

# MECHNOVATION

"Building Dreams, One  
Gear at a Time"

DEPARTMENT  
OF  
MECHANICAL ENGINEERING

MARCH 2022

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## Mechanical Engineering Department

### Vision of the Department

To become a nationwide recognized department for research-oriented quality technical education in line with emerging trends and evolving demands of society.

### Mission of the Department

The mission of mechanical engineering department includes:

1. To embrace excellent teaching learning techniques to provide practical quality education that is commensurate with the emerging trends and industry demands.
2. To promote research in interdisciplinary areas by forging collaborations with global industries and establishing state-of-the-art research facilities in order to develop among students innovative and creative capabilities.
3. To mentor and guide young technocrats and inculcate them with the spirit of entrepreneurship along with ethics, values and eco-sensitivity.

### Program Educational Objectives (PEOs)

After five years from completion of graduation, the student will:

1. Pursue career as practicing mechanical engineer in core mechanical or allied industries worldwide.
2. Meet the expectations of modern industries for catering the proliferating demand and rising quality standards.
3. Become a responsible engineer capable of conducting sustainable, environment-friendly, innovative research and development in advanced domains.
4. Serve the society better by practicing professional leadership roles with a commitment to lifelong learning.
5. Become a person with a strong will and attitude to excel through the challenges in all walks of life.

### Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyses complex engineering problems reaching substantiated

conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## Program Specific Outcomes (PSOs)

### Engineering Graduates will be able

1. **PSO 1:** Implement the concepts of mechanical engineering for generating innovative ideas on design, development and analysis.
2. **PSO 2:** Develop solutions for engineering problems through multi-disciplinary concepts of Industrial automation and Industry 4.0.
3. **PSO 3:** Work independently as a professional or entrepreneur in research and industrial environment.

## Solenoid Engine

A solenoid engine, also known as a solenoid-based engine, is a type of engine that utilizes solenoids as the main component for generating mechanical motion. This innovative technology has garnered attention for its potential to provide an efficient and environmentally friendly alternative to traditional internal combustion engines. In this report, we will explore the concept, working principle, applications, advantages, and challenges associated with solenoid engines.

### 1. Introduction:

A solenoid engine is a mechanical device that converts electrical energy into linear or rotational motion. It operates based on the electromagnetic principles, using solenoids to create motion.

### 2. Working Principle:

A solenoid is a coil of wire wound around a central core, typically made of iron or other magnetic materials.

When an electric current flows through the coil, it generates a magnetic field.

The interaction between the magnetic field and the core causes linear or rotational motion.

In a solenoid engine, multiple solenoids are arranged strategically to produce the desired motion.

### 3. Components:

**Solenoids:** The primary components responsible for generating motion.

**Power Source:** Usually an electrical power source to energize the solenoids.

**Mechanical Components:** These include a crankshaft, gears, and other necessary parts to convert linear motion into rotational motion (in the case of rotary engines).

### 4. Applications:

**Small-Scale Engines:** Solenoid engines are currently used in small-scale applications, such as model cars and toys.

**Research and Development:** Researchers are exploring solenoid engine technology for potential applications in eco-friendly transportation.

**Educational Purposes:** Solenoid engines are used in educational settings to teach electromagnetism and basic mechanical principles.

### 5. Advantages:

**Efficiency:** Solenoid engines can be highly efficient, with minimal energy loss due to friction.

**Reduced Emissions:** As they do not rely on combustion, solenoid engines produce fewer emissions.

**Versatility:** They can be adapted for various applications, including renewable energy systems.

**Low Noise:** Solenoid engines tend to operate quietly compared to traditional engines.

#### **6. Challenges:**

**Scalability:** Scaling up solenoid engines for large vehicles poses challenges.

**Energy Storage:** Efficient energy storage methods are required for practical applications.

**Heat Dissipation:** Managing heat generated during operation is crucial.

**Reliability:** Ensuring long-term reliability and durability is a significant challenge.

#### **7. Conclusion:**

Solenoid engines represent a promising technology with the potential to revolutionize transportation and energy systems.

While currently limited to small-scale applications, ongoing research aims to address scalability and efficiency challenges.

Solenoid engines have the advantage of reduced emissions and increased efficiency, making them a compelling option for a sustainable future.

In conclusion, solenoid engines are a novel and promising technology that harnesses electromagnetic principles to create mechanical motion. Although they are currently used in small-scale applications and face scalability and efficiency challenges, ongoing research and development may pave the way for their adoption in larger-scale, eco-friendly transportation and energy systems in the future.

*Mr. Rahul Sharma*

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# Electric Engine

## 1. Introduction:

Electric engines have gained significant attention in recent years due to their role in revolutionizing the automotive and industrial sectors. This report provides an overview of electric engines, including their working principles, applications, advantages, and challenges.

## 2. Working Principles:

Electric engines, also known as electric motors, operate on the principles of electromagnetism. They consist of several key components:

**Stator:** The stationary part of the motor that contains coils of wire.

**Rotor:** The rotating part of the motor that interacts with the magnetic field generated by the stator.

**Commutator (in DC motors):** A device that switches the direction of current flow in the rotor windings to maintain continuous rotation.

**Permanent Magnets (in some motors):** Instead of a rotor with windings, some motors use permanent magnets to create a magnetic field.

Electric motors work by applying an electrical current to the stator windings. This generates a magnetic field that interacts with the rotor (either through electromagnetic attraction or repulsion), causing it to rotate. The direction of rotation can be controlled by reversing the current flow or altering the polarity of the magnetic field.

## 3. Types of Electric Engines:

**Direct Current (DC) Motors:** Utilize direct current and are commonly used in household appliances and small machinery.

**Alternating Current (AC) Motors:** Operate on alternating current and are found in industrial equipment and HVAC systems.

**Brushless DC Motors:** Employ electronic commutation rather than physical brushes for improved efficiency and longevity.

**Synchronous Motors:** Maintain synchrony with the supply frequency, making them suitable for precision applications.

## 4. Applications:

Electric engines are employed across various sectors, including:

**Automotive:** Electric vehicles (EVs) use electric motors for propulsion.

**Industrial:** Electric motors power conveyor systems, pumps, compressors, and manufacturing machinery.

**Aerospace:** Electric engines are being explored for aircraft propulsion systems.

**Renewable Energy:** Electric generators convert kinetic energy from wind or water into electricity.

**Robotics:** Electric motors are essential components in robotic systems.

**Consumer Electronics:** Small motors are used in devices like smartphones and cameras.

## 5. Advantages:

**Efficiency:** Electric engines are highly efficient, with minimal energy wastage.

**Environmental Benefits:** Electric engines produce no direct emissions, contributing to a cleaner environment.

**High Torque at Low Speeds:** They provide strong torque even at low rotational speeds.

**Low Maintenance:** Many electric motors are brushless, reducing maintenance needs.

**Reversibility:** Electric motors can reverse their direction of rotation easily.

## 6. Challenges:

**Energy Storage:** Efficient energy storage systems, such as batteries, are crucial for mobile applications.

**Range Limitations:** Electric vehicles face range limitations compared to internal combustion engine vehicles.

**Charging Infrastructure:** Expanding charging infrastructure is essential for EV adoption.

**Cost:** Some electric engines and associated components can be expensive.

### **7. Conclusion:**

Electric engines play a pivotal role in modern technology, from powering electric vehicles to driving industrial machinery and supporting renewable energy generation. Their efficiency, environmental benefits, and versatility make them a cornerstone of sustainable technological advancement. Addressing challenges related to energy storage, infrastructure, and cost will be key to unlocking their full potential in various applications. As research and development continue, electric engines are poised to shape a greener and more efficient future.

*Mr. Arun Kumar Kushwaha*

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*Mechanical Engineering Department*



# Composite Materials

## 1. Introduction:

Composite materials are a class of engineered materials made by combining two or more distinct materials to create a new material with enhanced properties. These materials have found widespread use in various industries due to their unique characteristics, making them the subject of extensive research and development. This report provides an in-depth overview of composite materials, including their types, manufacturing processes, applications, advantages, and challenges.

## 2. Types of Composite Materials:

Composite materials are categorized based on the type of reinforcement and matrix used. The primary types include:

**Fiber-Reinforced Composites:** These consist of fibers (e.g., carbon, glass, or aramid) embedded in a matrix (e.g., polymer, metal, or ceramic). Fiber orientation and type significantly impact the material's properties.

**Particulate Composites:** These contain discrete particles (e.g., ceramic particles in a metal matrix) to enhance specific properties such as hardness, wear resistance, or thermal conductivity.

**Laminated Composites:** These are built by layering sheets of different materials, often with different fiber orientations, to achieve a desired balance of properties.

**Nano composites:** Incorporate nanoparticles (e.g., carbon nanotubes or graphene) into a matrix to enhance mechanical, electrical, or thermal properties.

## 3. Manufacturing Processes:

Composite materials can be manufactured using several techniques, including:

**Hand Lay-up:** Manual placement of reinforcing materials within a mold, followed by the application of resin.

**Compression Molding:** Applying pressure to shape composite materials.

**Injection Molding:** Injecting resin into a mold with reinforcing fibers.

**Pultrusion:** Continuous production of composite materials with a constant cross-section.

**Filament Winding:** Winding fibers around a mandrel and impregnating them with resin.

**Additive Manufacturing:** Using 3D printing techniques to build composite structures layer by layer.

## 4. Applications:

Composite materials are utilized in various industries and applications, including:

**Aerospace:** Aircraft components, including wings, fuselages, and interiors.

**Automotive:** Lightweight body panels and structural components.

**Construction:** Reinforced concrete, bridges, and architectural elements.

**Sports and Recreation:** Tennis rackets, golf clubs, and bicycle frames.

**Electronics:** Circuit boards and lightweight electronic enclosures.

**Marine:** Boat hulls, masts, and propellers.

**Renewable Energy:** Wind turbine blades and solar panels.

## 5. Advantages:

**High Strength-to-Weight Ratio:** Composite materials are lighter than traditional materials while maintaining high strength.

**Tailorable Properties:** Engineers can customize composites to meet specific requirements.

**Corrosion Resistance:** Many composites are highly resistant to corrosion.

**Design Flexibility:** Complex shapes and structures can be achieved with composites.

**Reduced Maintenance:** Longevity and durability reduce maintenance costs.

#### **6. Challenges:**

**Cost:** High-quality composite materials and manufacturing processes can be expensive.

**Recycling:** Composite recycling methods are still evolving.

**Environmental Impact:** Production of some composite materials may have environmental concerns.

**Quality Control:** Ensuring consistent quality in composite manufacturing is essential.

#### **7. Conclusion:**

Composite materials represent a vital class of materials with diverse applications across industries. Their unique properties, including lightweight and high strength, have led to their extensive adoption. While challenges such as cost and recycling need to be addressed, ongoing research and development continue to expand the capabilities and applications of composite materials, making them a key driver of innovation and efficiency in modern engineering and manufacturing.

*Mr. Shivang Tiwari*

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# Solar Power Plant

## 1. Introduction:

Solar power plants are an integral part of the renewable energy landscape, playing a vital role in reducing carbon emissions and transitioning towards sustainable energy sources. This report provides an overview of solar power plants, their working principles, types, benefits, challenges, and their significance in the global energy landscape.

## 2. Working Principles:

Solar power plants generate electricity by converting sunlight into electrical energy through photovoltaic (PV) or concentrated solar power (CSP) technologies:

**Photovoltaic (PV) Systems:** These systems use solar panels comprising photovoltaic cells to directly convert sunlight into electricity. When photons from sunlight strike the PV cells, they release electrons, generating a flow of electricity.

**Concentrated Solar Power (CSP) Systems:** CSP systems use mirrors or lenses to concentrate sunlight onto a central receiver, which heats a fluid to produce steam. The steam drives a turbine connected to a generator to produce electricity.

## 3. Types of Solar Power Plants:

**Utility-Scale Solar Power Plants:** Large installations that feed electricity into the grid to supply power to cities or regions.

**Distributed Solar Power Plants:** Smaller-scale installations on residential or commercial rooftops, providing localized power.

**Concentrated Solar Power (CSP) Plants:** Utilized for utility-scale power generation with thermal storage capabilities.

## 4. Components of a Solar Power Plant:

**Solar Panels or Reflectors:** To capture sunlight.

**Inverters:** Convert direct current (DC) electricity into alternating current (AC) for grid integration.

**Mounting Structures:** Support solar panels or reflectors.

**Tracking Systems (in CSP):** Mechanisms to follow the sun's path for optimal sunlight capture.

**Energy Storage (in some cases):** Batteries or thermal storage systems to provide power during low sunlight periods.

## 5. Benefits of Solar Power Plants:

**Clean and Renewable:** Solar energy is abundant and sustainable.

**Reduced Carbon Emissions:** Solar power plants help mitigate climate change by reducing greenhouse gas emissions.

**Energy Independence:** Decreases reliance on fossil fuels and foreign energy sources.

**Low Operating Costs:** Minimal maintenance and operational costs once installed.

**Job Creation:** Supports employment in manufacturing, installation, and maintenance.

## 6. Challenges:

**Intermittency:** Solar power generation depends on sunlight availability, which varies by location and time.

**Energy Storage:** Effective storage solutions are needed to supply power during cloudy days or at night.

**Land Use:** Utility-scale solar plants require significant land, potentially impacting ecosystems.

**High Initial Costs:** Installation costs can be substantial, although they have been decreasing.

**Technological Advances:** Rapid advancements in solar technology necessitate periodic upgrades.

#### **7. Significance and Future Outlook:**

Solar power plants are pivotal in achieving global renewable energy goals and reducing greenhouse gas emissions. As technology advances and costs decrease, solar power's share in the global energy mix is expected to grow significantly. Integration with energy storage systems, improved grid infrastructure, and policy support will further enhance the contribution of solar power plants to a sustainable energy future.

#### **8. Conclusion:**

Solar power plants represent a crucial component of the transition to clean and renewable energy sources. They offer a sustainable, environmentally friendly solution to meet growing energy demands while addressing climate change concerns. Continued research and development, alongside supportive policies, will drive the continued expansion of solar power plants, making them an indispensable part of the global energy landscape.

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# Geothermal Energy

## 1. Introduction:

Geothermal energy harnesses the Earth's internal heat to generate electricity and provide direct heating. This report explores the principles, technologies, advantages, challenges, and applications of geothermal energy.

## 2. Working Principles:

Geothermal energy relies on the Earth's heat emanating from its core. This heat can be captured through two main methods:

**Direct Use Applications:** Geothermal fluids from underground reservoirs are directly pumped to the surface to provide heat for space heating, hot water, and greenhouse operations.

**Geothermal Power Generation:** High-temperature geothermal reservoirs produce steam or hot water that drives turbines connected to generators, producing electricity.

## 3. Types of Geothermal Resources:

**Hydrothermal Resources:** These systems use naturally occurring groundwater heated by geothermal heat. Steam or hot water is extracted to generate electricity or provide heat.

**Enhanced Geothermal Systems (EGS):** Artificially created reservoirs by injecting water into hot, dry rock formations to produce steam for power generation.

**Geopressured Resources and Magma Resources:** Less common types that use high-pressure hot brine or magma for energy extraction.

## 4. Components of a Geothermal Power Plant:

**Well Systems:** Drilling to access geothermal fluids.

**Surface Power Plant:** Converts geothermal fluids into electricity through steam turbines and generators.

**Heat Exchangers and Pumps:** Transfer heat from geothermal fluids to a working fluid for power generation.

## 5. Advantages of Geothermal Energy:

**Renewable and Sustainable:** Geothermal energy is a constant, reliable source.

**Low Environmental Impact:** Minimal greenhouse gas emissions compared to fossil fuels.

**Base-Load Power:** Provides consistent electricity generation.

**Direct Heating:** Direct use applications reduce the need for other heating methods.

**Local Economic Benefits:** Provides jobs and economic growth in geothermal-rich areas.

## 6. Challenges:

**Resource Location:** Geothermal resources are location-dependent, limiting widespread adoption.

**Resource Depletion:** Overuse can lead to the depletion of geothermal reservoirs.

**High Initial Costs:** Drilling and plant construction expenses can be significant.

**Environmental Concerns:** Drilling and fluid disposal can have environmental impacts.

**Geological Risk:** Not all areas have suitable geological conditions for geothermal development.

### **7. Applications:**

**Electricity Generation:** Geothermal power plants are used for electricity generation in regions with suitable resources.

**Direct Heating:** Geothermal energy provides space heating, hot water, and district heating in many regions.

**Greenhouses:** Maintains optimal temperatures for plant growth.

**Aquaculture:** Supports temperature control in fish farming.

**Industrial Processes:** Used for various industrial heating and cooling applications.

### **8. Future Outlook:**

As the world seeks to transition to cleaner and more sustainable energy sources, geothermal energy holds great promise. Technological advancements in Enhanced Geothermal Systems (EGS) and improved resource mapping techniques are expanding the potential of geothermal power. Integration with energy storage systems and advancements in drilling technology may further enhance its feasibility.

### **9. Conclusion:**

Geothermal energy is a valuable and sustainable source of power and heat, offering a clean alternative to fossil fuels. While challenges exist, ongoing research and development, coupled with supportive policies, can make geothermal energy a significant contributor to the global energy mix, helping reduce greenhouse gas emissions and combat climate change.

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# Solar Power Refrigeration System

## 1. Introduction:

Solar power refrigeration systems represent an innovative and environmentally friendly approach to cooling and refrigeration. These systems utilize solar energy to drive the refrigeration cycle, reducing the carbon footprint associated with traditional cooling technologies. This report provides an overview of solar power refrigeration systems, their working principles, applications, benefits, challenges, and future prospects.

## 2. Working Principles:

Solar power refrigeration systems operate based on the principles of absorption or adsorption cooling. In both cases, solar thermal energy is used to provide the necessary heat for the cooling process:

**Absorption Cooling:** This method uses a refrigerant-absorbent pair (e.g., water-lithium bromide) to create a cooling effect. Solar collectors capture heat energy from sunlight, which is used to release the refrigerant from the absorbent, thus initiating the cooling cycle.

**Adsorption Cooling:** In adsorption cooling, a solid adsorbent material (e.g., silica gel) is used to adsorb a refrigerant vapor, and then, heat from solar collectors is used to desorb the refrigerant, generating cooling.

## 3. Components of Solar Power Refrigeration Systems:

**Solar Collectors:** These capture solar energy and transfer it as heat to the refrigeration cycle.

**Absorption or Adsorption Cycle:** Includes the refrigerant-absorbent pair and associated components.

**Cooling Circuit:** The circuit that delivers cooling to the desired application.

**Heat Exchangers:** Transfer heat from solar collectors to the refrigeration cycle.

## 4. Applications:

Solar power refrigeration systems find applications in various sectors, including:

**Food Preservation:** Used in off-grid areas to store perishable food items.

**Medical Refrigeration:** Ensures the safe storage of vaccines and medications in remote locations.

**Domestic Refrigeration:** Solar-powered refrigerators can serve residential cooling needs.

**Agricultural Storage:** Cooling systems for agricultural produce storage.

**Mobile Cooling:** Solar-powered refrigeration units for vehicles, such as refrigerated trucks.

## 5. Benefits:

**Renewable Energy Source:** Utilizes abundant and sustainable solar energy.

**Reduced Environmental Impact:** Minimizes greenhouse gas emissions compared to conventional cooling methods.

**Off-Grid Operation:** Suitable for remote and off-grid areas with limited access to electricity.

**Energy Efficiency:** Solar power refrigeration can be highly efficient.

**Energy Independence:** Decreases reliance on fossil fuels for cooling needs.

## 6. Challenges:

**Intermittent Operation:** Solar availability varies by location and time, which can affect continuous cooling.

**Initial Costs:** Higher upfront installation costs may be a barrier to adoption.

**Energy Storage:** Efficient thermal energy storage methods are needed for night-time or cloudy day operation.

**Maintenance:** Solar collectors and refrigeration components require periodic maintenance.

#### **7. Future Prospects:**

As the world seeks sustainable and energy-efficient cooling solutions, solar power refrigeration systems are gaining importance. Advances in materials, improved energy storage technologies, and cost reductions are making these systems increasingly viable. Integration with renewable energy microgrids and the development of hybrid systems that combine solar with other energy sources are enhancing their practicality.

#### **8. Conclusion:**

Solar power refrigeration systems offer a promising and sustainable approach to cooling and refrigeration needs. Their ability to reduce carbon emissions, provide off-grid cooling solutions, and leverage renewable energy sources makes them a valuable asset in the transition to a more sustainable and environmentally friendly future. Continued research and development, along with supportive policies, will play a pivotal role in advancing solar power refrigeration systems and expanding their applications.

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*Message from the editorial board*

*"Navigating Tomorrow's Horizons: Illuminating Insights, Enriching Perspectives."*

Our editorial board tag line encapsulates our commitment to providing you with a source of intellectual engagement and enlightenment. As stewards of information and ideas, we are dedicated to charting the course towards a brighter future. "Navigating Tomorrow's Horizons" symbolizes our mission to explore uncharted territories of knowledge and anticipate the trends and challenges that lie ahead.

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