



GANDHI INSTITUTE OF ADVANCED COMPUTER AND RESEARCH

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DEPARTMENT OF MECHANICAL ENGINEERING

THE MECHANICAL HORIZON

2024-25



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It gives us immense pleasure to present *The Mechanical Horizon*, the annual departmental magazine of the Mechanical Engineering Department. This publication stands as a reflection of the academic excellence, technical competence, and creative spirit of our students and faculty members. *The Mechanical Horizon* is a platform where knowledge meets creativity. Authored and edited by students and teachers, the magazine is published in English and showcases a comprehensive report of departmental activities. The magazine provides an opportunity for budding Mechanical engineers to express their innovative ideas, technical insights, research interests, and creative abilities. It encourages students to develop the habit of reading, writing, critical thinking, and professional communication — essential qualities for a successful engineer.

The Editorial Board comprises the Editor, Co-Editor, and Faculty Coordinators who work collectively to review and select quality contributions. We sincerely appreciate the enthusiastic participation of students and staff who contribute articles, technical papers, project summaries, site experiences, creative writings, and innovative ideas. This magazine not only documents the academic journey of the department but also serves as a source of inspiration for students to learn from the experiences and achievements of their peers. We hope that *The Mechanical Horizon* continues to motivate young minds to build not only strong structures but also strong ideas for the betterment of society.

Publisher

Gandhi Institute of Advanced Computer and Research, Rayagada

Message from Chairman



Dr. Chandra Dhwanja Panda

It is with great pleasure that I extend my heartfelt congratulations to the Department of Mechanical Engineering on the release of this year's edition of *Mechanical Horizon*. This magazine stands as a reflection of the department's unwavering commitment to academic excellence, innovation, and holistic development.

Mechanical engineering continues to be the backbone of industrial progress, driving advancements in manufacturing, automation, energy systems, and sustainable technologies. *Mechanical Horizon* captures this dynamic spirit through insightful articles, student innovations, and highlights of departmental activities that foster technical growth and creative thinking.

I am particularly pleased to see the emphasis on industry-academia collaboration, faculty development programs, and student participation in national and international forums. These engagements not only enhance learning but also prepare our students to meet real-world challenges with confidence and competence.

I commend the editorial team and all contributors for their dedication in bringing out this enriching volume. May *Mechanical Horizon* continue to inspire future engineers and serve as a beacon of knowledge and progress.

Message from Secretary



Mr. Manoj Kumar Palo

It gives me immense pleasure to present this edition of *Mechanical Horizon*, the annual magazine of our Mechanical Engineering Department. This publication is not just a compilation of articles and updates—it is a reflection of the creativity, innovation, and dedication of our students and faculty.

Over the past year, our department has continued to push the boundaries of knowledge and skill, embracing new technologies, fostering research, and encouraging hands-on learning. The spirit of mechanical engineering lies in solving real-world problems with precision and imagination, and I am proud to say that our students are embodying this vision with great enthusiasm.

I commend the editorial team, contributors, and all those who have worked tirelessly to bring this magazine to life. May *Mechanical Horizon* continue to inspire curiosity, nurture talent, and serve as a platform for sharing ideas that shape the engineers of tomorrow.

Let us keep striving for excellence, innovation, and teamwork—qualities that define not only our department but also the very essence of engineering.

Message from the Principal



Dr. Pratap Chandra Mishra

It is with great pride and joy that I extend my greetings to the readers of *Mechanical Horizon*, the annual magazine of the Mechanical Engineering Department. This publication reflects the vibrant academic culture, technical expertise, and creative spirit that define our institution.

Mechanical engineering, as a discipline, stands at the heart of innovation—transforming ideas into reality through knowledge, skill, and perseverance. Over the past year, our students and faculty have demonstrated remarkable commitment to excellence, embracing both traditional engineering principles and emerging technologies.

A magazine like *Mechanical Horizon* is more than a collection of words and images; it is a platform that showcases the intellectual pursuits, achievements, and aspirations of our department. I applaud the editorial team for their dedication and the contributors for their insightful articles and creative inputs.

I encourage all students to continue exploring, learning, and innovating, keeping alive the spirit of curiosity and problem-solving that drives engineering forward. May *Mechanical Horizon* inspire each reader to aim higher and contribute meaningfully to the progress of society.

Best wishes for continued success and excellence.

Message from the Head



Message from the Head of Department

Diploma in Mechanical Engineering

It gives me immense pleasure to extend my warm greetings to all readers of *Mechanical Horizon*, the annual magazine of the Department of Mechanical Engineering. This magazine serves as a creative platform for our students and faculty to express their technical insights, innovative ideas, and achievements.

Mechanical Engineering, being the foundation of industrial development, continues to evolve with advancements in automation, robotics, renewable energy, and smart manufacturing. Our department constantly strives to align academic learning with practical applications, nurturing students to become competent professionals and responsible citizens.

I take this opportunity to appreciate the editorial team and all contributors for their dedication and hard work in bringing out this edition. I also encourage our students to explore new technologies, engage in research, and uphold the values of innovation and teamwork.

Let *Mechanical Horizon* be a source of inspiration and knowledge that ignites curiosity and fosters a spirit of lifelong learning among our budding engineers.

Vision and Mission of the Institution

Vision

To become a globally recognized, value-driven educational institution committed to excellence in delivering quality education, nurturing students' inherent talents, and developing innovative professionals in technical and managerial fields, thereby equipping them to meet the future challenges of the global economy.

Mission

M₁: To deliver quality education through effective teaching–learning processes that foster academic excellence in technical and managerial disciplines.

M₂: To nurture students' inherent talents by encouraging creativity, critical thinking, innovation, and lifelong learning.

M₃: To develop competent and ethical professionals with strong values, leadership skills, and social responsibility.

M₄: To promote industry-oriented learning and research through collaboration, practical exposure, and adoption of emerging technologies.

M₅: To prepare globally competitive graduates capable of adapting to evolving challenges and contributing effectively to the global economy.

Vision & Mission of Department of Mechanical Engineering

VISION

To be a premier knowledge hub in mechanical engineering education, entrepreneurship, and industry engagement, producing skilled engineers ready to address industrial challenges.

MISSION

M1. To impart strong fundamental and advanced knowledge in mechanical engineering through effective teaching–learning practices and modern pedagogical methods.

M2. To promote innovation and entrepreneurship by encouraging creative thinking, problem-solving, and startup-oriented initiatives among students.

M3. To strengthen industry engagement through internships, industrial training, consultancy, and collaborative projects to enhance practical skills.

M4. To develop technically competent and ethical engineers with leadership qualities, professional integrity, and social responsibility.

M5. To equip graduates with industry-relevant skills and adaptability to effectively address real-world engineering challenges.

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THE RISE OF SUSTAINABLE MANUFACTURING: ECOFRIENDLY PRACTICES IN MECHANICAL ENGINEERING

By Basanta Benia^{2nd} Year

Imagine a world where factories hum with activity, but the air stays clean, the rivers run clear, and the planet breathes easy. This vision of sustainable manufacturing isn't just a dream—it's becoming a reality, thanks to the evolving practices in mechanical engineering. As industries face growing pressure to balance progress with environmental responsibility, sustainable manufacturing has emerged as a beacon of hope. At its core, sustainable manufacturing is about doing more with less. It's about rethinking how we design, produce, and consume products to minimize waste and reduce environmental impact. Mechanical engineers are leading the charge by pioneering innovative solutions that prioritize efficiency and sustainability without compromising performance. One of the biggest shifts in sustainable manufacturing is the adoption of renewable energy. Factories are now harnessing solar, wind, and hydroelectric power to reduce their carbon footprint. Mechanical engineers are designing energy-efficient systems and machinery that consume less power while maintaining productivity. For example, advanced heat recovery systems now capture waste heat from industrial processes and reuse it, significantly cutting down on energy waste. Another critical area of focus is material optimization. Engineers are finding ways to use lightweight, recyclable, and biodegradable materials in everything from automobiles to consumer electronics. Techniques like additive manufacturing, or 3D printing, allow for precise production, reducing material waste by up to 90%. Instead of discarding scrap materials, they are being repurposed, creating a circular economy where nothing goes to waste.

Water conservation is also at the forefront of eco-friendly manufacturing. Industries are implementing closed-loop systems that recycle water used in cooling and cleaning processes, ensuring minimal discharge into the environment. Advanced filtration technologies developed by mechanical engineers are making this recycling not only possible but also cost-effective. But sustainable manufacturing isn't just about processes—it's about mindset. Mechanical engineers are reimagining the lifecycle of products. From design to disposal, every step is being scrutinized for its environmental impact. Engineers are now creating modular designs that make it easier to repair and upgrade products, extending their lifespan and reducing the need for replacements. Finally, digital technologies are supercharging these

efforts. With the help of artificial intelligence and IoT, engineers can monitor energy consumption, predict equipment maintenance, and optimize supply chains in real-time. This data-driven approach ensures resources are used efficiently and sustainably. The rise of sustainable manufacturing is more than a trend; it's a necessity. With the planet's resources dwindling and the effects of climate change becoming more apparent, industries must adapt. Mechanical engineers are proving that innovation and sustainability can go hand in hand, creating a future where progress doesn't come at the cost of our planet.

In this journey, every step counts. Whether it's designing greener machines, rethinking waste, or embracing renewable energy, mechanical engineers are shaping a world where industry and nature can coexist harmoniously. The rise of sustainable manufacturing is not just the future of mechanical engineering; it's the future of humanity.

THE ENGINEER'S TOOLKIT FOR 2025: SKILLS FOR A DYNAMIC FUTURE

By: Durga Dinesh Kumar Reddy, 3RD Year

Engineering has always been about solving problems, but in 2025, the nature of these problems is evolving faster than ever. As industries navigate rapid technological advancements, climate change challenges, and global connectivity, engineers must rise to the occasion with a modern, adaptable toolkit. This isn't just about mastering technical skills, it's about embracing a mindset of lifelong learning, creativity, and collaboration. The cornerstone of the 2025 engineer's toolkit is digital fluency. Tools like Artificial Intelligence (AI), Internet of Things (IoT), and robotics are no longer fringe technologies, they are the heart of engineering. Engineers need to not only understand how these systems work but also how to integrate them seamlessly into solutions. Whether it's designing smart infrastructure or automating manufacturing processes, proficiency in programming and data analytics is now as critical as traditional technical skills like CAD or FEA.

But technical expertise alone won't cut it. Sustainability has become the new mantra, and engineers are expected to design with the planet in mind. From energy-efficient buildings to recyclable materials, engineers must consider the environmental impact of their work. This requires creativity thinking beyond conventional approaches and developing solutions that balance performance, cost, and ecological responsibility. Furthermore, resilience and adaptability are key traits for engineers in a world of constant change. Technologies will keep evolving, and new problems will arise. Engineers must cultivate a mindset that embraces uncertainty and thrives on problem-solving. Continuous up skilling through online courses, certifications, and hands-on projects will be crucial to staying relevant. Another indispensable skill for 2025 is collaboration. Modern projects often involve interdisciplinary teams spread across the globe.

Engineers must communicate effectively, not just with other engineers but with stakeholders from diverse fields like business, law, and public policy. Soft skills like empathy and adaptability are as vital as technical ones, especially when tackling complex, multifaceted challenges.

THERMAL MANAGEMENT INNOVATIONS: COOLING SOLUTIONS FOR HIGH-TECH INDUSTRIES

By: Krushna Chandra Naik, 3rdYear

As industries adopt cutting-edge technologies like AI, high-performance computing, and electric vehicles, effective thermal management has become a critical focus in mechanical engineering. Thermal management innovations are essential to prevent overheating, ensure efficiency, and extend the lifespan of modern systems. Advanced cooling solutions have emerged as a response to the increasing thermal challenges in sectors like electronics, automotive, and aerospace. Engineers are now leveraging phase-change materials, liquid cooling systems, and heat pipes to achieve superior temperature control. For instance, liquid cooling systems, which circulate coolant around high-temperature components, offer better heat dissipation compared to traditional air-cooling methods. In the realm of electric vehicles, thermal management is crucial for maintaining battery performance and safety. Engineers are developing innovative cooling methods, such as immersion cooling, where batteries are submerged in non-conductive liquid, ensuring even heat distribution. Similarly, aerospace applications require lightweight and efficient cooling solutions to manage extreme thermal conditions during flight. The use of advanced simulation tools has further revolutionized thermal management. Engineers can now model heat transfer processes with precision, enabling optimized designs before physical prototypes are created. This not only accelerates development but also reduces costs. Thermal management is also playing a pivotal role in sustainability. Modern systems are designed to recover and reuse waste heat, contributing to energy efficiency and reducing carbon footprints. In summary, thermal management innovations are at the forefront of addressing the demands of high-tech industries. By embracing advanced cooling technologies and sustainable practices, mechanical engineers are shaping a future where performance and efficiency go hand in hand.

SMART FACTORIES AND INDUSTRY 4.0: THE ROLE OF IOT IN MECHANICAL ENGINEERING

By: Deepak Kumar Naik, 2nd Year

The advent of Industry 4.0 has revolutionized the field of mechanical engineering by integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data into manufacturing and design processes. This transformation has given rise to "smart factories," where interconnected devices and systems enable real-time monitoring, automation, and optimization. IoT plays a central role in this paradigm shift by connecting machines, tools, and equipment through sensors and communication networks. These smart devices collect and exchange data, enabling engineers to make informed decisions, predict maintenance needs, and enhance operational efficiency. For instance, IoT-powered predictive maintenance minimizes downtime by identifying potential issues before they escalate, saving time and resources. Moreover, the integration of IoT in mechanical engineering fosters greater customization. Smart factories can quickly adapt production lines to create personalized products without compromising efficiency. This flexibility is essential in meeting the demands of modern consumers who seek tailored solutions.

Additionally, IoT enables energy optimization by monitoring power consumption and identifying inefficiencies. This not only reduces costs but also supports sustainability goals, a growing concern in the mechanical engineering landscape. In conclusion, IoT is reshaping the mechanical engineering sector, empowering smart factories to achieve higher productivity, enhanced quality, and sustainable practices. As we embrace Industry 4.0, the role of IoT will continue to expand, making mechanical engineering an integral part of the technological revolution.

HARNESSING THE SUN'S POWER: A HYPERBOLIC PATH TO SOLAR ENERGY HARVESTING

By: Jagannath Hikaka, 2nd Year

The sun, a radiant orb of immense energy, has long tantalized humankind with its potential to address our ever-growing power needs. While solar energy technologies have come a long way, capturing and converting its full spectrum into usable energy remains a challenge. Enter the realm of hyperbolic materials, offering a groundbreaking approach to solar energy harvesting with their unique light-trapping abilities. What are Hyperbolic Materials? Imagine a material that bends light not just towards, but also away from itself, defying the usual rules of optics. This is the essence of hyperbolic materials, characterized by a negative refractive index for one light polarization. This exotic property arises from their anisotropic nature, where the material behaves differently for different light waves. The result? Light gets trapped and concentrated within the material, leading to exceptional absorption. Nature's Gift: Harnessing Natural Hyperbolic Materials While engineered metamaterials can exhibit hyperbolic behaviour, their complex fabrication presents challenges. Fortunately, Mother Nature has provided us with naturally occurring hyperbolic materials like hexagonal boron nitride (h-BN) and transition metal dichalcogenides (TMDCs). These materials offer inherent hyperbolic properties, simplifying fabrication and potentially paving the way for cost-effective solar energy solutions. The Absorber Design: Pyramids to the Sun Researchers propose an ingenious absorber design utilizing periodic arrays of pyramidal nanostructures made from natural hyperbolic materials. These pyramids act like tiny light traps, guiding and confining sunlight within the material. The hyperbolic nature further enhances absorption, maximizing the conversion of solar energy into heat or electricity.

Unlocking the Potential: Challenges and Future Prospects While the potential of hyperbolic absorbers is undeniable, challenges remain. Scalability and cost-effective fabrication of large-area devices require further research and development. Additionally, integrating these absorbers into existing solar cell technologies needs careful consideration. Despite these hurdles, the future of hyperbolic solar energy harvesting appears bright. Continued research and advancements in nanofabrication hold the key to unlocking the full potential of this revolutionary technology. Imagine solar panels with enhanced efficiency, powering homes and cities with the sun's boundless energy. The hyperbolic path to a sustainable future beckon, and with each step forward, we harness the power of nature to illuminate our world. This article is just a glimpse into the captivating world of hyperbolic materials and their potential to revolutionize solar energy harvesting. As research progresses and technological hurdles are overcome, we can expect to see these extraordinary materials illuminating our path towards a brighter, more sustainable future.

HYDROGEN FUEL CELLS:A SUSTAINABLE SOLUTION FORDECARBONIZING HEAVY-DUTY TRANSPORTATION

By Jami Pavan Venkata Sai, 1st Year

Hydrogen fuel cells are a clean, effective source of energy, offering a favourable substitute to conventional fossil fuels. By converting chemical energy into electricity, hydrogen fuel cells yield simply water and heat as byproducts, producing those an attractive resolution for dropping greenhouse gas discharges and diminishing environmental deterioration. This technology has the potential to power an extensive sort of submissions, from conveyance and static energy production to portable electronics and industrial processes. With their high energy density, long lifespan, and zero-emission operation, hydrogen fuel cells are composed to execute a critical part in the conversion to a sustainable energy future. The transportation sector is an important provider towards greenhouse gas releases, with heavy transport vehicles being a major polluter. Decarbonizing heavy transport vehicles is crucial to mitigate climate change. This paper explores the strategies and technologies for decarbonizing heavy transport vehicles, including electrification, alternative fuels, efficiency improvements, sustainable fuels, hybridization, and green logistics. We analyze the benefits, challenges, and limitations of each approach and discuss policy and regulatory frameworks to support the transition. Our approach highlights the need for a multi-faceted approach to achieve net-zero emissions from heavy transport vehicles by 2050. By decarbonizing heavy transport vehicles, we can ominously diminish discharges, advance air value, and boost energy retreat, ultimately contributing to a sustainable transportation sector. Heavy-duty transportation is a significant contributor to greenhouse gas discharges, magnitude nearly 25% of overall transportation productions.

This paper presents a sustainable solution for decarbonizing heavy-duty transportation, focusing on hydrogen fuel cell expertise and electrification. We examine the benefits, challenges, and limitations of these technologies and discuss the necessary policy and regulatory frameworks to support their adoption. This very analysis highlights the potential for hydrogen fuel cells and electrification to reduce emissions by up to 70% and 100%, respectively. It can also explore the role of non-traditional energy, energy storage, and grid modernization in supporting the shift to a reduced-carbon transportation sector. By

adopting this sustainable solution, the aspects like emissions, air quality, and energy security are becoming optimize and ultimately contributing to a net-zero emissions future. Hydrogen fuel cells offer a promising solution for decarbonizing heavy-duty transportation, providing a zero-emission alternative to traditional fossil fuels. This work determines the latent of hydrogen fuel cells in reducing emissions and improving air quality in the heavy-duty transportation sector. We discuss the benefits and challenges of hydrogen fuel cell technology, including infrastructure development, energy efficiency, and cost reduction. We also examine case studies of successful hydrogen fuel cell deployments in heavy-duty transportation and provide recommendations for policymakers and industry stakeholders to support the adoption of this sustainable technology. By transitioning to hydrogen fuel cells, we can significantly diminish discharges and generate an additional ecological future for heavy-duty transportation. respectively. It can also explore the role of non-traditional energy, energy storage, and grid modernization in supporting the shift to a reduced-carbon transportation sector. By adopting this sustainable solution, the aspects like emissions, air quality, and energy security are becoming optimize and ultimately contributing to a net-zero emissions future. Hydrogen fuel cells offer a promising solution for decarbonizing heavy-duty transportation, providing a zero-emission alternative to traditional fossil fuels. This work determines the latent of hydrogen fuel cells in reducing emissions and improving air quality in the heavy-duty transportation sector. We discuss the benefits and challenges of hydrogen fuel cell technology, including infrastructure development, energy efficiency, and cost reduction. We also examine case studies of successful hydrogen fuel cell deployments in heavy-duty transportation and provide recommendations for policymakers and industry stakeholders to support the adoption of this sustainable technology. By transitioning to hydrogen fuel cells, we can significantly diminish discharges and generate an additional ecological future for heavy-duty transportation.

METAL 3D PRINTING VS. TRADITIONAL MANUFACTURING: WHICH SHOULD YOU CHOOSE FOR AEROSPACE INDUSTRY?

By Dadi Laxman Bhargav, 2nd Year

As metal 3D printing becomes the buzzword in the additive manufacturing industry, many argue it can overtake traditional manufacturing. But is this the case? We look at the pros and cons of both metal 3D printing versus traditional manufacturing to determine which the best is or whether they both play their part in producing spare parts.

The history of manufacturing dates back to the industrial revolution in the 1900s, when raw materials were transformed into useful products. Traditional manufacturing processes, such as molding, forming, machining, and joining, are mainly subtractive and suitable for large-scale production due to their costs and limited design flexibility. 3D printing, on the other hand, offers design flexibility, cost, and speed. Traditional manufacturing is commonly used in industries that mass-produce products made from materials like wood, steel, or plastic. Metal 3D printing, or additive manufacturing, offers unparalleled design flexibility, enabling the creation of complex geometries and customized parts that would be difficult or impossible to produce with traditional methods. It also reduces material waste and allows for rapid prototyping and iterative design. Traditional manufacturing methods, such as casting and forging, are highly efficient for mass production and can produce parts with excellent mechanical properties and surface finishes at lower costs per unit. A hybrid approach may provide the best solutions depending on specific project requirements and production scales.

3D Printing in Aerospace Industry

The aerospace industry is increasingly focusing on lighter, stronger, and more durable components. 3D printing technology has opened up new possibilities for design improvements in aircraft, with even a minor reduction in weight potentially saving significant money over its lifetime. For commercial airliners, even a small reduction in weight can make a significant positive cost impact. For defence planes and space crafts, sturdier and lighter components allow better payload. For all types of aircraft, lighter components lead to better speed and higher fuel efficiency. Benefits of 3D Printing for the Aerospace Industry Weight

reduction is a significant benefit of 3D printing, as even a small decrease in weight can save up to Rs. 1 billion for a plane's lifetime. New technologies and materials within the 3D printing field are fuelling this trend, such as metal powder-bed based additive manufacturing systems and new composite materials. 3D printing also offers improved aircraft design, enabling engineers to optimize designs that benefit from additive manufacturing processes, reducing life-cycle costs and increasing engine efficiency. Additionally, 3D printing increases production efficiency and improves supply chain lead times. The 3D printing material used in the aerospace industry must be sturdy, light, resilient, and strong.

This abstract examines the comparative aspects of metal 3D printing and traditional manufacturing methods, focusing on factors such as design flexibility, cost-effectiveness, material waste, production speed, and suitability for various applications. It suggests that a hybrid approach may often provide the best solutions depending on specific project requirements and production scales. Additive manufacturing or 3D printing is the process of creating 3D objects or products layer by layer using a 3D digital model. The industry is one of the few where weight of components really matters, and additive manufacturing technology has created new possibilities to meet these challenges.

By removing constraints related to traditional manufacturing processes, additive manufacturing has brought forth the potential for numerous design-related improvements in aircraft. For commercial airliners, even a minor reduction in weight can make a significantly positive cost impact. For defence planes and space crafts, sturdier and lighter components allow better payload.

The aerospace industry benefits from 3D printing technology in several ways. First, weight reduction can be achieved by removing constraints related to traditional manufacturing processes, which are essentially time-consuming and limited by the choice of raw material. Second, 3D printing offers improved aircraft design, enabling engineers to optimize designs that specifically benefit from additive manufacturing processes. Third, 3D printing increases production efficiency and improves supply chain lead times. The aviation and aerospace industry has unique demands about the 3D material used, which must be sturdy yet light and resilient yet strong. 3D printing is now used to manufacture almost all aircraft parts like engine, nozzles, cabin accessories, air ducts, engine suspension, dashboard bezels, brackets, etc. Stratasys, an industry leader in the 3D printing sector, has introduced a

thermoplastic filament called ULTEM™ 9085 Resin, which meets multiple aerospace industry standards for flame, smoke, and toxicity characteristics.

ADDITIVE MANUFACTURING 3D PRINTING

By Chandra Sekhar Mallik, 2nd Year

The latest industrial revolution, Industry 4.0, is encouraging the integration of intelligent production systems and advanced information technologies. Additive manufacturing (AM) is considered to be an essential ingredient in this new movement. In this paper, a comprehensive review on AM technologies is presented together with both its contributions to Industry 4.0. The review focusses on three important aspects of AM: recent advances on material science, process development, and enhancements on design consideration. The main objective of the paper is to classify the current knowledge (and technological trends) on AM and to highlight its potential uses.

INTRODUCTION

The fourth industrial revolution, namely Industry 4.0, is the recent movement on intelligent automation technology. In this new era, the utilization of modern manufacturing skills within the context of integrating novel information technologies plays an important role on economic competitiveness. As illustrated in Fig. 1, Industry 4.0 offers cyber and physical systems to cooperate profitably, aiming to build smart factories by redefining the role of humans. Its fundamental concepts associated with virtual environment comprise Internet of Things (IoT), Big Data, Cloud Computing etc., whereas its physical realm includes Autonomous Robots and Additive Manufacturing. With respect to the cyber-physical systems, IoT is described as the concept of gathering information from physical objects using computer networks or accelerated wireless connections. The extracted information from the products, machines, or production lines constitutes substantial amount of statistical data to be exchanged and analysed. Other sources of data are design records, customers' order, suppliers' delivery, stock and logistic related information. As a whole, this large quantity of data is defined as Big Data, which is another major notion in Industry 4.0. Moreover, cloud computing, which is related to the processing of all the available information, can also be

considered as one of the most significant terms in virtual industrial world. All of these cyber technologies help to ensure the effective utilization of existing information for smart manufacturing of future.

MATERIALS

By Kalivarupu Dinesh, 1st year

Material science key for understanding of developments in AM technologies. Researchers in this field have keen interest in new materials suitable for 3D printing applications. Although a large number of plastic/polymer constituents are available for AM, some specific materials attracts further attention of industry as illustrated in Fig. 2. In this section, the properties of prospective materials that are likely to be developed in the age of Industry 4.0 are to be discussed in detail and their potential uses are to be identified. I am planning to prepare my PHD to use in composite materials. In this section, novel AM processes are to be presented with a major focus on the ones related to MAM and hybrid manufacturing. Although the number of innovative AM processes is increasing substantially, they take their root from well-established fundamental technologies shown in Fig. 3. Probably, more enhanced processes will be developed with the technical advancements in AM. However, most of these processes are developed for printing customary materials like polymers, which are generally used for non-industrial applications. Due to the needs for heavy engineering applications in the context of Industry 4.0, specific AM processes have confronted recently. Since metals are the most commonly preferred material in the industry, the issue of MAM has received considerable attention in this new era. In addition to this, it is expected that the future of manufacturing will steer the industry towards the utilization of these processes in combination. Being known as hybrid manufacturing, this new popular field offers a way to practice subtractive methods accompanying with additive ones so as to fabricate better products with increased surface quality, fatigue strength etc. Nowadays, the growing interest in hybrid manufacturing leads to various manufacturing process combinations beyond the conventional AM processes. In this above study I have planned to do some mechanical test like tensile, surface roughness, hardness and others.

Conclusions

Cyber-physical integration facilitates smart factories with high efficiency that are capable of fabricating high quality customized products. On one side, the advancement of information technology has accelerated the transition to forthcoming industrial era. In fact, the existence of the fourth industrial revolution substantially depends on the capabilities of AM. These issues were summarized in three specific topics in this paper, namely material, processes and design issues. In the future, it is likely that more interdisciplinary research efforts should be expended. On the other hand, the role of designers, factories, and customers will be redefined remarkably since the manufacturing business will be distributed to many separate locations like small workplaces or homes. In other words, the current barrier of mass production on location will be overcome with personal- and customized fabrication. As a general outlook, there is a trend toward new materials available for AM such as smart materials and metallic constituents to achieve required characteristics on purpose. Another popular trend aims at creating functional parts/machines in just a single step of fabrication. Due to the opportunities provided by the novel AM technologies, the design- and production challenges are only restricted by the imaginations of the individuals.

THE ROLE OF NANO FLUIDS IN RENEWABLE ENERGY ENGINEERING

By **Kiran Kumar Naik, 1st year**

Nanofluids, a new class of advanced fluids engineered by dispersing nanoparticles (ranging from 1 to 100 nanometers) into base fluids like water or oil, are emerging as transformative agents in renewable energy engineering. Their unique thermal properties significantly enhance the efficiency and performance of various renewable energy systems, making them a focal point in the quest for sustainable energy solutions. In solar thermal systems, nanofluids offer considerable improvements in heat transfer efficiency. Traditional heat transfer fluids often suffer from limited thermal conductivity, which constrains the performance of solar collectors and heat exchangers. Nanofluids, with their superior thermal conductivity due to the high surface area-to-volume ratio of nanoparticles, enable more effective heat absorption and transfer. This can lead to increased efficiency in solar thermal collectors, enhancing the overall energy capture and conversion rates. In wind energy, nanofluids can improve the cooling systems of wind turbines. The efficiency of wind turbine generators can be significantly impacted by overheating, particularly in high power systems. Nanofluids, used in the cooling circuits of these generators, offer better thermal management, reducing the risk of overheating and improving the longevity and performance of the turbines. Enhanced cooling translates to more reliable and efficient energy production, which is crucial for maximizing the output of wind farms.

Additionally, nanofluids are making strides in geothermal energy applications. The enhanced thermal properties of nanofluids can be utilized in geothermal heat exchange systems to improve the efficiency of heat transfer between the geothermal wells and the surface systems. By improving the thermal conductivity and heat transfer rates, nanofluids can help in the efficient extraction and utilization of geothermal energy, making geothermal systems more competitive and effective. In the realm of energy storage, nanofluids are being explored for their potential in improving the performance of thermal energy storage systems. These systems, which are crucial for managing the intermittency of renewable energy sources, benefit from nanofluids' superior heat transfer properties. Enhanced thermal storage and transfer can lead to more efficient and reliable energy storage solutions, contributing to the stability and consistency of renewable energy supply. Despite their promising applications, the integration of nanofluids into renewable energy systems is not without challenges. Issues such as the stability of nanoparticle dispersion, potential environmental impacts, and the cost

of producing high-quality nanofluids need to be addressed. However, ongoing research and technological advancements are continually overcoming these barriers.

In summary, nanofluids represent a significant advancement in renewable energy engineering. By enhancing thermal management and efficiency across various systems from solar thermal collectors to wind turbine cooling and geothermal energy extraction they offer a pathway to more efficient and reliable renewable energy solutions. As research progresses and these challenges are met, nanofluids are poised to play a pivotal role in advancing the future of sustainable energy.