and decision-makers engaged in designing or maintaining electrical infrastructure.

Understanding Electrical Machines and Transformers

Electrical machines primarily refer to devices that convert electrical energy into mechanical energy or vice versa. Transformers, on the other hand, are static devices used to transfer electrical energy between circuits through electromagnetic induction, often altering voltage levels in the process. Both categories are integral to managing electrical energy efficiently, but they serve distinct functions within electrical networks.

Types and Functions of Electrical Machines

Electrical machines are broadly classified into motors and generators:

Motors: Convert electrical energy into mechanical energy. They are crucial in

1.
driving mechanical loads in manufacturing, HVAC systems, and electric vehicles.

Generators: Convert mechanical energy into electrical energy, serving as the

2.
primary source of electricity in power plants.

Motors can further be categorized into AC (alternating current) and DC (direct current) types, each with specific operational characteristics. For instance, induction motors dominate industrial applications due to their ruggedness and simplicity, whereas

synchronous motors are favored where precise speed control is necessary.

Role and Types of Transformers

Transformers operate on the principle of electromagnetic induction, enabling voltage transformation with minimal energy loss. This capability is pivotal for power distribution systems, allowing electricity to be transmitted at high voltages (reducing current and losses) and then stepped down for safe consumption.

Common transformer types include:

Power Transformers: Used in transmission networks to handle high voltages and

1.

large power ratings.

Distribution Transformers: Step down voltage for residential and commercial

2.

use.

Instrument Transformers: Employed for measurement and protection purposes

3.

within electrical grids.

Performance Characteristics and Efficiency Considerations

The efficiency of electrical machines and transformers directly impacts operational costs and system reliability. Losses in electrical machines include copper losses (due to resistance in windings), core losses (hysteresis and eddy currents), mechanical losses,

and stray load losses. Transformers experience similar losses, predominantly core and copper losses.

Design improvements, such as utilizing high-grade silicon steel, optimized winding configurations, and advanced cooling techniques, have enhanced efficiency levels significantly. For example, modern power transformers can achieve efficiencies exceeding 99%, minimizing energy wastage during transmission.

Comparative Analysis: Electrical Machines vs. Transformers

While both electrical machines and transformers deal with electromagnetic principles, their operational domains differ:

Energy conversion: Electrical machines actively convert energy forms (electrical

1.

to mechanical or vice versa), whereas transformers transfer energy between circuits without changing its form.

Mechanical Components: Electrical machines include moving parts like rotors and

2.

stators; transformers are static, with no moving components.

Applications: Machines drive mechanical processes; transformers regulate voltage

3.

levels within power systems.

This distinction is crucial when selecting equipment for specific industrial or utility applications.

Technological Advances and Industry Trends

The evolution of electrical machines and transformers has been influenced by material science, power electronics, and digitalization. Innovations such as high-efficiency permanent magnet motors reduce energy consumption in electric vehicles and industrial drives. Likewise, smart transformers integrated with sensors and IoT capabilities enable real-time monitoring, predictive maintenance, and grid optimization.

Moreover, the push towards renewable energy integration demands transformers and machines capable of handling variable loads and bidirectional power flows. Solid-state transformers (SSTs) are emerging as a promising technology, offering compact size, fast response, and enhanced controllability compared to traditional transformers.

Environmental and Economic Implications

Efficiency improvements in electrical machines and transformers translate into lower greenhouse gas emissions by reducing energy waste. The adoption of energy-efficient motors in industry can result in substantial cost savings and compliance with regulatory standards such as the IEC 60034-30-1 for motor efficiency classes.

However, challenges remain, including the environmental impact of raw materials used in manufacturing, such as rare earth elements in permanent magnets, and the need for sustainable disposal or recycling methods for aging equipment.

Maintenance and Reliability Considerations

Ensuring the longevity and reliability of electrical machines and transformers requires meticulous maintenance practices. For electrical machines, this involves regular inspection of bearings, insulation testing, and vibration analysis. Transformers demand oil testing for dielectric strength, thermal imaging to detect hotspots, and monitoring of load conditions.

Predictive maintenance, leveraging condition monitoring tools and data analytics, is increasingly adopted to minimize downtime and extend equipment life cycles.

Electrical machines and transformers continue to evolve, driven by technological advancements and shifting energy landscapes. Their foundational role in electrical systems underscores the importance of ongoing research, innovation, and skilled engineering to harness their full potential efficiently and sustainably.

electric motors, induction machines, synchronous machines, transformers, rotating electrical machines, power transformers, electrical generators, transformer efficiency, motor design, electromagnetic induction

electrical machines notes

Electrical Machines Notes

Electrical Machines Notes: A Detailed Guide to Understanding Fundamentals and Applications

electrical machines notes serve as an essential resource for students,

engineers, and

enthusiasts looking to grasp the core concepts and practical applications of electrical machines. Whether you're preparing for exams, working on projects, or simply eager to deepen your knowledge, having well-organized notes can make all the difference. In this comprehensive guide, we'll explore the key principles, types, and operational characteristics of electrical machines, offering insights that will boost your understanding and retention.

What Are Electrical Machines?

Electrical machines are devices that convert electrical energy into mechanical energy or vice versa. They play a vital role in power generation, transmission, and utilization across various industries. The two primary categories of electrical machines are motors and generators, each serving different but complementary functions.

Types of Electrical Machines

Understanding the different types of electrical machines is fundamental. Here's a brief overview:

DC Machines: These include DC motors and DC generators. Known for their

1.
simplicity and ease of speed control, DC machines are widely used in applications requiring variable speed and torque.

AC Machines: This category includes synchronous and induction machines. AC

2.

machines dominate industrial applications due to their robustness and efficiency.

Special Machines: Such as stepper motors and servo motors, these are used in

3.

precision control systems.

Each type comes with unique operating principles and characteristics, which are often covered in detailed electrical machines notes.

Fundamental Principles Behind Electrical Machines

The operation of electrical machines is grounded in electromagnetic principles. Faraday's law of electromagnetic induction and Lorentz force are two cornerstone concepts that explain how electrical energy is converted.

Electromagnetic Induction

When a conductor moves in a magnetic field, or when the magnetic field around a conductor changes, an electromotive force (EMF) is induced. This principle is the foundation for generators, where mechanical motion induces voltage.

Magnetic Fields and Forces

In motors, current-carrying conductors placed in magnetic fields experience forces that produce torque, causing rotation. The interaction between magnetic fields and electric currents is what enables electrical machines to perform work.

Essential Components of Electrical Machines

Electrical machines consist of several critical parts, each contributing to their function and

performance.

Stator: The stationary part of the machine, housing the field windings or

1.

permanent magnets.

Rotor: The rotating component that interacts with the stator's magnetic field to

2.

produce motion or induce EMF.

Commutator and Brushes: Found in DC machines, these components facilitate

3.

current flow and direction change within the machine.

Bearings: Support the rotor and allow smooth rotation.

4.

Understanding these components helps in troubleshooting and optimizing machine

performance, a key aspect often highlighted in electrical machines notes.

Performance Parameters and Testing Methods

To evaluate electrical machines effectively, several performance metrics and testing

procedures are used.

Key Performance Metrics

Efficiency: Ratio of output power to input power, indicating how well the machine

1.

converts energy.

Torque and Speed: Crucial for understanding the mechanical output capabilities.

2.

Power Factor: Especially relevant in AC machines, reflecting how effectively the

3.

machine uses electrical power.

Common Testing Techniques

No-load Test: Conducted to determine core losses and magnetizing current.

1.

Blocked Rotor Test: Helps in calculating parameters related to rotor resistance

2.

and reactance.

Load Test: Performed to analyze machine behavior under actual operating

3.

conditions.

These methods are essential knowledge for anyone studying electrical machines and are detailed in most comprehensive electrical machines notes.

Applications of Electrical Machines

Electrical machines have a broad range of applications that impact daily life and industrial processes.

Industrial Usage

In manufacturing plants, induction motors drive conveyors, pumps, and compressors.

Synchronous machines are often employed in power plants for electricity generation.

Transportation

Electric vehicles rely heavily on DC and AC motors for propulsion. Additionally, railway systems use specialized electrical machines for traction.

Household and Commercial Devices

From fans to air conditioners and washing machines, electrical machines are embedded in countless appliances, making them indispensable.

Tips for Effective Study and Note-Taking on Electrical Machines

Mastering electrical machines requires more than just reading; it demands active engagement and well-structured study materials.

Conceptual Clarity: Focus on understanding fundamental principles before

1.

memorizing formulas.

Diagrammatic Representation: Visual aids such as circuit diagrams and machine

2.

cross-sections can simplify complex ideas.

Regular Revision: Consistent review of notes helps reinforce learning and identify

3.

gaps.

Practical Examples: Relate theoretical concepts to real-world applications to

4.

enhance comprehension.

Use Supplementary Resources: Videos, simulation software, and textbooks

5.

complement written notes effectively.

Emerging Trends in Electrical Machines

The field of electrical machines is continually evolving, driven by technological

advancements and sustainability goals.

Energy-Efficient Designs

Modern machines focus on reducing losses and improving efficiency, often utilizing

advanced materials like high-grade silicon steel and rare-earth magnets.

Smart and IoT-Enabled Machines

Integration of sensors and connectivity allows for real-time monitoring, predictive

maintenance, and improved performance.

Renewable Energy Integration

Electrical machines are pivotal in wind turbines and hydroelectric generators, facilitating

the transition toward greener energy sources.

Exploring these innovations provides a glimpse into the future landscape of electrical

machines, enriching the knowledge base found in contemporary electrical machines notes.

Electrical machines are a fascinating and vital subject within electrical engineering. Armed with detailed and organized notes, learners can navigate this complex domain with confidence, connecting theory to practice seamlessly. Whether you're delving into the mechanics of motors or the nuances of generators, a deep understanding of electrical machines opens doors to numerous technological and industrial opportunities.

Question

Answer

What are the main types of electrical machines covered in electrical machines notes?

The main types of electrical machines typically covered include transformers, DC machines (motors and generators), and AC machines (synchronous and induction motors).

Why are electrical machines important in engineering studies?

Electrical machines are crucial because they convert electrical energy to mechanical energy and vice versa,

forming the backbone of power generation,
transmission, and various industrial applications.

What is the principle of
operation of an induction
motor explained in electrical
machines notes?

An induction motor operates on the principle of
electromagnetic induction where a rotating magnetic
field induces current in the rotor, producing torque and
causing rotation.

How do electrical machines
notes explain the concept of
back EMF in DC motors?

Back EMF (Electromotive Force) is the voltage
generated by the motor's armature as it rotates in the
magnetic field, opposing the applied voltage and
regulating the motor's speed.

What are common methods of
starting electrical machines
discussed in the notes?

Common starting methods include direct-on-line starting, star-delta starting, autotransformer starting, and using soft starters or variable frequency drives.

How do electrical machines

notes address losses and

efficiency in machines?

The notes typically discuss different types of losses such as copper loss, iron loss, mechanical loss, and stray losses, and explain how these affect the overall efficiency of the machine.

What role do electrical

machines notes assign to

synchronous machines in

power systems?

Synchronous machines are described as essential for power generation and grid stability, functioning as generators in power plants and sometimes as synchronous condensers for reactive power control.

Electrical Machines Notes: A Detailed Exploration of Principles, Types, and Applications

electrical machines notes serve as a foundational resource for students, engineers, and

professionals seeking to understand the principles, classifications, and operational intricacies of devices pivotal to electrical engineering. These notes encapsulate crucial theoretical concepts and practical knowledge surrounding electrical machines, which convert electrical energy into mechanical energy and vice versa. Given the central role of electrical machines in industrial automation, power generation, and transportation, a detailed and analytical review of these notes offers valuable insights into how these machines function, their classifications, and their significance in modern technology.

Understanding the Fundamentals of Electrical Machines

Electrical machines broadly fall into two categories: motors and generators. While motors convert electrical energy into mechanical energy, generators perform the inverse operation. The operation of these machines hinges on electromagnetic principles, particularly Faraday's law of electromagnetic induction and Lorentz force. Electrical machines notes often begin by emphasizing these fundamental physical laws as they govern the behavior of machines, dictating parameters such as torque, speed, and efficiency.

The constructional features typically highlighted in electrical machines notes include the stator, rotor, field windings, and armature. The stator is generally the stationary part that may contain the magnetic field, while the rotor rotates inside the stator, interacting with the magnetic field to produce motion or induce voltage. These components are crucial in differentiating between machine types and understanding their operation, losses, and performance characteristics.

Classification and Types of Electrical Machines

DC Machines

Direct Current (DC) machines are among the earliest types of electrical machines and are still relevant in applications requiring precise speed control. Electrical machines notes detail the internal mechanisms of DC motors and generators, including commutators and brushes, which facilitate the conversion between AC induced in the armature and the DC output or input.

Key features of DC machines include:

Separately excited or self-excited field windings

1.

Ability to provide high starting torque

2.

Ease of speed variation through voltage or field current adjustment

3.

Despite their advantages, DC machines suffer from maintenance challenges due to brush and commutator wear, making them less favorable in modern industrial settings compared to AC machines.

AC Machines

Alternating Current (AC) machines dominate contemporary electrical applications because of their robustness and suitability for high-power uses. Electrical machines notes

extensively cover two major categories of AC machines: synchronous and induction machines.

Synchronous Machines: These operate at a constant speed synchronized with the

1. supply frequency. They are widely used as alternators in power plants and in applications requiring precise speed control. Electrical machines notes highlight the importance of excitation systems and the role of synchronous motors in power factor correction.

Induction Machines: Also known as asynchronous machines, induction motors are

2. the backbone of industrial drives. Their simple construction, ruggedness, and low cost make them ideal for a wide range of applications. Detailed notes elaborate on the slip phenomenon, rotor types (squirrel cage and wound rotor), and starting methods.

Performance Parameters and Efficiency Considerations

Electrical machines notes invariably discuss performance metrics such as torque, speed, power factor, efficiency, and losses. These parameters are critical in evaluating machine suitability for specific tasks and optimizing operational costs.

Loss analysis typically distinguishes between copper losses, iron losses, mechanical losses, and stray load losses. For example, copper losses arise from resistance in

windings, while iron losses relate to hysteresis and eddy currents in the core material.

Understanding these losses enables engineers to design machines with better efficiency and reliability.

Efficiency in electrical machines can vary significantly based on type and load conditions.

Induction motors, for instance, generally achieve efficiency levels between 85% and 95%, while synchronous machines often exceed 95% under optimal conditions. Electrical machines notes provide comparative data and charts to illustrate these variations, assisting in informed decision-making.

Control and Applications of Electrical Machines

With the advent of power electronics and digital control systems, the operation of electrical machines has evolved substantially. Electrical machines notes now incorporate modern control techniques like vector control and direct torque control, which allow precise manipulation of motor speed and torque, enhancing performance in complex industrial processes.

Applications span diverse sectors:

Industrial Automation: Induction motors drive conveyor belts, pumps,

1.

compressors, and machine tools.

Electric Vehicles: Brushless DC motors and synchronous machines power electric

2.

propulsion systems.

Power Generation: Synchronous generators convert mechanical energy from

3.

turbines into electrical energy in power plants.

Household Appliances: Small-scale motors are embedded in devices like

4.

refrigerators, washing machines, and fans.

Advancements and Challenges in Electrical Machines

Recent developments in materials science, such as the use of high-grade silicon steel and rare-earth magnets, have significantly improved machine efficiency and power density.

Electrical machines notes also delve into these advancements, highlighting how innovations like permanent magnet synchronous machines (PMSMs) offer advantages in size, weight, and efficiency compared to traditional machines.

However, challenges remain. Thermal management, electromagnetic interference, and sustainability concerns linked to rare-earth material extraction are areas under active research. The notes often underscore the trade-offs between performance gains and cost or environmental impact, urging a balanced approach in design and application.

In educational contexts, electrical machines notes not only facilitate theoretical understanding but also emphasize practical laboratory experiments and simulation tools.

Software such as MATLAB/Simulink and finite element analysis (FEA) platforms are

frequently recommended to model machine behavior, validate design choices, and predict performance under varying conditions.

Integrating these resources forms a comprehensive learning pathway that equips learners with both conceptual clarity and hands-on experience. This dual approach is essential in preparing future engineers to innovate and maintain the electrical machines that underpin modern infrastructure.

Overall, electrical machines notes remain a vital repository of knowledge, continuously evolving to reflect technological progress and industry demands. Their detailed coverage of machine principles, classifications, performance metrics, and emerging trends ensures they remain indispensable for anyone involved in electrical engineering disciplines.

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