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Add-on lecture organized by the Department of Aeronautical and Aerospace Engineering

Report on the Add-On Lecture **"Aerospace Propulsion"**

Date of the event	29/04/2025
Title of the Event & Lecture	Add on lecture "Aerospace Propulsion"
Name of the Resource Speaker	Mr. Aditya Mishra, Sc F and Additional Director, propulsion directorate (CEMILAC), DRDO
No.of Participants	100
Venue	Seminar Hall 3

The Department of Aeronautical and Aerospace Engineering has organized an add-on lecture on **"Aerospace Propulsion"** on April 29, 2025. The event took place at Seminar Hall 3, starting at 01:30 PM. The speaker, Mr. Aditya Mishra, Sc F and Additional Director, Propulsion Directorate (CEMILAC), DRDO, has delivered the lecture. Students from various engineering departments have attended the event, making it an engaging and insightful session.

Dr. Niranjanappa introduces the chief guest

During the session, the speaker shared the contribution of various DRDO Labs in making our indigenous engine. The interactive session encouraged the students to ask questions and openly discuss challenges. The guest introduced the concept of aircraft power plants and their significance in the aerospace field. The speaker, an expert in the field of aerospace engineering, discussed the types of power plants used, their advantages, and applications.

The speaker began with an overview of power plants and advanced hybrid propulsion systems. The hybrid engines are revolutionizing aircraft power plants by combining traditional gas turbines with electric motors to enhance efficiency and reduce emissions. These systems can operate in series (where the gas turbine generates electricity for electric motors), parallel (where both the gas turbine and electric motor provide thrust), or turboelectric configurations (distributing power to multiple fans). While hybrid engines offer significant benefits, such as lower fuel consumption, reduced noise, and better performance across flight phases, they also face challenges, including battery weight limitations, thermal management issues, and integration complexity. Overcoming these hurdles requires advancements in energy storage, materials science, and control systems to make hybrid engines viable for commercial and military aviation.

Students attentively listen to the lecture.

Testing methods for advanced aircraft power plants:

Testing methods for advanced aircraft power plants involve a rigorous, multi-phase approach to ensure safety, reliability, and performance. Component-level testing first validates individual

elements like electric motors, batteries, and turbine modules under extreme conditions. Subsystem testing then examines integrated components, such as power electronics and thermal management systems, to verify seamless operation. Full-engine ground testing follows, using altitude simulation chambers and endurance trials to assess performance under realistic flight stresses. Finally, flight testing evaluates real-world operation, measuring thrust, efficiency, and compliance with aviation regulations. Advanced techniques like non-destructive testing (NDT) and real-time sensor monitoring further enhance defect detection and predictive maintenance. Together, these methods ensure hybrid and electric propulsion systems meet the stringent demands of modern aviation before certification and deployment.

Methods to improve reliability:

Ensuring high reliability in aircraft power plants requires a multi-faceted approach combining advanced engineering and smart maintenance strategies. Modern propulsion systems incorporate redundant critical components and fault-tolerant designs, allowing continued operation even if individual elements fail. The use of cutting-edge materials like ceramic matrix composites and thermal barrier coatings significantly enhances component durability under extreme operating conditions. Predictive maintenance systems powered by AI and machine learning analyze real-time sensor data to detect potential issues before they escalate, while digital twin technology enables virtual testing and performance optimization. Rigorous thermal management solutions, including advanced cooling techniques and phase-change materials, prevent overheating in high-stress components. Comprehensive testing protocols like accelerated life testing and failure mode analysis further validate system robustness before deployment. Together, these methods create a robust reliability framework that minimizes downtime, extends service life, and ensures safe operation throughout the power plant's lifecycle, meeting the stringent demands of modern aviation.

Digital Twin Methods for Aircraft Power Plants:

Digital twins—virtual replicas of physical engines—are transforming aircraft power plant development and maintenance. By integrating real-time sensor data with physics-based and AI-driven models, digital twins simulate engine behavior under various conditions, enabling performance optimization and predictive maintenance. Engineers can run virtual tests to identify potential issues before they occur, reducing costly physical trials. Airlines and manufacturers also use digital twins to monitor engine health in real time, scheduling maintenance only when needed. This technology not only cuts downtime and operational costs but also accelerates innovation in hybrid propulsion systems, paving the way for smarter, more efficient aviation.

Dr. Prabhu felicitating the Chief Guest, Mr. Aditya Mishra.

The add-on lecture on advanced propulsion concluded with a formal vote of thanks delivered by Dr. Sri Nithya Mahottamananda, who expressed sincere appreciation to the distinguished speaker for their insightful presentation on hybrid propulsion systems, AI-driven testing methodologies, and reliability enhancement techniques in modern aviation. He extended gratitude to faculty members for their academic support, recognized the enthusiastic participation of students and researchers, and acknowledged the organizing committee's efforts in successfully coordinating the event.

Dr. Mahottamananda highlighted how the lecture effectively bridged theoretical knowledge with practical applications in aerospace engineering, while also thanking the institution for providing the platform that fostered this valuable knowledge exchange, ultimately inspiring innovation in next-generation power plant technologies. The session was commended as a significant contribution to the field that would stimulate further research and development in sustainable propulsion systems.

Vote of Thanks by Dr. Sri Nithya Mahottamananda

Conclusion:

The add-on lecture provided a holistic overview of modern power plant technologies, emphasizing the transformative potential of hybrid-electric propulsion systems in aviation. It highlighted the critical importance of rigorous testing protocols, advanced reliability enhancement methods, and the integration of AI/ML for predictive maintenance and digital twin applications. The session underscored how the convergence of advanced materials science, intelligent monitoring systems, and sustainable engineering approaches is driving innovation in power plant development, ultimately paving the way for more efficient, reliable, and environmentally friendly aircraft propulsion systems that meet the evolving demands of the aviation industry.